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lates that this "dependency ratio"—the number of citizens under 25 and over 65 divided by the total population—is now roughly ten percentage points lower in the U.S. than in Japan, West Germany, and Britain. "That adds up to less drain, more gain, in the U.S. economy for the next 15 to 20 years," she says.

Most forecasters now reflect America's sparkling economic fundamentals in their long-range growth projections. Wharton Econometric Forecasting Associates, Data Resources Inc., and Chase Econometrics all predict that for the rest of the decade the U.S. economy will grow faster than the economies of West Germany, France, and Britain. The wizards of Wharton think America's average annual growth rate will be 57% higher than Western Europe's. Even the Japanese juggernaut is looking a little less fearsome. From 1960 to 1982, Japan's real gross domestic product grew at an annual average rate that was about double America's. Through 1989, Wharton projects that Japan's real GDP growth will average 3.8% a year vs. 3.3% for the U.S. Thus Japan will continue to gain on the U.S. but in a much more mincing manner.

Still, many U.S. businessmen and economic policy mongers remain deeply concerned that America is falling behind in manufacturing and high-technology markets critical to the economy's long-term health. Few feel threatened—for the moment—by Europe. Says Robert Hayes, co-author of a much noted 1980 *Harvard Business Review* article, "Managing Our Way to Economic Decline," and a professor at the Harvard Business School: "The U.S. has won the battle with Europe. I can't think of a single high-technology industry where we are concerned about Europe's leadership."

But to Hayes and anxious U.S. executives, taking comfort from outperforming Europe is like getting lathered about dominating the Olympics when the Soviet Union and East Germany stayed home. "It's like congratulating ourselves for finishing a race second to last," says Hewlett-Packard Chief Executive John Young, who spent the past two years chairing a presidential commission on industrial competitiveness. In their recent report to the White House, Young and his blue-ribbon panelists warned, "The U.S. is losing its ability to compete in world markets." They took special pains to note that "Japan and the newly industrializing nations of the Pacific Rim . . . now represent our major competitive arena." U.S. trade with these countries is already bigger than European trade, and if present trends continue it will be twice as big by 1995.

But such worries seem more than a little exaggerated. As much as 40% of last year's estimated $15-billion trade deficit in electronics with Japan reflects Japan's long-standing dominance in consumer electronics. The Japanese are coming on strong in particular markets, such as semiconductors, where they control 41% of the world market, up from 25% five years ago. They also have a technological edge in the commercial application of certain futuristic products, such as ceramics and gallium arsenide, a new semiconductor material far faster than silicon. But in a number of other so-called sunrise industries, the shadow cast by the land of the rising sun seems a little less threatening than it did five years ago. Says Irving Leveson, an economist with the Hudson Strategy Group, a conservative think tank: "While the Japanese are moving ahead in some areas they've targeted very heavily, we've been able to advance on a much broader front."

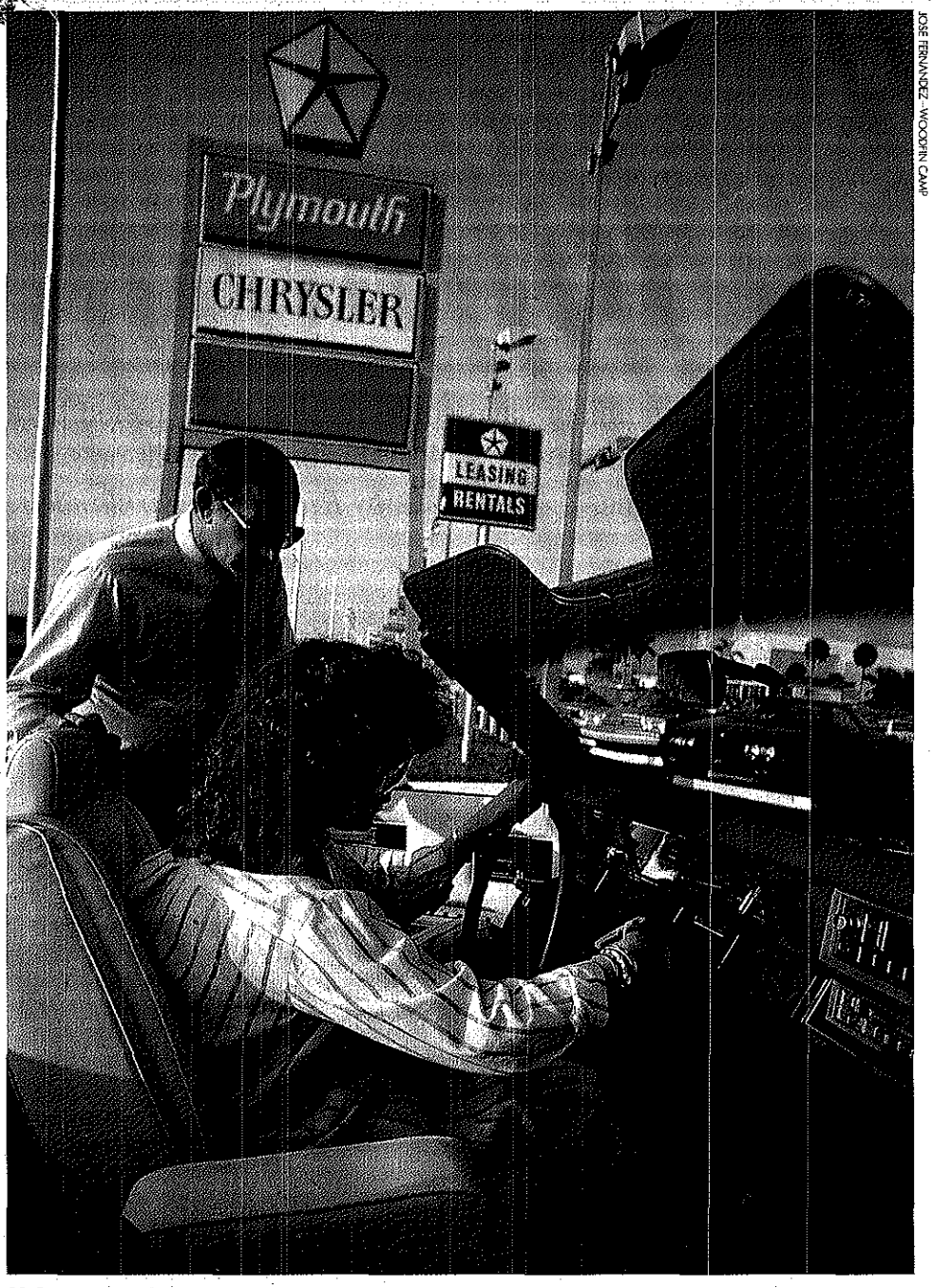
> "While the Japanese are moving ahead in some areas they've targeted very heavily, we've been able to advance on a much broader front."

U.S. computer makers are confident they can win the race to build the next generation of supercomputers, the voracious number crunchers that permit extraordinarily detailed mathematical modeling. Says John A. Rollwagen, chief executive of Cray Research, the dominant U.S. maker of supercomputers: "The Japanese goal is to make a computer 100 times more powerful than a Cray by 1990. We expect to do that well before then." With 55% of the world computer market—the same share it had five years ago—America shows little sign of losing dominance. Despite the rising dollar, U.S. computer exports have soared 83% since 1980 and climbed 30% last year. IBM's $6.5 billion in profits last year were about nine times Hitachi's, its principal Japanese competitor. Recently the hard-selling Japanese were chagrined to find the Chinese government turning to Wang Laboratories and IBM.

In fiber optics, AT&T and Corning Glass Works have kept pace with their leading Japanese rival, Sumitomo Electric Industries. The Asians' major inroads in telecommunications so far have been in consumer products—"schlocky phones from Taiwan and Korea," says one industry analyst. In the critical market for large digital switches, AT&T's toughest competitor has been Canada's Northern Telecom rather than a Japanese company. The world market share of U.S. pharmaceutical companies has remained steady at roughly 50%. Though their rate of new product introduction has begun to lag behind their Japanese and European rivals, they still have a big edge in research and development in biotechnology.

Even in industries where Japan has clearly gained the upper hand, all is not gloom and despair. U.S. automakers have used the protection offered by the now abandoned Japanese car quotas to get back on their feet. By slashing their production costs by 34%, they have at least blunted the Japanese charge. Some industry analysts believe General Motors' $5-billion Saturn Project, aimed at building a world-class small car by the end of the decade, holds out the promise of thrusting the U.S. back into the forefront of automotive design and manufacture. That project will also prove a boon to U.S. machine tool makers, who lost an additional 20% of their market to Japanese and European imports over the past five years. GM is seeking state-of-the-art production equipment, and Eli S. Lustgarten, an industry analyst with Paine-Webber, maintains, "The higher the machine tool technology, the stronger the U.S. position."

The strong U.S. dollar, which makes American exports dear and imports cheap, continues to batter the tradable goods sector of the U.S. economy, evoking ever stronger protectionist pressure. But the dollar's strength almost certainly is obscuring the fundamental improvement in the position of America's manufacturers, just as in the 1970s the dollar's weakness masked their steadily eroding competitiveness. Says William Niskanen, former chief economist of Ford Motor Co. and until March a member of President Reagan's Council of Economic Advisers: "Ford is much stronger today than it was in 1980 when it first began pressing for quotas, even though the dollar is much stronger against the yen. Whenever the dollar does weaken, American manufacturers are going to look good awfully fast." By contrast, Europe, far more dependent on trade than the U.S., would probably find a weaker



JOSE FERNANDEZ - WOODFIN CAMP

U.S. automakers *used the protection given them by the now abandoned Japanese quotas to get back on their feet. Sales are zooming at this Pompano Beach, Florida, Chrysler-Plymouth dealership.*

merely reflects the red ink of budget, trade, and current account deficits?

Certainly no small part of the reason the U.S. feels so good now is that it felt so lousy six years ago. Jimmy Carter was right in his so-called malaise speech in the summer of 1979 when he spoke of "a crisis of confidence" in America, though he didn't understand the extent to which his uncertain leadership was to blame. Polls at the time showed a majority of Americans expecting the next five years to be worse than the last five. Japan and West Germany, whose productivity growth had outpaced the U.S. for more than 20 years, seemed poised to seize the growth markets of the future. The dollar was so weak that OPEC's sheikhs openly debated taking payment for their oil in some other currency. The hostage situation in Iran made the U.S. feel it had truly become, in Richard Nixon's classic coinage, "a pitiful, helpless giant."

Worst of all, rapid money growth, exacerbated by the second oil price shock, triggered a terrifying bout of double-digit inflation that eroded consumer confidence and played havoc with business investment and planning. The best economic news in the U.S. over the past four years has been the dramatic two-thirds reduction in the inflation rate. Until it happened, few policymakers believed such a sharp decline in so short a time was possible.

But the U.S. hasn't simply ceased to shoot itself in the foot. "I'm more bullish today because the fundamentals are better now than they were five years ago," says William Ylvisaker, chairman of Gould Inc., an Illinois company that has transformed itself since 1980 from a supplier of auto parts and batteries to a maker of high-tech electronics, including minicomputers and factory automation equipment. One critical fundamental that has turned around is U.S. investment in research and development. After declining steadily since the late 1960s, R&D spending as a share of GNP began climbing in 1979 and now stands at 2.7% of GNP, probably the highest in the industrialized world.

PART OF THAT INCREASE reflects the Reagan Administration's military buildup, but business investment in R&D has also been growing at more than 6% a year in inflation-adjusted dollars since 1975, vs. 2% from 1970 to 1975. The cut in the capital gains tax in 1978 and again in 1981 has sparked an explosion in the U.S. venture capital market, which has soared by $10 billion since 1980. West Germany and Japan still spend more on civilian R&D as a percent of GNP (2.5% and 2.3%, respectively, vs. 1.8% for the U.S.). But playing the percentage game obscures the magnitude of the U.S. advantage. "You obviously get considerable economies of scale," says Rachel McCulloch, an economist at the Hoover Institution in Palo Alto, California. The $109 billion the U.S. will likely invest in R&D in 1985 is more than the investment of West Germany, Japan, and France combined.

U.S. capital spending has been booming, spurred by both the strength of the economy's recovery and the 1981 business tax cuts. Investment in plant and equipment is up 41% from the recession lows of two years ago. Robert Lawrence, an economist at the Brookings Institution, a Washington think tank, estimates that equipment spending, particularly for computers, has surged at twice the average rate of past recoveries. As a share of real gross domestic product, U.S.



steelmakers anywhere in the world.

PHOTOGRAPH BY PAUL CHESLEY

AMERICA ON TOP AGAIN

Confidence and optimism have come roaring back, fueled by a growth rate better than Japan's. And this boom is built on some solid new foundations. ■ *by Richard I. Kirkland Jr.*

THE U.S. IS FEELING on top of the world again. Poll after poll shows Americans brimming with a confidence in their country and a faith in their personal futures exceeding even the brief blip in optimism that greeted Jimmy Carter's election in 1976. A new outpouring of national pride, exemplified by the feverish exuberance with which America celebrated its athletic triumphs in the Los Angeles Olympics, seems to have finally washed away the self-doubt and defeatism left over from Vietnam and Watergate.

Americans certainly have plenty to cheer about. The strongest economic recovery since the Korean war has spawned more than seven million new jobs in two years. U.S. GNP growth since 1982 has left Europe's economies in the dust and even outstripped that perennial worldbeater Japan for two years running—the first time that has happened since scorekeeping began in the 1950s. After taking a severe battering in the 1970s, the dollar is once again almighty. Buoyed by the 85% rise in its value since 1980, Americans are rushing abroad in record numbers to spend a goodly chunk of their rising real incomes in the shops along Oxford Street and the restaurants near the Champs-Elysées.

U.S. allies have undergone a corresponding sea change in their view of America's economic vitality and role in the world. Denunciations of big U.S. budget deficits persist, but they are accompanied by acknowledgments among European policymakers that much can be learned from the so-called American miracle about how tax incentives and entrepreneurial activity can foster growth. The sharpest swing has come in France. Former French Prime Minister Raymond Barre maintains that the U.S. is once again becoming "the pole of stability and growth in the international economy" and is regaining its "predominance vs. the rest of the world." Many of his countrymen agree. Pollster Michel Brule of Paris-based BVA reports that in a recent survey 49% of Frenchmen said France's foreign policy should be staunchly pro-American rather than neutralist, up from 30% three years ago. Many Asians are similarly upbeat. Says a U.S. diplomat in the Far East, "I can't recall any time in the past five or six years when the U.S. has been so well regarded in Asia." In his State of the Union Address, President Reagan reveled in all this newfound popularity. "Our alliances are stronger than ever," he proclaimed. "Our economy is stronger than ever. We have resumed our historic role as a leader of the free world."

But a sizable body of informed skeptics at home and abroad wonder just how well-founded America's new optimism is, particularly the new sense of economic well-being. Says Tadashi Yamamoto, director of the Japan Center for International Exchange, an organization principally devoted to building good relations between Japan and the U.S.: "The situation doesn't merit euphoria. It's little better than the late 1970s." Is it really "morning again in America," as Reagan put it? Or is this a false dawn whose rosy color

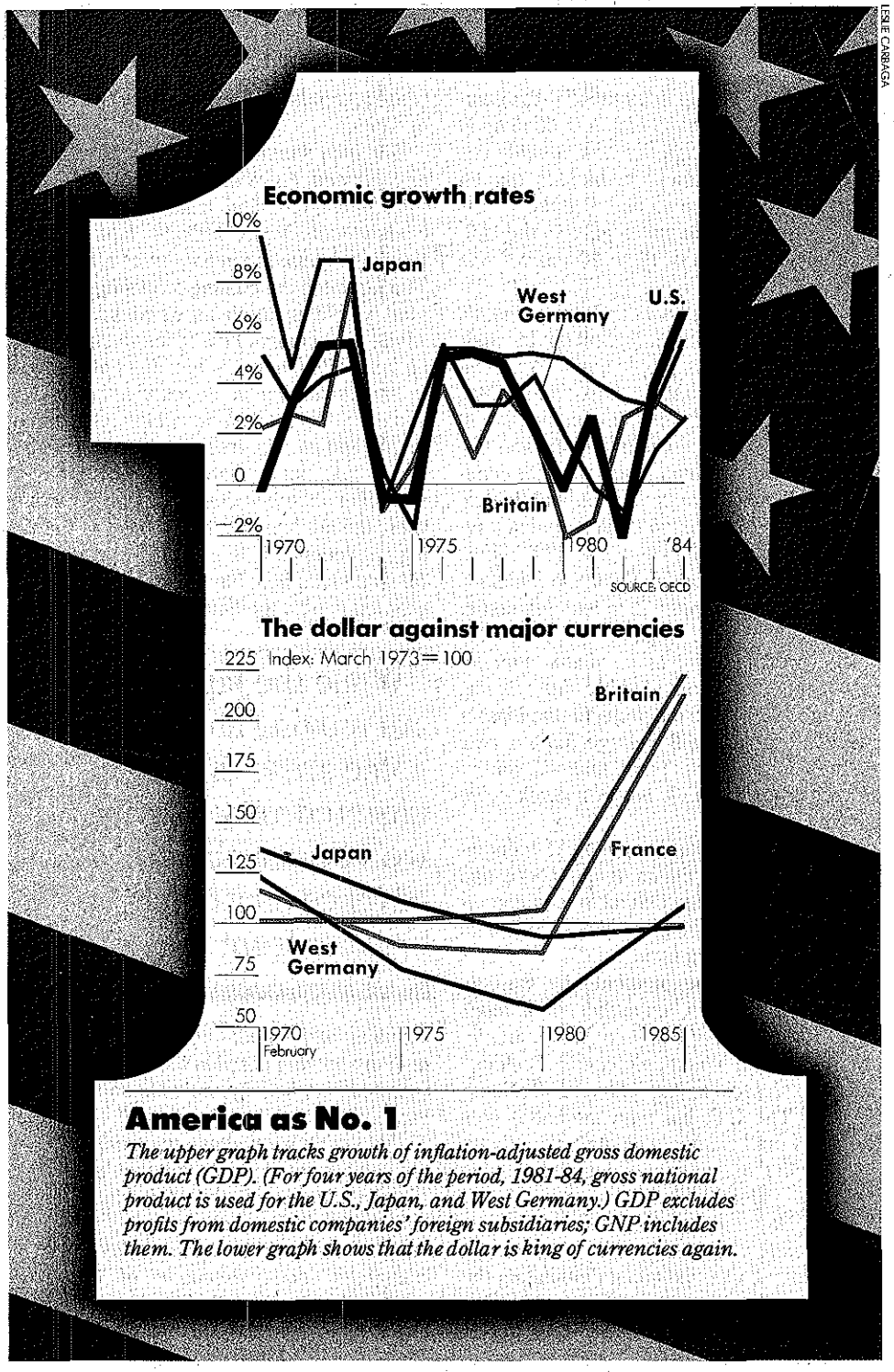
RESEARCH ASSOCIATE *Alison Bruce Rea*

business investment is now two percentage points higher than the average for the 1970s and has surpassed that of France and Germany, though it still trails Japan.

U.S. businesses are investing more in improving manufacturing technology as well as in product research—something management gurus have been urging them to do for years. Japan and West Germany still lead in this area. "But the U.S. is catching up," says Gerald Michael, a senior consultant at Arthur D. Little, the Cambridge, Massachusetts, consulting firm. "We've definitely turned around." Domestic sales of the fledgling U.S. robot industry jumped from $40 million in 1980 to about $400 million in 1984 and are expected to grow at 30% a year.

In large part because of this increased capital spending, most economists, including FORTUNE's, now believe the trend of productivity growth in the nonfarm business sector has shifted from the miserable 0.5% a year rate of 1973-1982 to at least the 1.5% to 2% range (FORTUNE, December 10). The double-whammy of disinflation and fierce import competition could encourage even higher U.S. productivity as American managers keep looking for ways to cut costs. Steven R. Malin, an economist with the Conference Board, a New York-based business research group, believes that the U.S. can enjoy 2.5%-a-year productivity growth for the rest of the decade. That rate would narrow, but not close, America's productivity growth gap with the hard-charging Japanese and pull the U.S. just about even with Western Europe's pace.

Another frequently overlooked cause for optimism about America's long-term economic outlook is the wave of deregulation that began under Jimmy Carter. "Transportation, telecommunications, and financial services are three critical parts of the economy's infrastructure," says Richard Blackhurst, chief economist with the Geneva-based General Agreement on Tariffs and Trade (GATT), the rule-making forum that governs world trade. "Their deregulation is bound to make the U.S. economy even more efficient and innovative."



America as No. 1

The upper graph tracks growth of inflation-adjusted gross domestic product (GDP). (For four years of the period, 1981-84, gross national product is used for the U.S., Japan, and West Germany.) GDP excludes profits from domestic companies' foreign subsidiaries; GNP includes them. The lower graph shows that the dollar is king of currencies again.

INTERNATIONAL COMPARISONS of service-sector productivity are almost nonexistent, but the U.S. is generally thought to have an edge. Deregulation can only sharpen it. So-called business services—public relations, temporary help, management consulting, and the like—make up the fastest-growing sector of the U.S. economy. Predicts Harald Malmgren, a Washington trade consultant: "The U.S. is going to just completely dominate the world services market."

Demography's iron hand will also weigh less heavily on the U.S. in the coming decade, even as it pushes down the economic growth of America's principal competitors. The baby boom in the U.S. peaked in 1957. The much smaller boomlets in Japan and Europe began and ended roughly a decade later. Those green, gawky 22-year-olds who were absorbed into the U.S. economy in the 1970s are now experienced workers in their late 20s to mid 30s and presumably a boon to productivity. By contrast America's allies now face what might be thought of as a yuppie gap. Not only must they find gainful jobs for their boomers—a particularly acute problem in Europe, where the average unemployment rate is 11%—they also have fewer workers in the productive 25- to 65-year age group to carry the social costs imposed by the very young and the very old. Deborah Olivier, president of Claremont Economics Institute, a California forecasting firm, calcu-

dollar distinctly depressing. Economist Alan Greenspan predicts that Europe's current complaints about the strong dollar will be "virtual cheeriness compared to how they're going to feel when the dollar declines."

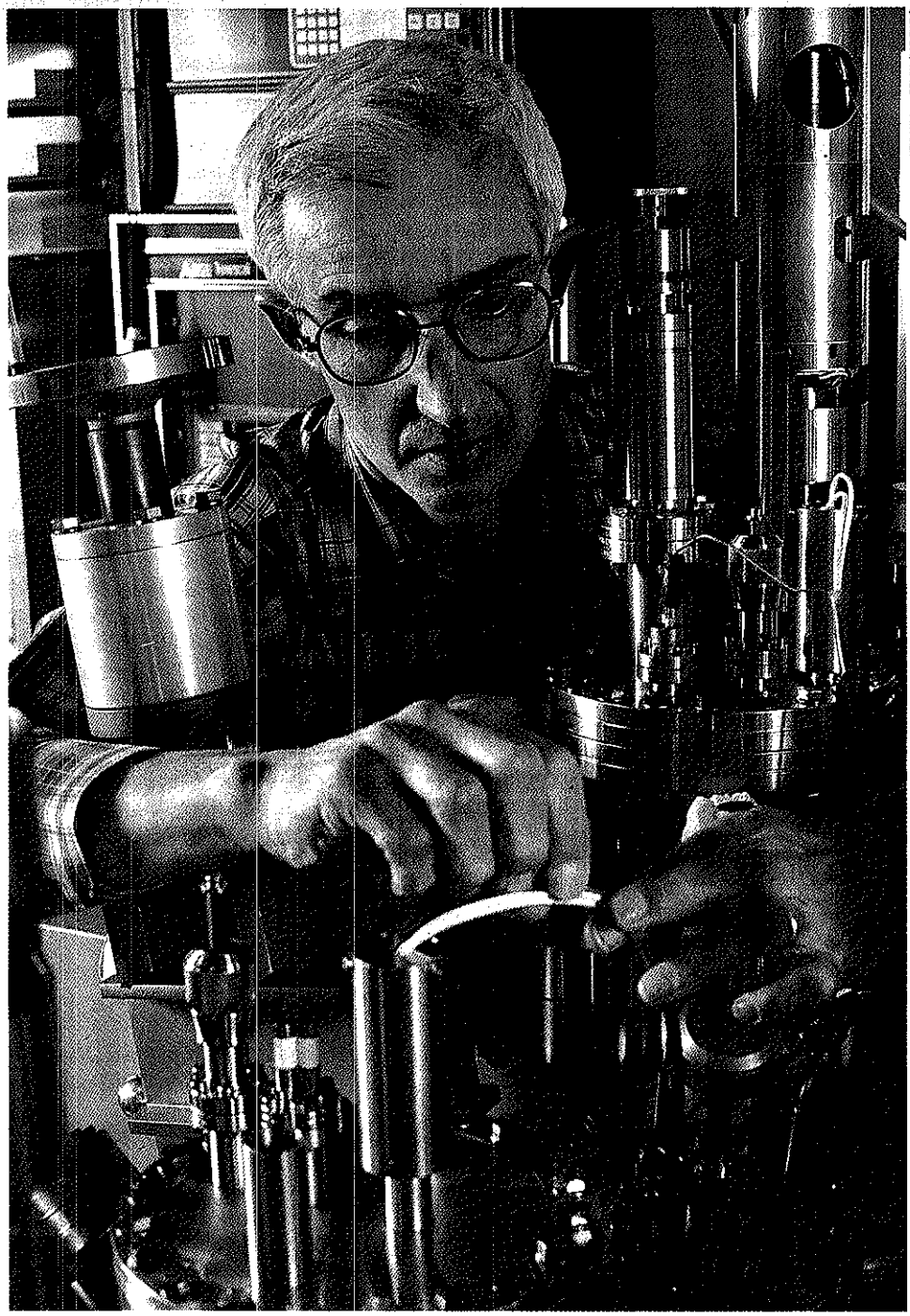
At the same time the dollar's stubborn strength clearly reflects the confidence the world's investors have in the American economy. Like many of his colleagues, Greenspan argues that the spread between U.S. real interest rates and lower rates offered abroad probably accounts for no more than one-third of the annual $100-billion inflow of capital into the U.S. "The most powerful factor attracting capital to the U.S. is that the prospect of earning profits is greater there than in the rest of the world," says Arthur Burns, the former Federal Reserve chairman who is retiring as ambassador to West Germany. This infusion of foreign savings, rather than a boom in the U.S. savings rate, has allowed the U.S. to run huge budget deficits without "crowding out" private investment.

How long can the U.S. count on its foreign capital fix? Conceivably for quite some time. Says Albert Wojnilower, managing director of the First Boston investment banking firm: "Inflows of $100 billion a year or more into an economy whose net assets are valued at some $12 trillion can persist for many years without becoming disturbing—so long as our political strength and economic growth outstrip the competition." From 1880 to 1900 the U.S. ran comparable trade deficits and capital surpluses—though they were measured in hundreds of millions rather than of billions. Those deficits eventually disappeared without a sharp drop in the value of the dollar as U.S. productivity rose and prices fell relative to its trading partners.

THE DARKEST CLOUD over America's economic future remains the political inability to get control over federal spending. Like a highly leveraged growth company, the U.S. economy depends on the confidence of its creditors. Lack of action to lower the deficit while the economy is perking along nicely raises the odds that a downturn could shake that confidence. A fall in the dollar, prompted by a stampede of foreign capital into other currencies, would boost inflation and force the Federal Reserve to raise interest rates to resist the dollar's decline. The sluggish growth that would ensue, in turn, would swell the budget deficit, send the interest bill on that debt spiraling, and increase the odds that policymakers would eventually feel compelled to reinflate the currency to pay off those debts.

On the other hand, as Alan Greenspan notes, taking up arms against the deficit, particularly through spending reductions, would probably lower long-term inflation expectations, interest rates, and the cost of capital. Says Greenspan, "If that happens, we could very easily vault the economy to an even higher growth path for quite a while."

What the U.S. is really celebrating, of course, isn't a return to economic preeminence—that's a position it never lost. As it has been since World War II, the U.S. remains the richest country in the industrial world, as measured by the per capita purchasing power of its citizens. Despite the stagflation-plagued 1970s, the absolute productivity of U.S. workers is still unsurpassed. Other countries will continue to narrow America's lead in these and other economic categories. But unlike five years ago, that lead no longer seems to be disappearing. While it may not be morning again in America, it no longer feels like dusk. Barring bad luck and bad management, as the late futurist Herman Kahn used to say, the U.S. seems poised to extend its day in the sun for a long time to come. F



GORDON/TRAUB—WAYFARER

Speedier silicon chips *are the goal of research at General Electric's R&D center in Schenectady, New York. The U.S. outspends Japan, Germany, and France combined on R&D.*

53. Lung disease patients with negative DTHR-T had: caseating granuloma (1), silicosis (3), tuberculosis with pleural effusion (1), intravascular angiogenic tumor (1), chronic bronchiectasis (5), chronic organizing interstitial pneumonitis (4), recurrent cyst (1), coccidioidomycosis (1), sarcoidosis (2), chronic obstructive pulmonary disease (8), chronic asthma emphysema, and pneumonitis (5), pneumonia (3).
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National R & D Policy: An Industrial Perspective

Roland W. Schmitt

Industrial policy has become one of the hot issues on our national agenda, with various advocates telling us how to beat the Japanese and solve the problems of unemployment, inflation, and industrial stagnation. The 1984 presidential candidates are picking up these ideas and testing them.

Industrial policy has many components—fiscal, monetary, and regulatory, for example. It touches on many areas, from international trade to retraining the work force. I can bring my expertise to only one corner of this many-sided subject: research and development policy. To me, industrial policy means what the government must do to shape our national industrial posture, and a clear understanding of what government should not do.

There has been no lack of proposals. Bills put before Congress in recent years have called for such changes as the establishment of a National Technology Foundation, or a Cabinet-level Department of Trade and Industry; the selection of a National Commission on Technological Innovation and Industrial Modernization to tell us "what the economic, educational, and industrial priorities of the United States ought to be"; a Presidential Program for the Advancement of Science and Technology; and a Commission on High Technology and Employment Potential. Another proposal would establish a government program to conduct research and development on improved manufacturing techniques; others would exempt joint research and development efforts from the antitrust laws.

All these proposals to aid U.S. R & D show a healthy and encouraging concern about the state of American industrial technology, but they may at the same time distract politicians and policy-makers from the most important need and the most important step that government can take to strengthen U.S. innovation. That task is to ensure and strengthen the health of our university system—in both the performance of basic research and the training of research manpower. The distraction is especially great if Washington pays too much attention to the growing number of calls for the government to take over the job of selecting and supporting R & D programs aimed at commercial results.

The author is senior vice president, Corporate Research and Development, General Electric Company, Schenectady, New York 12301. This article is adapted from his keynote speech at the National Conference on the Advancement of Research, San Antonio, Texas, 10 October 1983.

The Federal Role

In the commercial R & D area there are some things that government must and can do, and other things it cannot and should not do. Government has a crucial role to play in creating favorable conditions for commercial innovation, but not in actually producing those innovations. There are several reasons for this.

First, successful innovation requires a close and intimate coupling between the developers of a technology and the businesses that will bring products based on that technology to market and are themselves in touch with that market. This is essential in a diversified company, and even more essential in a complex and diversified economy. The R & D people must comprehend the strategies of the business as well as know what the market constraints are and what the competition is up to. The business people, in turn, must understand the capabilities and limitations of the technology. They must possess the technical strength to complete the development and believe strongly enough in the technology's potential to make the big investment needed to bring it to market.

Summary. An analysis of how the government can and cannot use research and development policy to improve the nation's industrial posture suggests four guidelines for federal R & D policy: (i) concentrate direct support on academically based research, not on government-targeted industrial R & D; (ii) concentrate on sunrise science and technology, not on sunrise industries and products; (iii) concentrate on strengthening the climate for privately based innovation, not on government-selected innovation; (iv) concentrate on development for the government's own needs, not on development for market needs.

Second, innovation works best if this close coupling is in place during the entire innovation process. It should exist when the R & D project is identified and should continue through planning and development. It must survive the inevitable adjustments during development, caused by shifting market constraints and technical surprises. It must withstand the decision points—when to go ahead or when to quit.

Finally, in a free-enterprise system, governments not only do not create the markets for products but are notoriously slow in reacting to shifts in the marketplace. They lack the crucial entrepreneurial spirit to perceive or acknowledge opportunities early in their development.

During the years of heavy government involvement in energy R & D, we used to hear over and over again the expressions "technology transfer," and "commercialization." Those terms embodied the notion that once a technology was developed by a government contractor or a national laboratory, the technology could then somehow be transferred to the marketplace and commercialized.

That did not happen for a simple reason. Technology transfer is not a separate process occurring downstream from R & D. The user and the performer of targeted R & D need to have established a close relation before there is anything to transfer.

In energy R & D, there were some who fell into the trap of thinking that if they got a concept defined, the technology to work, and someone to produce a favorable economic analysis, then commercialization would follow. They forgot to find out whether the customers would buy the product. The result was a misdirection of effort and money into technologies that never had a chance of commercial success.

Even in agriculture, where the United States has a great history of innovation, underlying research on corn genetics was performed at university research stations and largely supported by government. But private seed companies converted that research into hybrid corn products.

A close relation between the user and the performer of R & D cannot, in general, form when government selects commercial R & D targets. Instead, the government ends up being a third party—one that knows a great deal less about the technology than the developer and a great deal less about the market than the user.

As an example, there are proposals that the government fund R & D in manufacturing technology, in such application areas as programmable automation, robotics, advanced sensors, and computer-aided design and manufacturing. Part of this funding is to support R & D work to be done by industry.

These are key technologies for the future but, because they are so important, a large and growing number of companies are already addressing them. General Electric is investing millions of dollars in each of them. And, in each one, we are faced with a large number of tough competitors—foreign firms and U.S. firms, established firms and new ventures, joint ventures and industry-university cooperative programs. In just one corner of computer-aided design, for example, the field of solid modeling, we are competing against at least a dozen capable firms—established giants, smaller rivals, and newer ventures.

It is simply not plausible for an administrator in Washington—even with the help of a blue-ribbon advisory panel—to pick the winning solid-modeling product better than the dozen firms slugging it out in the marketplace. And even if government could pick the winner, that is only the first step. The suppliers of the funds, the performers of the R & D, and the businessmen who deal with the customers have to tie themselves together in a long-term relation. A government funding agency cannot create that kind of relationship.

There is, however, one important exception. It occurs when the government is the customer for innovation—as in defense R & D. Government should concentrate its development efforts on these needs of its own. If history is any guide, it will thereby also generate products and technology that can be tapped for commercial uses.

The government has clear needs in the area of supercomputers for weapons research, cryptanalysis, weather forecasting, economic modeling, the design of improved airfoils and projectiles, and many other uses. By meeting its needs in supercomputers, the government will also be sponsoring the development of a product that has many valuable civilian uses, such as improved oil exploration, better understanding of crack formation and propagation in alloys, new techniques in computer-aided engineering, and the design of new materials based on theoretical principles. The supercomputer is a prime example of a technology in which the government should take the lead.

In very large scale integrated circuits (VLSI) the government will also be a major customer and thus has a major role in sponsoring development work. One emerging opportunity is in the area of inference chips—VLSI implementations of intelligent electronic systems that work in real time, based on custom chips rather than computers. These inference chips could be used in military systems, for example, to help the pilot of an F-18 with an engine hit by shrapnel make the best use of the 3.6 seconds he has in which to decide whether he can limp home or should bail out.

Inference chips will also have great value in many commercial uses, such as in creating three-dimensional computer-aided design images in real time and in helping smart robots plan their paths. Again, by meeting its own development needs, the government may advance technology that can be used in commercial innovations. When the government is not the customer, government selection of developments is unlikely to promote such innovation and economic growth.

Competition from Japan

At this point, I would expect some people to be thinking about the Japanese. Did their government bureaucracy not pick the commercial technical winners and put money behind them? No, it did not. At the heart of that question is a misunderstanding about the Japanese government's Ministry of International Trade and Industry (MITI). The popular picture depicts MITI as selecting target industries, picking out the technological developments they need, establishing a consortium of Japanese firms, and supporting the commercial R & D needed

perspective, the Department of Energy's program expense for just one unproved, highly speculative energy technique, magnetically contained fusion, was $295 million in 1982 alone. We face the same problem in several other crucial areas of university research. This is particularly true of engineering research—fundamental research in such areas as software engineering, automation, machining systems, materials engineering, and computer-aided engineering techniques.

The crucial distinction again is between support of the underlying research (the job that the government should be doing) and support of efforts aimed directly at generating products (the job the government should stay away from). Some of the bills before Congress do not clearly make this distinction. Consider, for example, the calls for government support of R & D in manufacturing technology. If a program for conducting the underlying research at universities is to be established, I will support it wholeheartedly. But when programs to produce more efficient manufacturing technologies are proposed, I worry that someone has ignored the difference between broadly relevant research and the job of selecting specific technology targets for new products and processes. And when anyone proposes conducting research utilization activities to encourage widespread adoption of these technologies, then I have serious reservations.

In the technology of controls, for example, fundamental theoretical advances are needed to catch up with the speed and power of microelectronics. Such work should be strongly supported at universities. But the job of putting research to work in, say, robots or machine tool controls for commercial markets should be addressed by private companies.

Some may be concerned that with so much emphasis on support of academic research in fast-moving areas, such as microelectronics and computer science, the needs of core industries, such as automobiles and steel, will be neglected. That is not so. The increases in efficiency needed by these industries will be provided much more by some of these fast-moving areas than by advances in the core technologies. These industries, too, are dependent on strong university research in the fast-moving areas. Moreover, these industries suffer from a lack of investment in already available technology. Giving them new technology without the corresponding investment to use that technology is hardly likely to improve their plight.

Immigration Policy

Another policy issue that strikes at the heart of our universities, yet is rarely discussed in the context of R & D policy, is immigration policy. In 1982 as many foreign students received engineering Ph.D.'s in our universities as did American students. Some regard these foreign students as a problem, and there even have been proposals to reduce their numbers. But the real problem is that not enough Americans are entering doctoral programs. The solution is to encourage more of our students, through adequately supported graduate fellowships, to go on to graduate studies. What is clearly not a solution is to force foreign students to leave. They are an important resource for our country. They account for a disproportionately large portion of our skilled manpower in the fast-moving areas of science and technology. They are not taking jobs away from Americans. They are filling a void and advancing U.S. science and technology. Historically the United States has benefited immeasurably from opening our doors to immigrant scientists and engineers. I need only mention such greats as Steinmetz, Alexanderson, and Giaever at General Electric; Tesla, Zworykin, and Ipatieff at other companies; and Fermi, Debye, Mark, and many others at American universities. Yet current laws create obstacles for foreign scientists who seek employment here. If we are truly concerned about enhancing U.S. industry's capability to do R & D, we should ease the regulatory barriers to hiring foreign-born students, especially those trained in this country. Proposed amendments to the Simpson-Mazzoli immigration bill now before Congress would do exactly that. Unfortunately, for reasons that have nothing at all to do with science and technology, that bill is now stalled in the House. The critical role that foreign scientists play in the United States must be addressed directly, rather than as an afterthought to a bill intended to deal with the problem of illegal, and largely unskilled, aliens.

Technology Leaks

A related national issue also directly affects the health of our universities: the problem of leakage of technology to the Soviet Union. In an attempt to stop that leakage, the Department of Defense and the Department of Commerce proposed regulations that would prevent foreign nationals from taking part in advanced microelectronics research in universities and industry. This is intended as just a first step. In the long run, the two departments are proposing to impose the same restrictions on virtually all fast-moving areas of advanced technology considered to be militarily critical.

There is no question that we must do a better job of preventing the Soviets from acquiring our technology, but such regulations are overkill. The Defense and Commerce Departments propose to change the export control regulations in ways that would seriously disrupt the nature of scientific discourse in U.S. universities and industrial R & D laboratories. No doubt some technology does leak to the Soviets in the course of our open scientific discourse. But by the Administration's own account, this is a very small part of the problem. It is counterproductive to impose such major restrictions on U.S. science and technology for such a small part of the problem. Again, foreign scientists play a critical role in most of our important areas of science and technology. Deny them access to these areas of research and we will do far more to damage our technological capabilities than any of the proposals being made in the name of industrial policy will do to help.

Conclusion

National R & D policy today poses both risks and opportunities. The excitement and attention that proposals for industrial R & D policy have generated threaten to distract us from the federal government's most important tasks. We need to go back to the basics. We need to remind ourselves of what it is that the government can and cannot do, and what it is that industry can and cannot do.

In summary, I want to suggest four specific guidelines for federal R & D policy: (i) concentrate direct support on academically based research, not on government-targeted industrial R & D; (ii) concentrate on sunrise science and technology, not on sunrise industries and products; (iii) concentrate on strengthening the climate for privately based innovation, not on government-selected innovation; (iv) concentrate on development for the government's own needs, not on development for market needs. I believe that these simple guidelines—many of which we have followed with success in the past, some of which we have violated with pain—will go a long way toward greatly strengthening and rejuvenating the dynamic innovative powers of our American system of research and development.

Boom Time for British Biotechnology?

Venture capital is now flowing into small companies and the government is encouraging the commercialization of university research it funds

London. After a relatively slow start in the late 1970's, Britian's biotechnology industry is beginning to pick up speed. Government officials, academics and industrialists all claim that a recent report from the U.S. Office of Technology Assessment (OTA) was excessively pessimistic in its claim that Britain lacks the "dynamism" to produce serious competitors to American companies. They also contest the OTA's conclusion that Britain ranks second behind West Germany among European nations.

"I think that conclusion is completely wrong, particularly if you take the combination of the science and its applications into account" says Gerard Fairtlough, chief executive of Britain's principal biotechnology company, Celltech, which is currently riding a crest of investor enthusiasm.

British industry has benefited from various forms of direct government support for biotechnology. Many smaller companies, for example, have made good use of consultancy grants and other special funds offered as part of a $24-million biotechnology package launched by the Department of Trade and Industry in November 1982. Other industrial initiatives in fields such as fermentation technology have been successfully catalyzed by the Biotechnology Directorate of the Science and Engineering Research Council (SERC).

According to Robin Nicholson, chief scientific adviser in Prime Minister Margaret Thatcher's Cabinet Office, broader political changes must also share the credit. "The policy of the government since 1979 has been to free restrictions and to remove barriers to enterprise," says Nicholson. "The relatively healthy state of biotechnology in the U.K. seems partly to reflect the success of those policies."

He picks out, for example, efforts to encourage Britain's venture capital market—now considered the second largest in the world after the United States—through developments such as the Business Expansion Scheme, which allows individuals to write off against tax an investment of up to $60,000 in a small company, provided the money is left in for up to 5 years.

"The Business Expansion Scheme was the first real fiscal change in small company funding for 50 years" says Peter A. Laing of Biotechnology Investments Limited (BIL), a venture capital fund set up by merchant bank N. M. Rothschild in 1981 and chaired by a previous top government science adviser, Lord Rothschild. BIL is said to be the largest biotechnology-oriented venture capital fund in the world. Partly due to this recent flow of venture capital, Britain now has more small biotechnology companies than any of its European competitors.

The government's willingness to let the commercial and industrial communities act as the senior partner in its efforts to boost biotechnology research and development has played a large part in both the establishment and subsequent operation of Celltech. The company was set up in 1980 primarily at the initiative of the National Enterprise Board, a government body recently amalgamated into the British Technology Group. Although initially providing 44 percent of Celltech's start-up capital, with the four remaining stakes of 14 percent each divided between a group of financial and industrial institutions, the government always intended to hand over its share to private enterprise. It moved in this direction last year when Rothschilds' venture capital company—previously criticized for not investing its funds in any British biotechnology company—bought out a proportion of the government's stock and gained with it a seat on the board of the company.



Gerard Fairtlough

Celltech chief says OTA misjudged Britain.

Like similar companies in the United States, Celltech has actively sought collaboration with larger companies with broader industrial interests or special marketing skills. A joint venture was launched last year with Britain's largest pharmacy chain, Boots, for example, to develop the application of monoclonal antibodies to new diagnostic products. And a technology licensing agreement has been signed with the Japanese company Sankyo to develop tissue plasminogen activator and calcitonin.

Fairtlough says that Celltech, with a current research staff of about 120 scientists and technicians, does not at present share the ambitions of companies such as Genentech to grow into a major corporation. However, with a number of clearly defined product lines, each in a potentially large market, "We could be talking about a turnover of hundreds of millions of dollars in a few years."

Celltech is already earning profits from a reagent for the purification of interferon and has recently created a Culture Products Division which, based on techniques developed with direct government funding, already claims to be the world leader in the in vitro bulk production of monoclonal antibodies.

One reason for Celltech's early success is a unique—and in some quarters highly controversial—agreement with Britain's Medical Research Council (MRC), under which the company was initially given first option on the rights to all results produced in the fields of genetic engineering and monoclonal antibodies in the council's laboratories. These include the prestigious Laboratory of Molecular Biology in Cambridge.

This arrangement was approved by the Conservative government over the opposition of officials in the Treasury, who felt it wrong that one company should be granted exclusive access to what was considered public property. One factor in the decision, it is widely rumored, was the failure in the late 1970's to take out a patent on the technique for producing monoclonal antibodies, which was first developed in the MRC's Cambridge laboratory. Giving Celltech exclusive rights to MRC's work might avoid such lapses in the future.

When Celltech started to register its

first commercial successes, criticism of its deal with the MRC shifted from the political to the industrial community. Both large and small companies complained at being locked out of access to MRC's research. "The academic excellence in places like the MRC should be treated as a national resource and the government should be providing even-handed access to it," says Chris Keightley, managing director of one of the newest and most active small biotechnology companies on the British scene, IO (Bio) Ltd. in Cambridge.

The main product of Keightley's company, set up in 1981 by Acorn Computers and recently recipient of a $1.2-million investment from Rothschild's BIL, is a technique for improving the sensitivity of enzyme-based diagnostic tests. It is based on the research of a scientist whose work was not supported by the MRC, Colin Self of Cambridge University's biochemistry department.

Given the growing pressure to encourage similar initiatives, the MRC has recently renegotiated its licensing arrangements with Celltech. The company will retain first option to developments in fields in which it has already started to develop products. In other fields, however, it will now have to become a competitive bidder, for the MRC is setting up an industrial liaison office to distribute licenses more widely among companies interested in turning its research into commercial products.

The new arrangements have met with general approval in both the industrial and academic worlds. Sydney Brenner, director of the MRC's laboratory in Cambridge, says that at the beginning "there is no doubt that in terms of goodwill, the MRC connection was a major asset to Celltech."

Since then, however, the laboratory has been receiving an increasing number of direct approaches from industry. "In the past, we have had to tell them to go away, since the first options on research in the defined fields had to be offered to Celltech. Now we no longer have to do so."

Brenner and other British scientists point out that there are several differences between the United Kingdom and the United States in the factors affecting the growth of links between the academic biomedical research community and the private sector.

One is a greater reluctance on the part of British academics to get involved in the process of transferring research results from the laboratory, a tradition which is admittedly changing as cuts in government support for the universities as well as general, increase the pressure for university scientists—and universities in general—to look elsewhere for financial support.

A second factor until now has been the tax structure, which has made it more difficult to offer stock options to employees in small companies with initially low turnovers (or profits). The budget proposed in mid-March brings British policy in this area more in line with that in the United States, however.

On the other side of the coin has been a greater willingness to combine public

Pressure for Patent Reform

Cambridge, England. British scientists contend that differences in patent laws between Europe and the United States give U.S. companies a potential advantage in the commercialization of biotechnology. Under European patent laws, a scientific discovery cannot be patented once it has been published in the open literature or even referred to in public debate. In contrast, up to 1 year is allowed after publication for a patent application to be filed in the United States.

"I believe that the greatest inhibitory influence on a closer working relationship between academic and industrial scientists, and the greatest management problem for people like me, comes from this business of prior disclosure," says Sydney Brenner, director of the U.K. Medical Research Council's Laboratory of Molecular Biology in Cambridge, England.

There has long been an awareness of this discrepancy, particularly among patent officers on both sides of the Atlantic, but until now no serious pressure for change. Large corporations, in particular, often welcome being able to scan the scientific literature for new (and unpatented) ideas while employing patent attorneys to keep a close watch on the proposed publications of their own scientists. They tend to argue that they find little wrong with the current system. Robin Nicholson, chief scientific adviser to the British Cabinet, claims that "no one brought the issue to our attention" when his office was preparing a recently published set of recommendations for changes in the British patent law, and expresses some doubt over whether change is really necessary.

Among smaller companies, however, the situation is seen differently. "In this field, the 1-year grace period after publication gives the Americans a considerable competitive advantage" says Gerard Fairtlough, chief executive of Celltech. "I feel that Europe should have the same system."

Although admitting that biotechnology patents can frequently be successfully challenged by sufficiently motivated competitors, such companies also argue that patent rights are seen as crucial assets by potential investors.

Brenner also argues that it would ease the management problem in basic research laboratories such as his—as well as taking some of the pressure off individual scientists—by removing the immediate conflict between the professional demands for fast publication and the commercial demands of patent application. "Patents could be the currency of the interaction between research scientists and industry" says Brenner. "At the moment they are just a burden."

Change will not come easily. Friedrich-Karl Beier, director of the Max-Planck-Institute for Foreign and International Patent Law in Munich, and long a campaigner in favor of a 6-month grace period in Europe to bring it more in line with the United States, points out that this would now require an internationally agreed change in the European Patent Convention. "To do this, it will mean finding sufficient support within the whole European community," says Beier. However, he has already convinced the International Association for the Protection of Intellectual Property to endorse the idea, and suggests that there may be a general move in this direction "within the next 2 or 3 years."

Some British government officials point out that a grace period would help avoid situations—such as that which occurred with monoclonal antibodies in the mid-1970's—where the commercial potential of a discovery is only realized after it has been published, and when it can no longer, under the present system, be patented in the United Kingdom.—**D.D.**

The business environment ahead... and how to handle it

D. Bruce Merrifield

The decade of the 1980s will almost certainly be a major watershed period in which many well-known companies will disappear or be restructured, and other new companies will emerge as industrial leaders. Moreover, the growth, and in many cases, survival of many U.S. businesses in the 1980s will be primarily determined by two interacting factors. One of these is economic and the other involves technology. The economic factor relates to an adverse synergism between former U.S. tax laws and chronically high rates of inflation, which together are causing many American companies to liquidate their fixed assets, often without conscious awareness that they are doing so.

The technology-related factor arises from a worldwide explosion in the sciences that has generated in the last 30 years some 90% of the current knowledge in physics, chemistry, engineering, and the biological sciences. As a direct result, much of the capital now invested in this country is invested in obsolete products and processes. It is important to understand both the risks and unparalleled opportunities that are associated with these two factors, and the manner in which they affect the marketing function.

For example, inflation must be seen as a direct tax on fixed assets, and a simplistic equation for "real retained earnings" illustrates the relationship:

[Return on equity (ROE)]	−	[Dividends paid out]	−	[Rate of inflation]	=	[Real retained earnings]
15%	−	7%*	−	10%	=	−2%

(* Represents the average payout for U.S. companies.)

The equation shows that a company reporting a solid 15% return on equity is actually eroding its assets in "real" terms when inflation is running at 10% per year, and when it is paying out 40–50% of its earnings in dividends and has minimal debt (2/1 equity to debt ratio). Many capital intensive businesses (steel, automobiles, tires, textiles, etc.) don't report even a 15% ROE and are liquidating their assets at 5–15% per year.

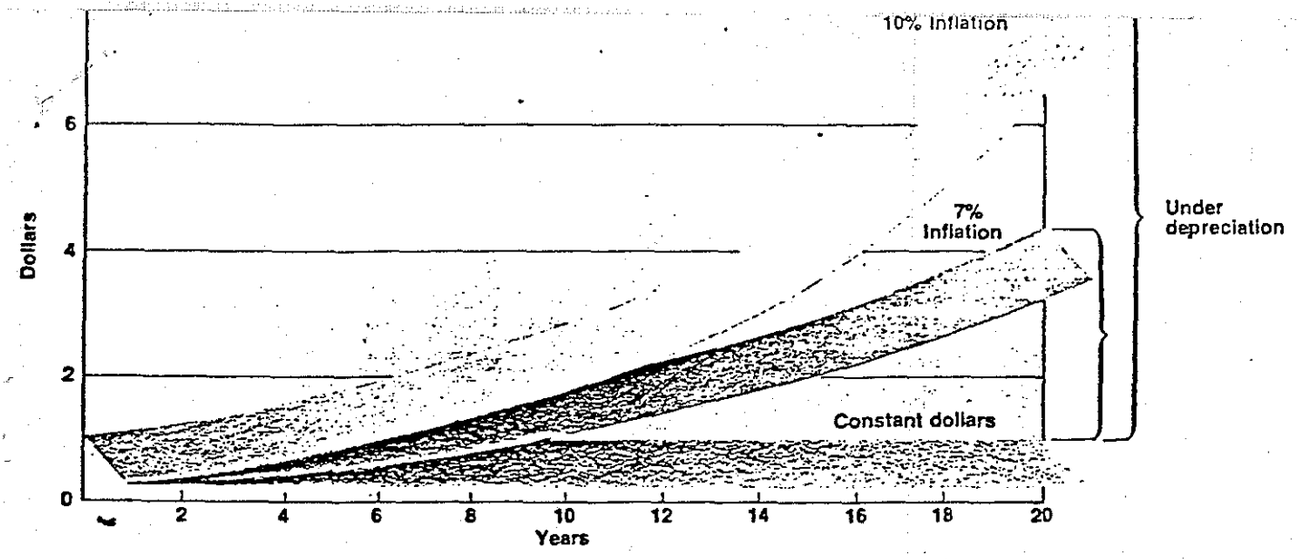
In principle, a company can reduce its dividend payout and/or leverage its assets (1/1 equity to debt ratio), but these strategies impact the market price and increase vulnerability to takeover. The net effect, therefore, is that tax laws that do not adjust for inflation provide rates of depreciation insufficient to reproduce the original assets at the end of their "useful life." Compounding the problem is that new technology is making assets obsolete long before their "useful life" is realized. The adverse synergism of these factors (inflation, tax laws, new technology) will likely lead to the demise of many well-known companies.

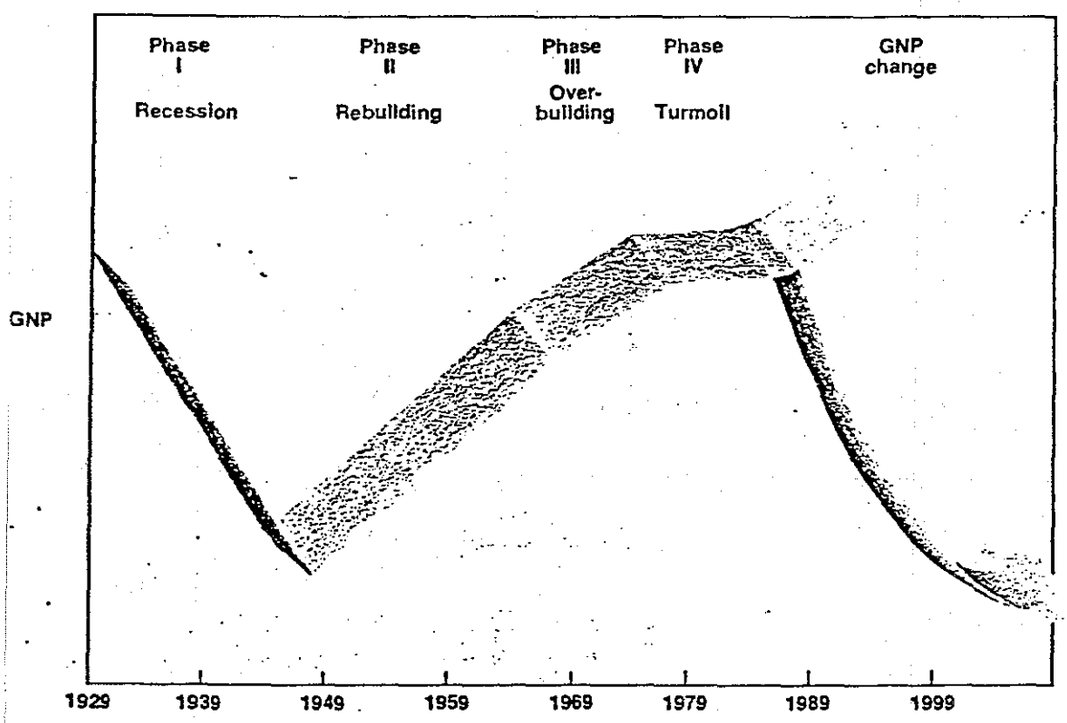
Let me illustrate the impact of inflation on depreciating assets by the following examples: $10 million investment in a manufacturing plant with a "useful life" of 20 years could (according to former tax laws) be recovered in depreciation allowances over that period. But at 10% inflation, the same plant would cost $80 million to replace. Moreover, the $70 million difference would not have been reserved. Instead the difference has been appearing on the balance sheet as false profits on which 46% taxes and 40–50% dividends will have been paid out. The new tax laws allowing more rapid rates of depreciation will somewhat mitigate the effects of inflation, but they only apply to new facilities now being built (Figure 1).

Therefore, the adverse political–economic climate that now exists for fixed-asset intensive operations has created a new set of business guidelines that can be summarized as follows: Given a policy of 2/1 equity to debt ratio and 40–50% dividend payout, any operation that has more than 60–70¢ of depreciating assets per dollar of sales cannot produce real retained earnings in a period averaging 10% inflation, and should be harvested or divested. The resulting cash flow should be allocated to either those types of businesses with appreciating assets and/or are "indexed to inflation" such as oil and gas, timber, land, financial and other services, distribution, etc.; or to low capital-intensive, high-growth, strongly proprietary (patented) products or processes with a high asset/turnover ratio.



D. Bruce Merrifield, Assistant Commerce Secretary-Designate for Technology, Productivity, and Innovation, is former vice president of technology and venture management for The Continental Group (1 Harbor Place, Stamford, Conn. 06902). He brings to this position extensive experience in research, research management, and new venture management. Merrifield, who is a Princeton graduate and holds M.S. and Ph.D. degrees in physical chemistry from the University of Chicago, is a former director and currently president-elect of the I.R.I.





These options, however, may be unattractive for an established company since they necessitate radical changes in operating strategy. The anxiety involved in entering an unfamiliar business is multiplied by the reluctance to concede that the existing business may not survive, let alone grow. Good acquisitions carry a heavy premium in good will, and internally generated new ventures have had some notable failures. The dilemma is real.

There may be a logical explanation for this dilemma. In the early 1920s, Kondratieff first identified a 50-year recession–boom cycle, or "long wave," which at that time had persisted for 150 years and which seemed to characterize the capitalist economies. However, there was no apparent theoretical basis for these observations, and he was banished to a Siberian salt mine, since his predictions of periodic capitalist resurgence as well as collapse were not politically acceptable at the time.

Recently the M.I.T. economist J. Forrester rediscovered the same cycle. His data base comes from a "System-Dynamics National Model" built up in some detail from 15 major industrial sectors. Forrester identifies four phases in the 50-year cycle. The first is a 15-year recession period; the second is a 20-year massive reinvestment period; the third is a 10-year continued "over-building" period, and the fourth is a 5–10 year period of economic turbulence leading into the next recession (Figure 2).

This time it's different

However, it appears unlikely that a 1929-like depression will now or ever again recur. Although many well-known companies may not survive in their present form, we are seeing the emergence of new companies in new technologies at a rate that has never before occurred. Going back to 1929, the beginning of Phase I of the last Kondratieff–Forrester cycle, the economy was characterized by zero or negative GNP growth, high rates of inflation (10% per year), a low

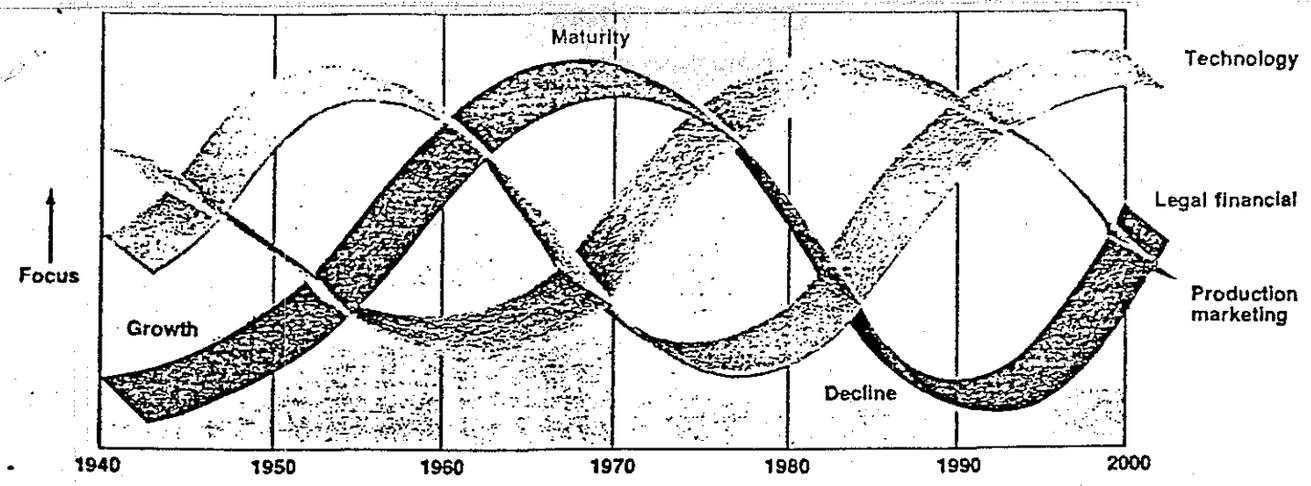


Figure 3. Management focus

return on investment (ROI) in capital intensive sectors, declining profits, increased debt, tightening credit, declining capital investments, high interest rates, and perhaps most importantly, over-capacity relative to worldwide demand. Moreover, the focus of management was no longer on production and marketing, but primarily on legal and financial aspects of business; and R&D budgets were both declining in constant dollars and were focused more tightly on short-term product optimization. Major new innovations tended to be discouraged or rejected. Management tended to be anxious and conservative. Plant facilities and equipment tended to have reached the limit of productivity for that state of the art, and justified little additional investment. The marketing function reflected these changes in decreasing budgets and diminished creativity (Figure 3). (This is a familiar syndrome some 50 years later.)

As the cumulative effects of over-capacity, cutbacks in investment, and conservative short-term focus management were felt, the world economies slid into depression. But a pool of underused new technology that had been accumulating for 30 years was now available to fuel a massive reinvestment in the capital sector. Management again looked to innovation, production, and marketing as the new technology resulted in much higher productivity and therefore decreasing inflation. The momentum of this second phase of the Kondratieff cycle continued beyond the point where demand and supply were again in balance (1965) to again produce a worldwide over-capacity in the basic industries. Moreover, these maturing technologies could no longer generate increased productivity to match rising costs, and inflation resumed. We are now in the final stage of the cycle with recession cycles deepening as many fixed asset intensive companies erode their assets in real terms.

The key factor in their self-liquidation is this inability to further increase productivity in obsolete facilities. The open-hearth furnace can no longer compete with the basic oxygen furnace, let alone with the new Swedish plasma technology. Even more significant is the fact that soon graphite-reinforced plastics that are stronger than steel, lighter than aluminum, and do not corrode or suffer stress fatigue, will further erode the metal markets. In fact, we can expect the new "engineering plastics" to progressively capture specialty markets that now use steel, aluminum, zinc, and copper, as an explosion in materials sciences provides an increasing array of cost/performance superior

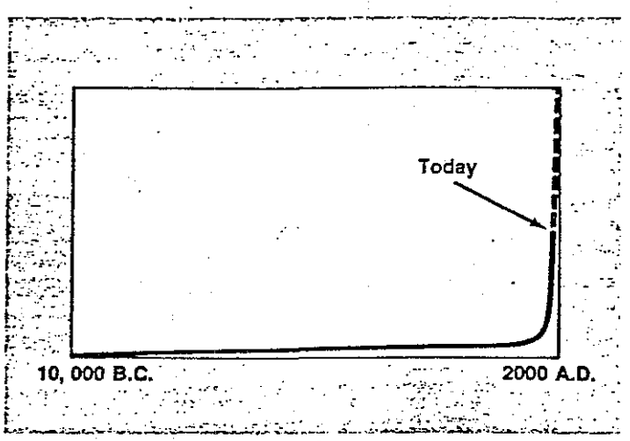


Figure 4. Technology explosion

options for many applications (Figure 4).

Similar revolutions are occurring in almost all areas of business. Another 30-year pool of underused technology has now accumulated that represents 90% of all knowledge ever developed in the sciences. This enormous pool of technology can be expected to spawn continually a proliferating array of new businesses that will be the IBM and Xerox of the next decade. For example, current work in biochemistry will see significant intervention into the learning process, memory, and the treatment of mental disease, as well as major progress in cure of viral diseases, including cancer. The life span will likely be extended many years, and genetic defects (diabetes, sickle cell anemia, certain forms of mental retardation) will progressively become correctable through genetic manipulations.

Electronics will tie the world together in "real time" through satellite and fiber optic communication systems, bringing electronic mail into our living rooms within a few years. Instant access to the Library of Congress and to other world data banks will become commonplace, producing an enormous growth in life-long continuing adult education, and introducing new dimensions to the marketing function for all businesses. Computer-aided design and optimal analysis theory will telescope engineering development time frames and further accelerate the demise of older facilities.

Equivalent revolutions are occurring in the area of energy and energy systems, the materials sciences, specialty chemicals, food sciences, packaging, and financial services.

These businesses will not only be high in growth rate, but will tend to be low in capital intensity and therefore much less vulnerable to inflation. Strong proprietary character will make them much more profitable because of their high asset/turnover ratios. Moreover, they will cause a progressive fragmentation of large market areas into many niche or specialty markets, each served by continually changing new products or processes.

The management of the future, therefore, is the management of change. Technology is the engine, and strategic planning is the guidance system. Marketing must function both as eyes and ears as well as in delivery. A disciplined process of selection from among this proliferating array of continually changing opportunities will become an increasingly important function.

A simplistic logic tree for doing this can be described in a three-step regime (Figure 5). Each of the questions has an expanded check list of critical factors designed to assess the probability of *commercial* success, once technical success can be demonstrated.

This "constraint analysis" has correlated with success in

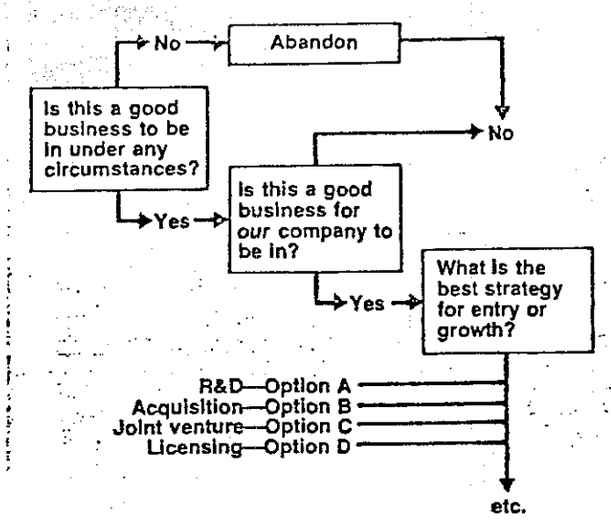


Figure 5. Strategic planning

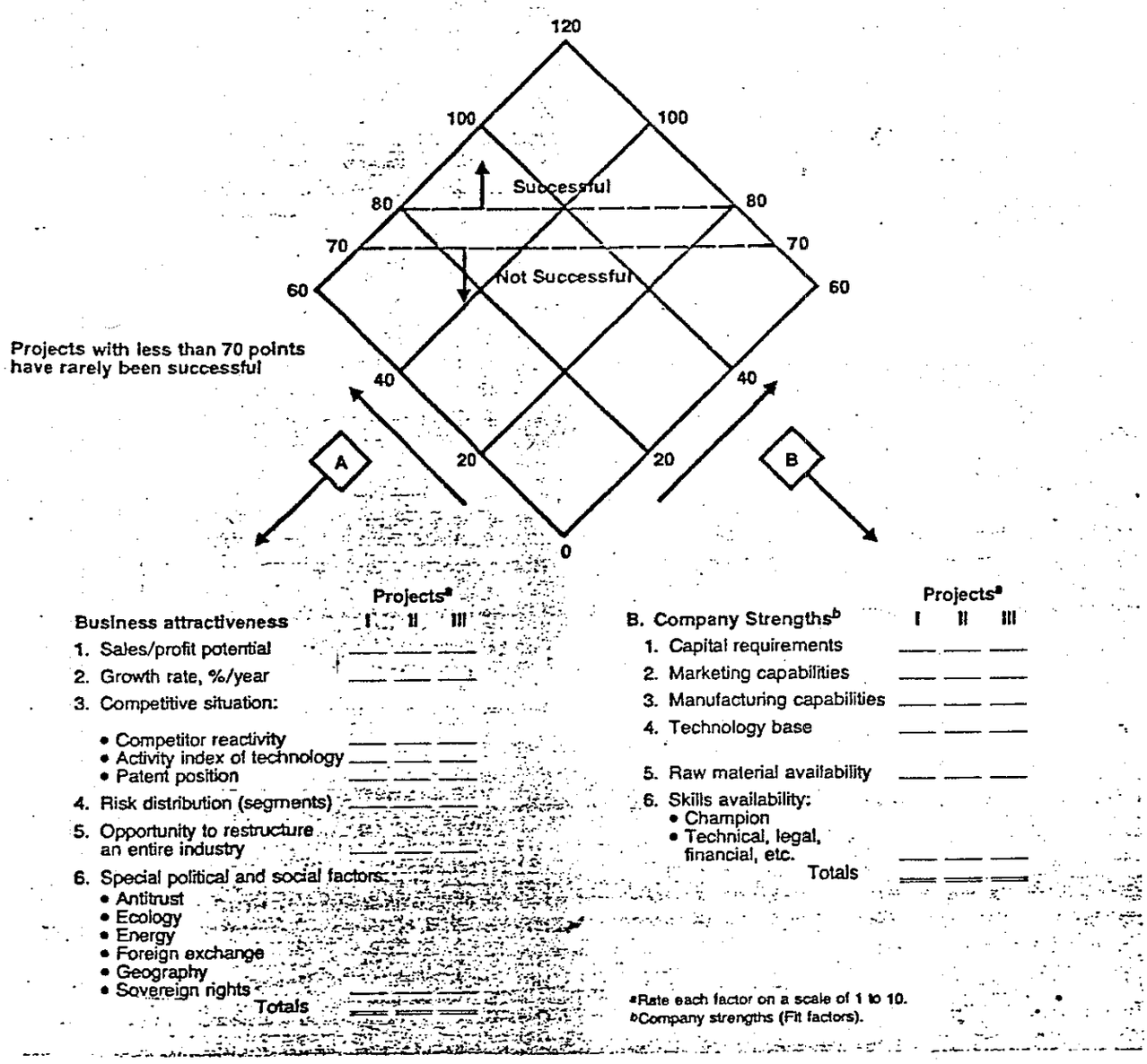


Figure 6. Score card for expanded constraint analysis

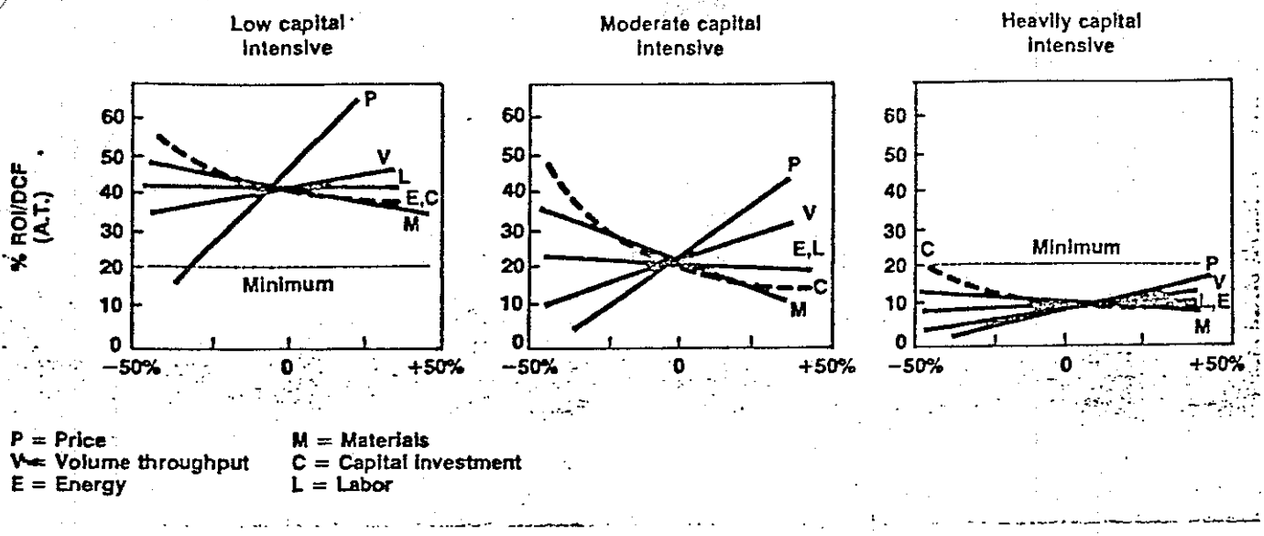


Figure 7. Effects on the discounted cash flow return on investment

8 out of 10 cases over a dozen years of use and is helpful in analyzing existing businesses or profit centers, as well as new ventures and R&D projects. (The 2-out-of-10 failures resulted from unexpected regulatory interventions and from the oil embargo, which altered the raw material economics.) Figure 6 shows an expanded check list of critical factors that need to be addressed. Each factor is scored on a scale of 0 to 10, giving a maximum possible score of 60 for "business attractiveness" and 60 for "company strengths." Statistically, those opportunities with scores of 80 points or higher were successful in 8 out of 10 cases. Below 70 points, the probability of success falls off rapidly.

The data base needed to quantify the six factors listed under "business attractiveness" and the six under "company strengths" should include a careful market segment analysis that defines real customer needs and the niches corresponding to those needs. Also useful is a sensitivity analysis of production and marketing costs as shown in Figure 7. This figure quantifies the effect upon the discounted cash flow return on investment (ROI/DCF) of each factor as it is independently changed. The steeper the slope, the more sensitive is the factor and the more carefully it needs to be analyzed and controlled. Using this type of analysis allows direct comparison of dissimilar opportunities for allocation of limited resources. Weaknesses must be specifically addressed and can often be corrected by acquisitions or by joint ventures with other companies having the needed strengths.

In summary, it appears unlikely that the U.S. will experience another 1929 collapse now or in the future. Instead, a major disproportionation will occur over the next decade, in which those companies that are innovative and are doing effective strategic planning will do exceedingly well, while others fail, are restructured, or are taken over. Once this traumatic readjustment period is over, the U.S. may be launched into one of the most growth-oriented periods in history. A continuous evolution of new technologies, combined with the obsolescence of older technologies in 5–10-year time frames, will preclude the 50-year cyclic buildup and collapse syndrome.

Moreover, it would appear that a creative marketing function will be both a necessary and increasingly important focus of management concern as this process unfolds. Progressive fragmentation of large markets into many smaller niche markets can be expected, with each niche served by its own best cost/performance solution for its needs. A meticulous and continuous process of market segmentation analysis will be a key requirement of the marketing function as new technology continuously develops new possibilities. Sales, advertising, distribution, and financing strategies are likely to remain in a continuous state of change.

This emerging era will put increasing emphasis on life-long continual personal growth and development, and upon the management of diversified business portfolios in order to mitigate the risk of sudden obsolescence. The quality of life in the U.S. and in other developed and developing countries may see an exponential improvement as these events take place. But the U.S., in particular, with its unparalleled depth, breadth, and strength of industrial infrastructure could be the major beneficiary.

Adapted with permission from a lecture before The Conference Board, October 1981.

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Conservatives Eyeing Tax Reform As Step To Pro-Business Federal Economic Role

In a turnabout, some conservatives are talking industrial policy. At the top of their wish list are tax proposals to lengthen depreciation and extend R&D credits.

BY BRUCE STOKES

While the Reagan Administration basks in its overwhelming election victory, which could be interpreted as an endorsement of President Reagan's minimalist approach to government, a loose coalition of businessmen and conservatives is advocating a concerted government effort to improve the international competitiveness of American industry.

"The laissez-faire conservatives' view of the role of government is simply inadequate in today's global economy," said conservative analyst Kevin P. Phillips, author of *Staying on Top: The Business Case for a National Industrial Strategy* (Random House, 1984). "Political conservatives must accept a new pro-business role for government—from coordination of economic and trade strategies to targeting of export assistance and credits—as a necessity."

The coming battle over tax reform will be the first test of conservatives' "competitiveness strategy." Several tax proposals being floated—such as lengthening depreciation periods and extending tax breaks for research and development—would, in the view of some, encourage investment in areas that improve U.S. competitiveness in the international economy.

In recent years, many liberals have advocated an industrial policy to revitalize failing industries through the creation of a bank to finance economic reconstruction and a national government-labor-industry board to direct these efforts. Such an industrial policy would target specific industries for government help.

In contrast, the conservatives' approach would improve productivity by restructuring the tax code, liberalizing antitrust laws and beefing up federal support for R&D, all spurring export-oriented economic growth.

"To be opposed to the industrial policy approach does not presume that government cannot and should not play an active role in economic growth," said Rep. Daniel E. Lungren, R-Calif. "Promoting economic growth is best achieved by fostering a competitive environment."

"The proper role for government is to create an environment for innovation," said Rep. Ed Zschau, a fellow conservative Republican from California.

Early next year, the President's Commission on Industrial Competitiveness will issue its report, which likely will urge closer government-industry cooperation in the economy. A 1983-84 Harvard Business School colloquium involving leading academics and corporate chief executives came to similar conclusions. Republicans in both the House and Senate have drafted competitiveness agendas. And top-ranking union and business leaders have been meeting regularly as the Labor-Industry Coalition for International Trade to suggest ways to use trade policy to improve competitiveness.

"Political conservatives must accept a new pro-business role for government—from coordination of economic and trade strategies to targeting of export assistance and credits," writes conservative analyst Kevin P. Phillips.

"A thread that runs through all these solutions, from left to right, is that someone has to take responsibility for this problem," said Jeff Faux, president of the Economic Policy Institute and an advocate of industrial policy.

With that responsibility would come considerable authority. "The bottom line politically is this: a new round of government involvement in the economy is developing, and the question is, who is to control it," noted Phillips.

EVERYTHING'S RELATIVE

Mainstream economists have generally blamed the mounting U.S. trade deficit on an overvalued dollar. "The over-all performance of the United States does not suggest a long-term problem of competitiveness," said the 1983 Economic Report of the President.

But increasingly, economists argue that more profound problems are at the root of the economy's international ills.

"Some overvaluation of the dollar may be unavoidable for the foreseeable future," said Bruce R. Scott, professor of business administration at Harvard University Business School. "We may have to [learn to] compete under these conditions. The exchange rate cannot always be used as an excuse."

A study by Scott and his associates at Harvard Business School, *U.S. Competitiveness in the World Economy* (1984), concluded the problem is "one of relative performance, not absolute decline," he

said. "The central issue is current performance compared with preceding decades, performance relative to our major competitors and performance relative to U.S. goals and commitments."

In 1960, for example, the U.S. share of world trade was 16 per cent; by 1980, it had fallen to 11 per cent, before major problems began with the dollar. Despite a positive export balance in high-technology products, U.S. manufacturers of items such as aircraft, computers, drugs, engines and electrical equipment have steadily lost market share to foreign competitors since 1970.

While these data are not new, the Harvard report contends that they have never been taken seriously enough because U.S. performance has traditionally been judged against the European track record, which is even worse. "That is like General Motors comparing itself with Chrysler while disregarding Toyota," notes the study. Japan and the countries of East Asia are now a more important market for U.S. exports than any of the major European nations and are a more important source of U.S. imports.

The Harvard researchers attribute the rise of the East Asian countries' economies to their determination to transform their competitive position. Asians chose those sectors of the economy they thought could be competitive in the future and then used the power of the state to bring those industries up to international standards.

"The Asian five [Hong Kong, Japan, Singapore, South Korea and Taiwan] have shown the world how to become rich by discrete and careful protectionism combined with comprehensive domestic organization for education, productivity, technological innovation and effective participation in the global corporate system," Scott said.

Not all business executives and conservatives would agree with this analysis, but there is a growing consensus that the competitive threat posed by the Pacific Basin nations is, in part, due to the activist role their governments play in their economies.

In response to the mounting East Asian challenge, the Harvard study calls for a "national strategy to utilize market mechanisms to emphasize work, saving and investment."

RAISING CAPITAL

Increasing the incentive for industrial investment by lowering the cost and increasing the availability of capital is crucial to improving U.S. international competitiveness, say many business leaders.

U.S. gross capital formation—total investment plus depreciation—was 18 per cent of gross domestic product in 1981, compared with 32 per cent in Japan. Moreover, much of the U.S. investment is short-term speculative investment.

One reason investment lags is that in 1981, American industry's average cost of capital was 16.6 per cent, compared with 9.2 per cent in Japan, says a Commerce Department study. Experts think this capital cost differential harms competitiveness as much as a wage differential.



Jack M. Albertine of the American Business Conference favors tax changes to cut the cost of raising capital from the stock market.

Most observers agree that reducing the federal budget deficit is the single most important thing that can be done about capital problems because government borrowing is crowding out corporate borrowers and raising the cost of capital.

In addition, some charge that tax laws are biased against the long-term investment needed for permanent improvements in productivity. They argue that the economy needs a mix of investments that go beyond the three-year strategy encouraged by current depreciation rules.

The Senate Republican Task Force on Industrial Competitiveness and International Trade, reflecting an interest in the computer industry by some members, suggests the opposite tax change for high-tech firms, allowing them to deduct investment costs immediately to cope with the rapidly changing nature of computer technology.

The President's commission and the Harvard study also recommend identical tax treatment for equity and debt. Now dividends are an after-tax cost, while interest payments are tax deductible. Thus raising money by selling stock is costlier than borrowing, discouraging companies from tapping potential shareholder capital. Equalizing tax treatment would cut the cost of capital raised from the stock market, according to Jack M. Albertine, president of the American Business Conference, a lobby for small and medium-sized high-tech firms.

Congress has already lent some support to such proposals. The 1984 Tax Reform Act has two provisions that directly affect investment. It now allows U.S. firms to write off R&D expenditures for foreign operations and reduces the long-term capital gains holding period from one year to six months, which Scott argues encourages speculation not long-term investment.

There seems to be support for more extensive cost-cutting initiatives. According to an Opinion Research Corp. survey in April and May, 71 per cent of 103 Washington opinion leaders think the high cost of capital has contributed to a lack of long-term investment in industrial capacity.

There is also widespread agreement among those concerned with improving U.S. competitiveness that the future well-

being of the economy is closely related to the level of private and government R&D.

In 1982, the United States spent 1.8 per cent of its gross national product on R&D, while Japan was investing 2.5 per cent, according to the President's commission.

In its waning days, the 98th Congress enacted what many think are key encouragements for private R&D, removing major antitrust impediments to joint R&D activity, extending copyright protection on semiconductors and toughening counterfeiting laws.

The President's commission already has recommended making the R&D tax credit permanent, a move strongly supported by the Chamber of Commerce of the United States and other business groups. The commission will also suggest a change in how the credit is calculated. Now it is incremental, based on the annual increase in expenditures; the commission would like to see it be based on the full amount of a company's R&D, which would tend to increase the credit.

To better coordinate federal R&D expenditures, which now account for roughly 43 per cent of the nation's total R&D, the commission is likely to recommend the creation of a Cabinet-level Science and Technology Department.

Many conservatives complain that fragmentation of U.S. trade laws and policies are a disincentive for businesses to enter the international market. "Our policy is a mess, and we do things that don't acknowledge the globalization of the market," said a commission staffer.

For example, "if other markets are governed by a monopoly, as is the case in telecommunications, and we have destroyed our monopoly [American Telephone & Telegraph Co.], that puts us at a competitive disadvantage," said Alan Wm. Wolff, a deputy U.S. trade representative in the Carter Administration.

The commission has discussed revision of antitrust laws so that a firm's size in the world market, not solely its size in the U.S. market, is considered when the legality of a merger is being judged.

The commission will likely propose streamlining export controls to reduce the time needed for government clearance of high-tech exports, an issue the 98th Congress wrestled with to no avail. It may also suggest expanding the scope of government remedies for unfair trade practices by foreign firms. It may suggest incentives for domestic industries that get import relief to improve their competitiveness, a move supported by the Senate task force on competitiveness.

TARGETING TAX REFORM

Most observers agree that over the next year, efforts to reform the tax system will be the single most important congressional activity affecting the U.S. position in the world economy. To date, debate over various proposals has not focused on their competitiveness implications. In fact, there is no agreement on what should be in a tax reform bill to maximize the economy's international strengths. But reform proponents agree that lower tax rates and reduced government subsidies are consistent with a more efficient industrial system.



"It may take a decade to accomplish" a competitiveness strategy, says Harvard University Business School professor Bruce R. Scott.

For example, the chamber points out that 75 per cent of corporate capital outlays come from internal cash balances. Thus, raising corporate taxes, says the chamber, would inhibit investment by reducing available financial resources.

In the eyes of many experts, key provisions in the major tax reform proposals would have an impact on competitiveness, and often in a counterproductive fashion.

The so-called fair tax plan, sponsored by Sen. Bill Bradley, D-N.J., and Rep. Richard A. Gephardt, D-Mo., would raise the corporate tax rate and eliminate the distinction in tax treatment between short and long-term capital gains, which may discourage long-term investment. It would also eliminate investment tax credits and the special R&D investment tax credit. And it would substantially increase the period over which assets are depreciated, which would discourage short-term investment.

By comparison, the "fast tax" plan, sponsored by Rep. Jack F. Kemp, R-N.Y., and Sen. Robert W. Kasten Jr., R-Wis., would reduce the corporate capital gains tax. It would also continue to permit rapid investment write-offs, which would discourage long-term investment. The plan would eliminate the consumer interest expense deduction, except for home mortgages and education loans, which would force people to save in order to pay cash for consumer purchases. Until that money was used for consumer purchases, it would be available through the banking system for investment. But the plan also would do away with investment tax credits and R&D tax credits.

Many conservatives argue that if the goal of tax reform is not just simplicity but improving the economy, then the income tax should be replaced with a tax on expenditures. The cash flow income tax, introduced by Rep. Cecil (Cec) Heftel, D-Hawaii, would exempt from taxation money that is saved or invested. Interest on consumer loans would no longer be deductible, but interest on borrowing for investment would. For corporations, new investments would be immediately subtracted from the tax base, rather than depreciated, encouraging new, but possibly short-term, investment.

The final Administration tax plan is not known. But on Nov. 27, the Treasury Department suggested lowering the corporate tax rate from a graduated rate of up to 46 per cent to a flat 33 per cent and proposed allowing companies to deduct half of all dividends they pay to shareholders, effectively lowering their costs of raising capital. It also suggested adjusting capital gains for inflation before taxing them, possibly creating an incentive to hold investments longer.

These proposals are in line with a competitiveness strategy. However, Treasury's plan would eliminate the investment tax credit, a move sure to be opposed by many industries.

Of the greatest importance to internationally oriented businessmen and economists, Treasury would replace the Accelerated Cost Recovery System (ACRS) of figuring depreciation with a Real Cost Recovery System (RCRS). ACRS allows large write-offs for companies that invest heavily in real estate, plant and machinery but has been of little use to electronics firms and others in the high-tech field. RCRS would index the basis of depreciable assets for inflation, and depreciation allowances would approximate real economic depreciation.

On the plus side for competitiveness strategy, such a change would probably shift investment away from real estate, a sector of the economy that can never be competitive internationally. But it may also drain some investment from heavy industry, where the United States has been losing ground internationally.

Many observers think tax reform is unlikely in the 99th Congress, and improving industrial competitiveness is certainly not the prime objective of reformers. However, the international ramifications of what is now largely a domestic issue may surface as a result of the debate on these proposals.

The White House position on tax reform will be crucial. "I think the Administration wants to decrease taxes on capital gains but won't increase them on consumption," said James P. Love, an economist with the Center for the Study of Responsive Law. "That won't increase savings and as a result doesn't have a prayer of increasing capital formation."

Other competitiveness strategy proposals are likely to be equally difficult to enact. "It is going to be hard to sell to business decision makers or to Members of Congress," said Allan D. Cors, director of governmental affairs for Corning Glass Works.

Similarly, survey data suggest that public opinion continues to be against government involvement in the economy. Only 37 per cent of the 103 Washington opinion leaders surveyed by Opinion Research Corp. thought government should provide loans and tax credits for selected high-risk ventures with strong export potential. And only 33 per cent of business executives polled in January by Louis Harris and Associates Inc. supported measures such as central strategic planning to save decaying industries.

The loose-knit nature of the various competitiveness proposals inhibits the creation of a neat legislative package that can be marketed to the public and Congress.

The President's commission, which would be uniquely qualified to educate the public, is scheduled to go out of business on Dec. 31.

LEFT AND RIGHT

The notion of a business-oriented competitiveness strategy has met a chorus of objections and raised questions from both the left and the right.

"It's the conservative philosophy under the label of competitiveness strategy," said a liberal House committee staffer.



"Promoting economic growth is best achieved by fostering a competitive environment," says California Republican Rep. Daniel E. Lungren.

Richard W. Rahn, chief economist for the chamber, questions the need for concerted public initiatives. "We were for a while losing competitiveness, but we passed the [1981 Economic Recovery Tax Act] and suddenly we are regaining our technological edge," he said.

Liberal proponents of industrial policy fear that merely creating a competitive environment will be insufficient. Without direct government support of industry, they say, the United States will be forced to compete with the newly industrial nations by cutting labor costs, thus reducing the American standard of living.

Business executives in traditional industries also criticize many of the capital investment incentive proposals now being suggested because they are oriented toward the development-capital needs of high-tech companies while neglecting the long-term plant investment needs of industries such as steel and autos.

Conservatives do not support targeting industries for help, but at the same time, the desire to create a more competitive economy is driven by an analysis that the United States is losing its competitive edge in high technology. The suggested policy responses would lower capital costs in all industries but would probably favor high-tech, capital-intensive firms. There is a similar bias in favoring rapid depreciation or cuts in short-term capital gains taxes. While competitiveness advocates do not explicitly favor targeting the Atari Inc.'s of the future over the Bethlehem Steels, their proposals would have that effect.

The distinction between liberal and conservative positions on government activities to improve competitiveness often turns on whether intervention is direct or indirect. Open support of specific industries would be too political, say many business leaders, and subject to pressure from special interests. "Without the capacity to plan out in the open," said Faux, "then it all becomes politics. As long as it's informal, then whoever has the resources will shape the strategy."

"Proponents of industrial policy have come up with concrete things that you can point to—a bank, a board—while the opponents have come with minor adjustments that seem more ephemeral," said James R. Morris, the chamber's survey research director.

Competitiveness strategy proponents are not sanguine about the chances for policy changes in the short-run. "It may take a decade to accomplish this," Scott acknowledged.

Nevertheless, even old-line conservatives such as Phillips see some form of conservative policy as inevitable. "American businessmen must set aside old concepts of laissez-faire and adjust to—even advocate—new kinds of business-government collaboration," he said. □

Inside the Administration

An Inside Washington Publication

An exclusive report on the Reagan Administration's economic, regulatory and management policies

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Looking at a $290-292-billion defense spending bill

CONGRESS TO HOLD 'SUMMIT' TO REACH COMPROMISE ON DEFENSE SPENDING

Key congressional members on the Budget, Appropriations and Armed Services Committees are expected to meet this month in a highly unusual joint session — being billed as a 'Defense Summit' — to hammer out a compromise bill on defense spending which could total between $290-$292-billion. Informed sources say there is a growing consensus developing among key Republicans and Democrats that the Congress may be able to agree to a defense bill in the $290-292-billion range as contrasted to the Reagan Administration proposal of $299-billion approved by the Senate and the $286-billion level agreed to by the House. A key source said Senate Majority Leader Howard Baker (R-TN) has privately told key congressional members that he thinks a defense summit meeting is a "good idea." Sources say the meeting — which is expected to be held after Sept. 10 — was the idea of Sen. Lawton Chiles (D-FL) who is ranking

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NATIONAL LEAGUE OF CITIES CHARGES TREASURY IS POLITICIZING STATE FISCAL STUDY

The National League of Cities has charged the Treasury Dept. is attempting to inject politics into a broad congressionally-mandated study on federal and state fiscal issues saying a draft of the study "proceeds from the assumption that the deductibility of state and local taxes and the issuance of tax exempt bonds denote federal subsidies." In an Aug. 30 letter, Frank Shafroth, legislative counsel for the National League of Cities told Treasury Deputy Assistant Secretary Robert Rafuse that Treasury's contention "verges upon being a conclusion before the question has even been examined." One source said the Treasury Dept. is attempting to "shape the outline" so that it evolves into a "biased and self-serving proposal" to generate state and local government tax options that Treasury could cut to lower the federal deficit as the Reagan Administration prepares policy options to overhaul the tax system.

Shafroth told Rafuse "the pertinent section of the law [Local Government and Fiscal Assistance Amendments of 1983] calls upon the Secretary to examine the 'impact of state and local governments of'

(continued on page 8)

Without consulting the Justice Dept.

COMMERCE DRAFTING LEGISLATION TO EXEMPT BIG MERGERS FROM ANTITRUST LAWS

Secretary of Commerce Malcolm Baldrige has directed his staff to draft a specific legislative proposal to exempt big mergers subject to intense foreign competition from section 7 of the Clayton Act, a major federal antitrust law. Sources speculate that Commerce will ask the President to make the proposal part of his legislative agenda should he be re-elected in November. Sources say Baldrige has directed Commerce General Counsel Irving Margulies to draft the bill which is considered to be a "high priority" at the department. The Justice Dept., the agency responsible for enforcing federal antitrust laws, has not been consulted or asked to comment on Commerce's plans to propose new federal antitrust legislation although sources say Justice "may be consulted" before the bill is sent to Congress.

A key Justice Dept. source said last week he is unaware of Commerce efforts to amend federal antitrust laws and suggested it was being done secretly without the participation of Justice to avoid a conflict between the two agencies. During the past year, both agencies engaged in lively discussion over how

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OMB INVESTIGATION WILL DIRECT DOE TO COMPLY WITH PRESIDENTIAL PATENT ORDER

The Office of Management & Budget (OMB) is planning to order the Dept. of Energy (DOE) to comply with a presidential directive that orders federal agencies, "to the extent possible," to give private contractors the rights to patents for inventions developed with federal funds following an OMB investigation into the issue which was raised by Sen. Finance Committee Chairman Bob Dole. In an Aug. 24 letter to OMB's Associate Director Fred Khedouri, who oversees federal patent policy, Dole complained DOE practices are not consistent with Administration patent policy and are unfair to DOE private contractors. Dole was reportedly angered last month when DOE lobbied, without OMB approval, against legislation he authored to implement an agency-wide patent policy. He asked OMB to investigate DOE's patent

Zinc, the Cold-Fighter

Serendipity Spawns Research That Suggests the Metal Is Nothing to Sneeze At



GERALD MARTINEAU—THE WASHINGTON POST

By Judith Randal
Special to The Washington Post

In 1979, Karen Eby, a 3-year-old in Austin, Tex., was taking zinc gluconate as a dietary supplement because she had leukemia and—like many leukemic youngsters—was deficient in zinc. One day, when she was coming down with a cold, she refused to swallow the tablet and insisted on letting it melt in her mouth.

It was to change her father's life.

When Karen's sneezes, sniffles and scratchy throat vanished within hours, George Eby, an urban planner, couldn't help noticing. Had the child stumbled onto an important discovery? Or was this merely a fluke?

Eby dug into the considerable scientific literature on the healing properties of zinc and brought his findings to the attention of Dr. William Halcomb, the family's general practitioner, and nutritional scientist Dr. Donald Davis from the University of Texas' Clayton Foundation Biochemical Institute in Austin. At first, the three men used the compound on themselves when they had colds and gave it to relatives and friends. The results were so consistently promising that when Eby inherited some money, the trio recruited some cold sufferers for a more rigorously scientific trial.

Participants were volunteers who, without knowing which was which, took either actual zinc gluconate tablets or placebos—look-alike dummy lozenges. Ideally, these human guinea pigs would also have been tested to be sure they were actually infected with rhinoviruses—the known cause of common colds—but Eby and his colleagues could not afford to hire a microbiologist to do the analyses. However, Halcomb examined the recruits and disqualified those he suspected might have allergies or bacterial infections rather than bona fide colds.

Each volunteer was given either a seven-day supply of 180-milligram zinc gluconate tablets (each containing 23 milligrams of zinc) or an equivalent number of placebos. They were instructed to suck on them for at least 10 minutes to bring the tablets' contents into direct contact with the tissues of the throat where rhinoviruses replicate. (Cold viruses also spawn in the nasal passages, and Eby, Halcomb and Davis had earlier informally tried zinc nose drops and zinc nasal sprays. At effective concentrations, both were painful, and when diluted until they did not burn, they also did not work.)

Adults and youngsters weighing 60 pounds or more took two tablets at the outset, then one every two hours for as long as they were awake, but never more than 12 tablets a day for the adults and nine for the youngsters. For smaller children, the dosage was halved and six tablets a day was the limit. All were instructed to do nothing else for their colds for the duration of the study and to stop treatment entirely six hours after symptoms disappeared.

Because very few of the 146 participants embarked on the experiment with brand-new colds, the results weren't as dramatic as with young Karen. Still, test subjects who had actually used zinc gluconate were symptom-free in an average of 3.9 days, while it was typically 10.8 days before the placebo users were well again.

The researchers reported in the journal Antimicrobial Agents and Chemotherapy last year that, no matter how severe the cold, subjects receiving the zinc typically got better seven days sooner than those who received the placebo.

"It didn't matter," says Eby, "whether people had bad colds or mild ones or how long they had them when they entered our study; they got well about seven days earlier than they would have normally."

The publication of that first report has brought Eby, its senior author, letters and inquiries from all over the world. It has also brought him a venture capitalist of sorts, J.C. Godfrey, an organic chemist associated with the Center for Concept Development, a New York marketing research firm.

Godfrey has arranged, with the Food and Drug Administration's approval, to have a group of Florida physicians repeat the study that Eby, Halcomb and Davis conducted in Texas. If these physicians get similar results, more than two dozen other studies will be launched to be certain that zinc gluconate is not only effective against colds, but also safe.

"Among the things we need to nail down in order to get the FDA's ultimate approval," says Godfrey, "is what the ideal dose is and whether there are some people for whom zinc gluconate may be hazardous. George chose the 23-milligram dose arbitrarily, because that is what Karen had been taking, but we really don't know whether a smaller dose would work just as well or a larger one would work even better. And, oh yes, there's the matter of zinc gluconate's bitter taste."

Some people find this taste merely unpleasant, but 12 of the 83 Texas volunteers who took zinc gluconate felt sick to their stomachs and two of these actually threw up. Godfrey, who has served as a flavor consultant to major food companies, has come up with several formulations—one of them sugar-free—that make the tablets taste like hard candy. Nonetheless, it is still uncertain whether the tablets will retain their apparent effectiveness if they are also made palatable.

Meanwhile, back in Austin, two things have happened. One is that Karen Eby, now 8, has recovered from her leukemia. The other is that her father has set up George Eby Research Inc.—a nonprofit, tax-exempt public charity to delve further into the therapeutic potential of zinc. Eby has been notified that his patent of a zinc gluconate lozenge to shorten the duration of colds will be issued Jan. 22. Assuming the lozenges eventually win FDA approval, sales will help to fund further research.

Still, full FDA approval will probably take at least three years, and Eby is already champing at the bit. If he can get funding, he plans to launch studies that will pit zinc against herpes viruses—both genital and oral—and then to probe further the common metal's alleged ability to detoxify insect stings and snake bites and relieve menstrual cramps.

Even this tall order will, says Eby, barely scratch the surface of zinc's potential since there are also reports in the scientific literature of its activity against dozens of other viruses. Zinc may be good for boosting the aging immune system and for treating certain types of prostate gland inflamation.

"I intend to stay in medical research," he says. "True, I don't have scientific credentials. But you don't have to be highly trained in medicine to offer leadership." ■

Judith Randal is the science correspondent in the Washington bureau of the New York Daily News.

The Risks

Zinc gluconate is available without prescription at some pharmacies and health food stores. But before trying it, talk it over with your doctor. Then, if you decide to go ahead, do not exceed the dose Eby and his colleagues used in Texas and do not take the tablets for more than a week.

A recent study at Memorial University in Newfoundland found preliminary evidence suggesting that long-term use of 300 milligrams of zinc a day—about the same zinc dose that Eby and Halcomb administered—may have adverse effects on blood cholesterol and the body's immune system. Besides, prophylactic use of zinc—taking it to *prevent* the onset of colds—has been found not to work.

Eby warns, too, that zinc gluconate can cause oral irritation. This is most likely to happen if you fall asleep with a tablet in your mouth. Also a good idea—to prevent queasiness—is to avoid taking the tablets on an empty stomach and to nibble on soda crackers if your stomach protests.

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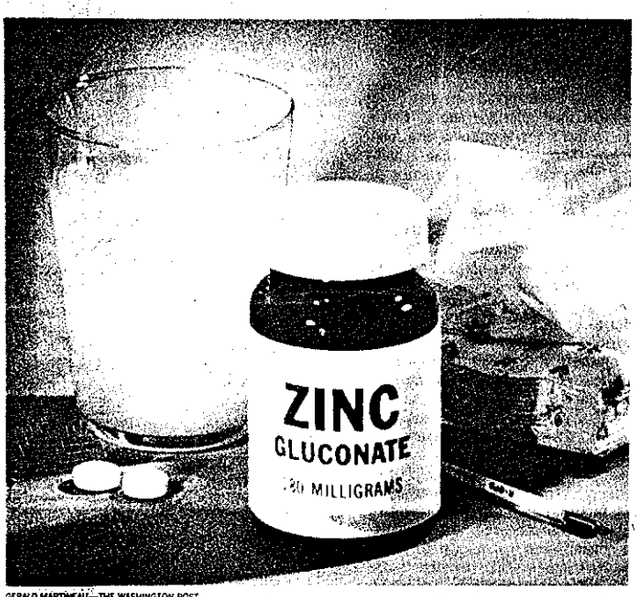
— Judith Randal

Zinc, the Cold-Fighter

Serendipity Spawns Research That Suggests the Metal Is Nothing to Sneeze At



GERALD MARTINEAU—THE WASHINGTON POST

By Judith Randal
Special to The Washington Post

In 1979, Karen Eby, a 3-year-old in Austin, Tex., was taking zinc gluconate as a dietary supplement because she had leukemia and—like many leukemic youngsters—was deficient in zinc. One day, when she was coming down with a cold, she refused to swallow the tablet and insisted on letting it melt in her mouth.

It was to change her father's life.

When Karen's sneezes, sniffles and scratchy throat vanished within hours, George Eby, an urban planner, couldn't help noticing. Had the child stumbled onto an important discovery? Or was this merely a fluke?

Eby dug into the considerable scientific literature on the healing properties of zinc and brought his findings to the attention of Dr. William Halcomb, the family's general practitioner, and nutritional scientist Dr. Donald Davis from the University of Texas' Clayton Foundation Biochemical Institute in Austin. At first, the three men used the compound on themselves when they had colds and gave it to relatives and friends. The results were so consistently promising that when Eby inherited some money, the trio recruited some cold sufferers for a more rigorously scientific trial.

Participants were volunteers who, without knowing which was which, took either actual zinc gluconate tablets or placebos—look-alike dummy lozenges. Ideally, these human guinea pigs would also have been tested to be sure they were actually infected with rhinoviruses—the known cause of common colds—but Eby and his colleagues could not afford to hire a microbiologist to do the analyses. However, Halcomb examined the recruits and disqualified those he suspected might have allergies or bacterial infections rather than bona fide colds.

Each volunteer was given either a seven-day supply of 180-milligram zinc gluconate tablets (each containing 23 milligrams of zinc) or an equivalent number of placebos. They were instructed to suck on them for at least 10 minutes to bring the tablets' contents into direct contact with the tissues of the throat where rhinoviruses replicate. (Cold viruses also spawn in the nasal passages, and Eby, Halcomb and Davis had earlier informally tried zinc nose drops and zinc nasal sprays. At effective concentrations, both were painful, and when diluted until they did not burn, they also did not work.)

Adults and youngsters weighing 60 pounds or more took two tablets at the outset, then one every two hours for as long as they were awake, but never more than 12 tablets a day for the adults and nine for the youngsters. For smaller children, the dosage was halved and six tablets a day was the limit. All were instructed to do nothing else for their colds for the duration of the study and to stop treatment entirely six hours after symptoms disappeared.

Because very few of the 146 participants embarked on the experiment with brand-new colds, the results weren't as dramatic as with young Karen. Still, test subjects who had actually used zinc gluconate were symptom-free in an average of 3.9 days, while it was typically 10.8 days before the placebo users were well again.

The researchers reported in the journal Antimicrobial Agents and Chemotherapy last year that, no matter how severe the cold, subjects receiving the zinc typically got better seven days sooner than those who received the placebo.

"It didn't matter," says Eby, "whether people had bad colds or mild ones or how long they had them when they entered our study; they got well about seven days earlier than they would have normally."

The publication of that first report has brought Eby, its senior author, letters and inquiries from all over the world. It has also brought him a venture capitalist of sorts, J.C. Godfrey, an organic chemist associated with the Center for Concept Development, a New York marketing research firm.

Godfrey has arranged, with the Food and Drug Administration's approval, to have a group of Florida physicians repeat the study that Eby, Halcomb and Davis conducted in Texas. If these physicians get similar results, more than two dozen other studies will be launched to be certain that zinc gluconate is not only effective against colds, but also safe.

"Among the things we need to nail down in order to get the FDA's ultimate approval," says Godfrey, "is what the ideal dose is and whether there are some people for whom zinc gluconate may be hazardous. George chose the 23-milligram dose arbitrarily, because that is what Karen had been taking, but we really don't know whether a smaller dose would work just as well or a larger one would work even better. And, oh yes, there's the matter of zinc gluconate's bitter taste."

Some people find this taste merely unpleasant, but 12 of the 83 Texas volunteers who took zinc gluconate felt sick to their stomachs and two of these actually threw up. Godfrey, who has served as a flavor consultant to major food companies, has come up with several formulations—one of them sugar-free—that make the tablets taste like hard candy. Nonetheless, it is still uncertain whether the tablets will retain their apparent effectiveness if they are also made palatable.

Meanwhile, back in Austin, two things have happened. One is that Karen Eby, now 8, has recovered from her leukemia. The other is that her father has set up George Eby Research Inc.—a nonprofit, tax-exempt public charity to delve further into the therapeutic potential of zinc. Eby has been notified that his patent of a zinc gluconate lozenge to shorten the duration of colds will be issued Jan. 22. Assuming the lozenges eventually win FDA approval, sales will help to fund further research.

Still, full FDA approval will probably take at least three years, and Eby is already champing at the bit. If he can get funding, he plans to launch studies that will pit zinc against herpes viruses—both genital and oral—and then to probe further the common metal's alleged ability to detoxify insect stings and snake bites and relieve menstrual cramps.

Even this tall order will, says Eby, barely scratch the surface of zinc's potential since there are also reports in the scientific literature of its activity against dozens of other viruses. Zinc may be good for boosting the aging immune system and for treating certain types of prostate gland inflamation.

"I intend to stay in medical research," he says. "True, I don't have scientific credentials. But you don't have to be highly trained in medicine to offer leadership." ■

Judith Randal is the science correspondent in the Washington bureau of the New York Daily News.

The Risks

Zinc gluconate is available without prescription at some pharmacies and health food stores. But before trying it, talk it over with your doctor. Then, if you decide to go ahead, do not exceed the dose Eby and his colleagues used in Texas and do not take the tablets for more than a week.

A recent study at Memorial University in Newfoundland found preliminary evidence suggesting that long-term use of 300 milligrams of zinc a day—about the same zinc dose that Eby and Halcomb administered—may have adverse effects on blood cholesterol and the body's immune system. Besides, prophylactic use of zinc—taking it to *prevent* the onset of colds—has been found not to work.

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— Judith Randal

U.S. Trade Representative **William E. Brock** still hopes to get one major trade bill through Congress this year that will include a grab bag of proposals he considers crucial.

But his aides and trade experts on the Hill are concerned that any trade measure will become a Christmas tree hung with baubles providing trade relief to the auto, steel, copper, shoe and tuna-processing industries, to name a few.

It is possible—though unlikely—that the bill will reach the Senate floor as early as next week, when the legislative calendar is relatively empty.

Some congressional trade specialists are pressing the Reagan administration to include some provisions of a trade remedy bill, sponsored by Rep. Sam Gibbons (D-Fla.), chairman of the House Ways and Means subcommittee on trade.

Despite Gibbons' reputation as a free trader, the bill has been attacked as protectionist for its attempts to widen the definition of unfair trade practices to include such things as Mexico's selling of natural gas to domestic industries at lower prices than the gas it exports to the United States.

Even the administration's short list for the trade bill includes at least two sticky issues: the extension of the Generalized System of Preferences (GSP), which gives Third World nations special tariff status for imports of certain products into this country, and a proposal to grant free trade status to Israel.

GSP is not popular with a Congress that faces pressures from constituents to restrict imports rather than to let more foreign goods in. Yet there seems to be a recognition that GSP is important and should be continued, though it is likely that goods from some of the emerging industrial powers in the Third World will be removed from the GSP list.

On the surface, the proposal to grant free trade status to Israel should have clear sailing in Congress since both Tel Aviv and the administration favor it. But it has been attacked in committee hearings by California farm interests, who voice fear that their markets will be taken over by low-priced Israeli produce.

☆ ☆ ☆

TRADE REORGANIZATION . . . Brock has played the good soldier and kept quiet about any differences he may have with the administration's trade reorganization plan, the pet project of **Commerce** Secretary **Malcolm Baldrige,** whose large department would take in Brock's specialists.

But according to sources in the administration and on Capitol Hill, Brock is balking at Baldrige's efforts to declare the creation of a **Department of International Trade and Industry** a top priority for next year if President Reagan wins reelection.

Baldrige won White House support for the bill even though it was opposed by many trade and economic specialists in the administration.

☆ ☆ ☆

ON AND OFF THE FIELD . . . Staff members from Brock's office spend a good deal of their time facing their Japanese counterparts across the conference table. On Tuesday, however, they met at a Hains Point ball field, where the USTR baseball team handily defeated a team from the Japanese Embassy, 28 to 7.

Brock's office should only do as well in trade negotiations.

—*Stuart Auerbach*

pg A19, July 22

Inside U.S. Trade

An Inside Washington Publication

An exclusive weekly report on major government and industry trade action

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STOCKMAN HITS SHULTZ ON CLAIMING LEAD ON TELECOM WITHOUT WHITE HOUSE OKAY

Office of Management & Budget Director David Stockman has sharply criticized Secretary of State George Shultz for telling Congress that State has the undisputed lead in making policy on international telecommunications issues, asserting Shultz has caused the Administration "considerable embarassment." Without making a call on the heated turf battle between the Commerce Dept. and State over which agency advises the President on telecom policy, Stockman nonetheless told Shultz he was wrong to assert jurisdiction in letters to Congress that were not sent to OMB for the traditional interagency review process. The review ensures agency statements conform with Administration policy.

The question of which department has the lead — Commerce through the National Telecommunications & Information Administration or State through the Office of Transportation & Telecommunications

(continued on page 11)

HIGH TECH INDUSTRY SCUTTLES EAA NATIONAL SECURITY COMPROMISE PACKAGE

The high tech industry late last week played a key role in dismantling a national security compromise package developed earlier by House and Senate conferees trying to work out differences in the Export Administration Act bill. Chances of enacting an EAA this session became dimmer when the conferees failed to agree on any major differences between House and Senate bills before adjourning for three weeks. The high tech industry is demanding a "meaningful reduction" in its licensing requirements that goes beyond the tentative compromise reached by the conferees.

The EAA conferees will resume negotiations when Congress returns from its break, and there is a good chance they will discuss a new compromise that will give the high tech people part of what they want. But it may not be enough. Much of the opposition by the high tech industry to the compromise

(continued on page 5)

COMMERCE OFFICIALS SAID TO BE MOVING TO REWRITE EXPORT LICENSE PROPOSAL

The Commerce Dept. will propose in about two months a whole new set of distribution license regulations more palatable to U.S. businesses and allies, according to several informed sources outside the Commerce Dept. These sources say that Commerce officials, finally responding to criticism from all quarters, recently agreed to a new proposal that will drop a requirement for foreign company reporting of licensed exports and possibly other provisions as well.

"I have no doubt there will be new distribution license regs," said one observer closely following the issue. "They might just be restructured, but there probably will be a major rewrite." He said Commerce is between a rock and a hard spot because the existing regs are not acceptable to Commerce, and the proposed ones have been severely attacked by some 250 U.S. firms. Xerox, for example, told Commerce recently it could lose as much as $350-million a year in high tech sales if the proposal becomes final.

(continued on page 6)

IRS DEVELOPING GUIDANCE ON RDLP FINANCING EXPLOSION, CAPITAL GAINS AN ISSUE

The Internal Revenue Service tax shelter division has begun to develop guidance on a recent explosion in financing for research & development limited partnerships (RDLPs) — including making potential policy on whether profits derived from sales of patents and other rights developed in RDLPs are eligible for capital gains rather than straight income tax treatment. Informed sources call the capital gains question the central issue in the further development of RDLPs, which have been touted as a major new funding vehicle for U.S. efforts to capitalize new projects with world export potential.

The RDLP phenomenon has taken the investment community by storm, with the amount of money raised for new high tech projects expected to approach $2-billion by the end of this year from the program's launch in 1981. At that level it will eclipse the venture capital markets, the traditional source of export-rich high tech financing. The program was developed by Commerce Dept. officials in a effort to provide a "free market" approach to spur development of high tech projects. It is based on the principle that a partnership can be formed to create specific advanced technology to be sold back to a company or companies that can commercialize the projects. Observers consider it a Reagan Administration approach to industrial policy, using the capital markets rather than the federal government to pick winning

technologies to support.

But the program also has reportedly attracted the tax shelter industry, particularly because of the lucrative gains made possible through capital gains treatment of profits from the sale of patents and related technology. Thus a limited partner can take the attractive business losses of a research & development partnership but still have the opportunity for major gains if the project is successful. But sources stress the IRS has yet to rule whether RDLP architects are correct in their determination that such profits are subject to only capital gains tax (generally 50-60% less than comparable income tax rates) — making guidance in this area a key determinant of the program's future as an export incentive.

Capital gains treatment. The IRS last November issued a letter ruling that addressed a portion of the capital gains issue — asserting that capital gains do not apply to the portion of profit that equals the original deduction in the partnership. But observers point out that the letter ruling may or may not be upheld by the service and that the ruling does not address any profit beyond that corresponding to the amount of deductions taken from partnership losses. RDLP proponents assert that the profits are derived from patents and copyrights, which are real property and thus subject to only capital gains tax. IRS officials so far have been silent on this issue, but they are expected to address it in the upcoming guidance.

RDLP independence from parent company. Most RDLPs are spun off by a major executive from a company that stands to benefit from the new technology, and, sources say the IRS is concerned that RDLPs may not have an independent life from the spin-off company. This was an issue in a movie development partnership in a tax court case called *Estate of Helliwell vs. Commissioner*, and, sources assert, it may directly apply to RDLPs.

Prepayment. IRS is concerned that limited partners have too many options on which year to take the deduction for their investment in RDLPs. The service is reportedly considering a 6-month delay requirement on taking a lump sum deduction. The issue was also part of the tax bill approved in conference and voted on by Congress last week, with the House eliminating prepayments but the Senate proposing controls on all but farm syndicates.

OMB HAS DECIDED NOT TO MAKE ANY POLICY CALLS IN A KEY STUDY OF THE USE OF OFFSETS in military and other international trade deals, according to informed Administration sources, even though the study is expected to form the basis for a major congressional push to control the practice of offsets in the next congressional session. The Office of Management & Budget got the lead on developing the study as part of a House-Senate compromise on offsets contained in the Defense Production Act Amendments of 1984. The practice of offsets — where foreign purchasers of U.S. goods require companies to give up technology or to make investments in the country as a condition of the sale — has increased in controversy over the last year. U.S. officials and congressmen are becoming increasingly inclined to raise the issue as an international problem with U.S. trading partners.

Administration sources say OMB has tentatively decided to include in its report four chapters which will examine the impacts of offsets on defense preparedness, industrial competition, employment and international trade. In its first meeting with top Administration officials last month, OMB also decided to include three sections which will provide a general data base on offsets, a summary of offset agreements contained in multinational and bilateral treaties and a compilation of all offset arrangements contained in government memorandums of understanding.

The report, which is to be submitted to the Congress this September, will lack any policy prescriptions or specific recommendations, sources say. But there is a possibility that the Administration may express general views on the subject at the time the report is sent to the Congress. OMB is leading an interagency working group on the issue, which includes Treasury, U.S. Trade Representative, Defense, Labor, State, Commerce and the Federal Emergency Management Agency. The working group will not be the major policy body on the issue, OMB officials note, asserting that the Treasury-led Senior Interagency Group on International Economic Policy will likely be the "driving force" behind any effort to negotiate multilateral reductions in the use of offsets.

LACK OF GSP STATUS FOR WOOD IMPORTS FROM TAIWAN AND YUGOSLAVIA HASN'T CUT SALES in the U.S. market, the International Trade Commission said in an analysis released late last month. ITC pointed out that Taiwan lost Generalized System of Preferences status for furniture of wood other than chairs in 1980 and that Yugoslavia lost GSP eligibility for nonfolding chairs of teak in 1983. But the loss of GSP status appears to have had no impact on the level of imports from these two countries. ITC's report, Competitive Assessment of the U.S. Wood and Upholstered Household Furniture Industry, found that U.S. imports of these products increased by 154% during 1979-83, rising from a value of $312-million to $795-million. Based on the ratio of imports to consumption for wood and upholstered

Inside the Administration

An Inside Washington Publication

An exclusive report on the Reagan Administration's economic, regulatory and management policies

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Although Administration estimates cost at $8-billion

DRAFT OTA REPORT SAYS NASA SPACE STATION COULD COST $60-BILLION

The Office of Technology & Assessment (OTA), a congressional research arm, has prepared a draft report assessing the Reagan Administration's proposal for a space station which estimates the project may cost as much as $60-billion over a 25-year period — refuting an estimate by the National Aeronautics & Space Administration (NASA) which claims the intitial project can be completed for $8-billion over a five-year period. Moreover, sources say the report concludes the U.S. could save about $25-billion if the space station was built with the cooperation of other nations in an international joint venture. It also suggests, sources say, NASA's space station proposal is nothing more than a "grandiose" project whose primary purpose is to provide a justification for continuing its $7.5-billion yearly budget. OTA's draft finding comes at a time when the White House is completing its review of a broad initiative to promote industry involvement in space commercialization.

Sources say OTA's initial conclusions have evoked hostility among some members of the House

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CANADIANS TO ASK EPA TO REDRAFT RULES BANNING ASBESTOS IN SIX PRODUCTS

The Canadian government is expected to informally ask the Environmental Protection Agency (EPA) this week to consider redrafting regulations which would ban the carcinogen asbestos in six commercial products — rules that currently are under "extended review" at the Office of Management & Budget, which in earlier meetings with EPA suggested that asbestos should be regulated by the Occupational Safety & Health Administration (OSHA). One Administration source says the EPA asbestos rule is a "serious matter that will be thoroughly reviewed by OMB."

Sources say the Canadian government will ask EPA to change its draft rule — which they say proposes to ban asbestos in roofing and flooring felt, vinyl asbestos tile, asbestos cement pipe, asbestos paper, and asbestos sheeting — to provide for "controlled use limits" of the carcinogen. Reportedly, the Canadian government also is concerned that EPA's proposed ban will adversely harm the Canadian

(continued on page 7)

60 Senate cosponsors challenge Metzenbaum's hold as

ADMINISTRATION PRESSES BAKER FOR SENATE VOTE ON JOINT R&D BILL

Secretary of Commerce Malcolm Baldrige this month telephoned Senate Majority Leader Howard Baker (R-TN) to press for action on legislation unanimously (417-0) passed by the House in May to grant joint research and development ventures qualified immunity from federal antitrust laws. Senator Howard Metzenbaum (D-OH) has so far blocked a Senate vote on the bill by threatening to filibuster the measure, and with less than 20 legislative days left in this Congress, Baker is said to be relunctant "to call his bluff." Baldrige is not alone in calling for a vote on the bill (S. 1841) which is expected to pass the Senate with only Metzenbaum casting a dissenting vote. Sources say a bipartisan contingent of prominent senators and industry officials led by Judiciary Committee Chairman Strom Thurmond (R-SC) and John Young, chairman of the President's Commission on Industrial Competitiveness, are also lobbying Baker for action. Reportedly, Baker has refrained from moving the bill under Metzenbaum's filibuster threat

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To speed commericialization

WHITE HOUSE PLANNING UNIQUE JOINT REG APPROVAL PLAN FOR BIOTECHNOLOGY

A White House working group on biotechnology is preparing to propose an unusual dual regulatory approval program for overseeing the development of the infant industry as an alternative to vesting biotechnology regulation in one agency, according to informed Administration sources. The move is part of an effort to remove commercial barriers to development of biotechnology as an export industry, these sources say, while meeting all environmental, health and safety precautions.

"We are looking for a practical, concrete mechanism through which U.S. biotechnology firms may interface effectively with the government," said a source at the Office of Science & Technology Policy (OSTP). The office chairs the working group on biotechnology of the Cabinet Council on Natural

BALDRIGE ASKS BAKER FOR FLOOR VOTE ON R&D TAX CREDIT . . . begins page 1

because there are less than 20 legislative days left in this Congress.

The bill's chief sponsor, Senate Judiciary Committee Chairman Strom Thurmond (R-NC), recently garnered over 57 cosponsors for the bill, strongly supported and authored by the Reagan Administration, which sources say is intended to send a clear signal to Metzenbaum to withdraw his filibuster threat. Sources say the Senate is also considering whether to invoke an unusual parliamentary procedure — a "cloture" vote — in which 60 Senators agree to limit an extended floor debate "if it comes to that," according to one key congressional source. Administration officials indicated last week they felt Baker would move the bill to the floor "with or without a compromise from Metzenbaum."

The Administration submitted the legislation to Congress as a means of encouraging U.S. companies to engage in joint r&d and enhance their international competitiveness. The legislation has been a top priority for the Reagan Administration and is considered to be one of the most widely supported bills in this Congress. The House passed a similar bill, H.R. 5041, sponsored by House Judiciary Committee Chairman Peter Rodino (D-NJ), by a unanimous vote of 417-0 the same week (May 1) the Senate Judiciary Committee reported Thurmond's bill out.

The Senate and House bills, while not identical, are very similar in that both: 1. exclude activities such as production, marketing, licensing and collaboration on pricing from antitrust immunity; 2. eliminate liability for treble damages in antitrust cases only for those joint r&d ventures that comply with "negative disclosure" — which requires the Dept. of Justice to be notified of planned ventures; and 3. apply the "rule of reason" analysis in reviewing joint r&d cases which allows the Justice Dept. to weigh the anticompetitive effects of joint r&d ventures against their pro-competitive effects.

The pending legislation differs in the House and Senate in one key area which has to do with how courts award attorney fees. Current antitrust law provides the court may award attorney fees to a prevailing plaintiff but not to a prevailing defendant. The House-passed measure allows the court to award attorney fees to "a prevailing litigant" while the Senate bill does not change current law on this question. Proponents of the House attorney fee provision argue it is simply "equitable treatment" but opponents say it will discourage, if not eliminate, many antitrust suits. Current law provides that if a non-profit organization (plaintiff) sues a major corporation for antitrust violation and wins, it may recover attorney fees; however, if the corporation wins it may not collect fees because it is the defendant in the case.

Metzenbaum believes the Senate bill "properly omits any provision awarding attorneys fees to prevailing defendants. However, in reducing incentives for private antitrust enforcement by eliminating treble damages, the bill as reported goes too far. . ." Senate sponsors of the bill had hoped to reach a compromise with Metzenbaum but sources close to the negotiations begun in May say efforts broke down this month when it became clear that "neither side was willing to give." Metzenbaum reportedly offered several alternative approaches to the bill's treatment of damages, including: 1. double the damages in antitrust cases (rather than limit them to single damages as the legislation does); 2. provide that liability to damages be limited to single damages for those joint r&d ventures that were lawful when they were formed but later became anticompetitive; and 3. limit liability to single damages when plaintiffs bring antitrust suits after a joint r&d venture has become successful.

CANADA TO ASK EPA TO REDRAFT ASBESTOS REGS . . . begins page 1

domestic asbestos mining industry, which now exports about 33% of its asbestos to the U.S.

Sources say Canadian research on asbestos-containing products has yielded inconclusive data on whether exposure to the products is harmful. The Canadians are also reportedly concerned that EPA is proposing the ban without considering possible substitutes. Additionally, the Canadians are concerned that the ban could harm the Canadian asbestos industry and have a negative impact on the worldwide trade of asbestos.

EPA currently plans to phase out the remaining uses of asbestos during a 10-year period in a rulemaking it will propose in November. Industry sources say EPA's more limited ban of the substance in six products will cost "in the billions" because there's currently 600,000 miles of asbestos-containing water pipe alone in the U.S. One industry source says he is "concerned" by EPA's move to ban asbestos in products when the agency has "failed to state the level at which the chemical will cause harm," adding that EPA's latest move may "set a precedent for the agency to ban substances because it's easier to do than regulating them."

Commerce Dept. sources say the proposed EPA ban is likely to distort the U.S. domestic asbestos market although they could not estimate how much the ban would cost industry.

computer scientists are more aware of the potential of the present systems and are willing to put more effort into using them, while pure scientists, for whom the computer is another tool, have a lower level of pain. If this is the case, it may be only a matter of time before everybody operates in the same mode. However, one can make the following observation: scientists, either in the laboratory or in computing, have shown that they will push their systems or tools to the limit in order to get to the results. In computing they are willing to learn to program in machine language if that gives the performance they need for a specific problem. We are now seeing physicists developing and building their own special-purpose calculating machines at a great cost in time and effort. In the laboratory it is common for scientists to take commercial instruments apart and rebuild them to improve performance, again at a great cost in time and effort.

In our laboratories, pure and applied scientists have access to the same facilities, but their patterns of collaboration are very different. It may well be that we are dealing here with subtle but strong cultural factors. It is easy to develop theories of why this is so, but it is difficult to decide one way or the other. This is a fascinating and important subject but more work, and perhaps more experience, is required to understand the reasons. Similar questions arise in connection with other fields that have proved intractable. For example, will education, that crude process in the classroom that has withstood every technical assault for the past 2000 or 3000 years, finally crumble before the impact of electronic progress? Some people think so and have projected that the interaction of computers with instruction will do it, but still we do not know. Will the availability of terminals in the home, the ability to program at home, and the ability to interact with others over wires, over glass, or possibly through satellites fundamentally change the working patterns of people? That is certainly possible, and again we do not know. Our inability to understand and predict the qualitative effects of computer technology is great. But even the straight-line projection, from what we have experienced to what we can reasonably expect to be the impact on science, is impressive.

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Protection of Plant Varieties and Parts as Intellectual Property

Sidney B. Williams, Jr.

The coming of age of the biological sciences has raised new questions about the protection of technology under the intellectual property laws. Intellectual property, as opposed to tangible property such as real estate or personal property, includes subject matter that is protected by patents, trademarks, copyrights, trade secrets, and more recently, patent-like plant variety protection for varieties reproduced by seed. The protection of intellectual property is not a new concept since its availability can be traced back to Greece as early as 200 B.C. (*1*). However, because the rewards for intellectual property have been high, the requirements for obtaining it have also been quite high. It is the question of what must be given in exchange for patent protection, together with the question of what scope should be given to such protection, that creates many problems in patent law. Nowhere is this more evident than in the protection of plant varieties and their parts.

The importance of protecting plant varieties is evidenced by the number of countries that have passed plant breeders' rights legislation and by the formation of the International Union for the Protection of Plant Varieties (UPOV) (*2*). UPOV administers the treaty that, among other things, requires member states to provide the same rights to plant breeders of other member states as it provides its own nationals.

Protecting Intellectual Property

Intellectual property is protected in two primary ways. The first is by statutory grants such as patents, trademarks, and copyrights. The second is by maintaining the subject matter a trade secret. Unlike patents, trademarks, and copyrights, which are mandated by federal statutory law, trade secret rights arise primarily from state court decisions or laws.

Trademarks are used to distinguish one's goods from those manufactured by others. They indicate the source of goods. The mark can be a word, symbol, name, device, or combination thereof. Examples include the Xerox, Coca-Cola, and Kodak brands.

Copyrights protect the manner of expression but not the ideas embodied in the expression. Examples are books, music, operas, maps. A copyright can only prevent others from copying the mode of expression. Independent creation is not an infringement of the copyright.

Utility (general) patents exclude others from making, using, or selling the invention and actually protect the embodied idea. They do not necessarily mean that the patentee can use his invention because it could be dominated by another patent. To be patentable the invention must be useful, novel, and unobvious (unobviousness requires a step that is not merely a technique within the scope of a person with ordinary skills in the art).

Plant patents provide protection for plant varieties that are reproduced asexually (by budding, grafting, tissue culture, and so on). Uncultivated and tuber-propagated plants (such as Irish potatoes and Jerusalem artichokes) are excluded from protection.

Plant variety protection provides patent-like protection for plant varieties re-

Sidney B. Williams, Jr., is associate patent counsel and manager, domestic patents, The Upjohn Company, Kalamazoo, Michigan 49001.

produced by seed. Fungi, bacteria, and first-generation hybrids are excluded from protection.

Trade secret law protects against unauthorized appropriation or disclosure of the proprietary information.

The systems for granting intellectual property rights vary. The two broad classes are registration and examination systems. Protection under a registration system is easier to obtain because usually the only requirement is that of either novelty or originality. Novelty requires that the subject matter be different from existing subject matter that is known. The extent of the difference is irrelevant. Originality means that the applicant created the subject matter. In other words, the subject matter was not copied. Examples of registration systems are the U.S. copyright, trademark, and plant variety protection schemes.

Protection under an examination system is more difficult to obtain because there is generally a requirement for unobviousness or an "inventive step" as it is referred to in some foreign patent laws. Unobviousness requires a step or result that is beyond that expected of a person with ordinary skills and knowledge in the field of the invention for which protection is being sought. Examples of examination systems are the patent systems of the United States, United Kingdom, Federal Republic of Germany, the Netherlands, and Japan. Patents obtained under examination systems generally provide a broader range of protection than those obtained under registration systems.

The claims of an invention define what is protected. The claims can be analogized to a real estate deed. Instead of using distances and landmarks the claims contain works that outline the boundaries of the invention claimed. For example, Fig. 1 shows the boundaries of a claim to a group of chemical compounds. The boundaries surround any use of the compounds and any method of making them. Therefore, if someone else either discovers a new use of the compounds or a new method of making them, he will have to cross the boundary to compound A to practice the new use or method. Crossing the boundary without the owner's permission is a trespass or, in intellectual property terms, an infringement.

Protecting Plant Varieties and Their Parts

Plant varieties. It is established that plant varieties that are reproduced asexually can be protected under the Plant Patent Law, the Townsend-Purnell Act of 1930 (*3*). It is also clear that plant varieties that are reproduced by seed are protectable under the Plant Variety Protection Act of 1970 (*4*). It is not so clear, however, whether asexually or sexually reproducible plant varieties can be protected under the general patent statute. Even though patents issued under the general patent law (*5*) have covered material containing living matter, the general patent law has most often been applied to inanimate subject matter. As a matter of fact, a great body of technology in which living material was utilized to produce chemicals provided the fertilizer for the production of steroids and antibiotics. However, a great deal of controversy arose when attempts were made to claim living organisms per se. Part of this controversy culminated in the case of *Chakrabarty* v. *Diamond, Commissioner of Patents and Trademarks* (*6*), in which the U.S. Supreme Court held that the fact that the claimed invention encompassed living matter did not preclude general patent protection. Specifically the Court held that the important fact in determining whether or not subject matter is patentable subject matter is whether or not there has been human intervention. *Chakrabarty* involved claims to certain human-modified microorganisms that were capable of "eating" oil. The case did not change the criteria of patentability (usefulness, novelty, and unobviousness). The Court specifically ruled on what was patentable subject matter. In other words, before the criteria of usefulness, novelty, and unobviousness can be applied to an invention it must first meet the criteria of being patentable subject matter.

Answering the question of whether the general patent statute can be used to protect plant varieties that are also protectable under the Plant Patent Law or the Plant Variety Protection Act requires a considerable amount of statutory construction. Statutory construction is a procedure used to interpret laws. One of its objectives is to determine which law among several laws dealing with the same subject matter is applicable when the laws conflict. Although such an analysis is beyond the scope of this article (*7*), it is clear that some thought will have to be given to whether or not there should be different treatment of food crop varieties as opposed to nonfood crop plant varieties. For example, the Plant Variety Protection Act contains express provisions for research (experimental use) and crop exemptions, whereas the general patent statute contains no such provision. Since the Plant Variety Protection Act was an attempt to correct the inequity of there being no patent-like protection for seed-reproduced plant varieties and since many of the varieties reproduced by seed are food crops, did Congress, by providing expressly for a research and crop exemption, articulate a different policy for food crop varieties than other plant varieties?

Summary. In view of the Supreme Court decision in *Chakrabarty* v. *Diamond, Commissioner of Patents and Trademarks*, it is possible that plant varieties can be protected under three different U.S. statutes: the Plant Variety Protection Act, the Plant Patent Law, and the General Patent Law. The Plant Variety Protection Act protects varieties that are reproduced by seed, whereas the Plant Patent Law protects varieties reproduced asexually. Varieties, irrespective of how they are reproduced, could be patentable under the General Patent Statute. It is not clear whether parts of plants can be protected by grants under the Plant Patent Law or Plant Variety Protection Act and it is possible that they will be best protected under the General Patent Statute and by maintaining them as trade secrets. Only time will show whether the existing statutes are sufficient to provide both guidance and adequate protection or whether changes in the law will be required.

Plant parts. Plant patent and plant variety protection laws provide for the protection of plant varieties, that is, whole plants. But how do we protect their parts? This question has to be analyzed from two perspectives. First, if protection of the whole plant is obtained, are parts of the plant also protected? Second, is it possible to protect parts of plants without protecting the whole plant?

The question of whether protection of plant parts is obtained when a plant patent is granted has received some attention, especially in the area of cut flowers. The problem with cut flowers is that a plant can be purchased in the United States and taken to a country where there is no plant variety protection; the variety is then reproduced and the flowers are cut and imported back into the United States. The question here is whether it is an infringement of the plant patent to so sell the import under section 337a. One view is that a plant

ute, it is probable that the disclosure requirements can be met by depositing seeds or other reproductive material for those varieties.

The Plant Variety Protection Act. It is already a requirement of the Plant Variety Protection Act that a sample consisting of 2500 seeds of the variety to be protected be deposited at the National Seed Laboratory at Fort Collins, Colorado. However, many questions linger with respect to depositing microorganisms or seeds. If the seed or microorganism mutates, are the requirements of reproducibility met? Is the mutant itself protected? Does the claimed process include use of the mutant?

To be protectable under the Plant Variety Protection Act a variety must be novel (*13*) and the right to the variety must not be precluded by the activities set forth in the section that defines the right to plant variety protection (*14*). A variety is novel under the Act if it is distinct, uniform, and stable. If a variety differs from all prior art varieties by one or more morphological, physiological, or other characteristic then it meets the criterion of distinctness (*15*). The degree to which a characteristic must differ to be distinct has not been addressed by either the Plant Variety Protection Office (PVPO) or the courts. This question has been raised by the International Union for the Protection of New Varieties of Plants (UPOV) under the categorization of minimum distance.

A variety is uniform if its characteristics can be described and predicted and if they are commercially acceptable (*16*). In the case of *In re Waller* (*17*), PVPO had to consider an application in which the question of uniformity was involved. In reversing a denial of protection on the grounds of lack of uniformity, the secretary of agriculture held that PVPO could not deny protection for a dahlia solely on the ground that it did not have a uniform flower color "if the variations in flower color are describable, predictable and commercially acceptable" (*17*, p. 7).

The requirements of stability (*18*) are met if the variety's main and distinctive characteristics remain unchanged when it is reproduced by seed. While the definition of stability has not been specifically addressed by either PVPO or the courts, it has been addressed implicitly by PVPO because the denial of the application by PVPO in the *Waller* cases was on the ground that it did not meet the requirement of uniformity and stability (*16*).

Difference between food and nonfood crops. Both the Plant Patent Law and the Plant Variety Protection Act provide protection for food and nonfood crops. However, except for fruits and nuts, most nonfood crops have been protected under the Plant Patent Law, whereas most food crops have been protected under the Plant Variety Protection Act. This is probably more historical than by design. The flower nursery industry, whose primary concern is with ornamental varieties, was a strong proponent of the Plant Patent Law, whereas passage of the Plant Variety Protection Act was strongly supported by the seed industry.

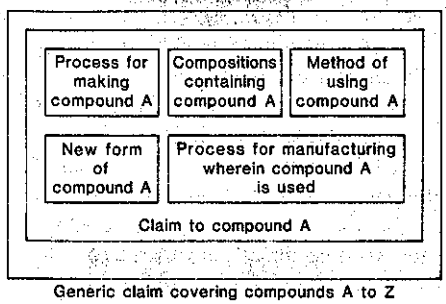


Fig. 1. Boundaries of a claim to a hypothetical group of chemical compounds. Compositions containing compound A include combination products having more than one ingredient.

As pointed out above, when the Plant Patent Law was enacted it was felt that the only way to reproduce varieties true to form was by asexual reproduction. Most ornamental plants (roses, chrysanthemums, and so forth) are reproduced asexually. They form the bulk of those plants covered by plant patents. Since most food crops are reproduced by seed, they cannot be protected by plant patents unless they are subsequently reproduced asexually. Because the technology has not yet developed to the point that most seed-produced crops can be produced more efficiently by asexual reproduction, food crops will probably continue to be protected under the Plant Variety Protection Act except when it is advantageous to attempt to do so under the general patent statute.

Protection of plant varieties under the general patent statute will raise some questions. One of the first is the question of experimental (research) use. Under the general patent statute there is no express provision for experimental use. However, a very narrow exception has evolved from case law. This exception excuses what would normally be considered infringing acts on the grounds that the acts were committed to satisfy scientific or philosophical curiosity. Acts have also been excused as being experimental on the grounds that they are considered to cause so little damage to the owner of the patent as to be meaningless. The Plant Variety Protection Act provides an express provision for a "research use" exception to infringement (*19*). Therefore, conflict could arise if a general patentee would attempt to prevent others from conducting research experiments with a protected variety. A question giving rise to the conflict is whether Congress expressed a public policy against suing researchers for infringement under the Plant Variety Protection Act that would override any rights under the general patent statute.

Another exemption that could create problems for the general patentee is the Farmers' Crop Exemption (*20*). This exemption gives a farmer who purchases a protected variety the right to use the variety to reproduce seed for production or use on his farm or to sell seed reproduced from the purchased seed. The right of a farmer to do this would appear to conflict with the provision under the General Patent Law under which the purchaser of a patented item can repair it but cannot reconstruct it. Also, at least one court has held that the Farmers' Crop Exemption does not entitle a farmer to promote or advertise the protected variety for sale (*21*).

Another difference between the General Patent Law and the Plant Variety Protection Act is that the former provides for compulsory licenses and the latter does not. Under the compulsory license provision the secretary of agriculture can permit others to produce a protected variety if he finds that to do so will be in the national interest. This difference, however, may be one of form rather than substance since the U.S. government (or a court when there has been an antitrust violation) can, under its powers of eminent domain, authorize others to use the patentee's invention. The patentee then has a remedy against the government in the U.S. Court of Claims (*22*).

Breadth of Protection

Two of the most interesting questions concerning the protection of plant varieties are (i) how different will the new variety have to be from the closest old variety in the prior art to obtain protection and (ii) how different will a variety have to be from a protected variety without infringing that variety?

The Plant Variety Protection Act. Many people in the seed industry contend that once a difference has been identified between a new variety and

sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made."
6. *Chakrabarty* v. *Diamond*, 206 *U.S. Pat. Q.* 193 (U.S. Supreme Court, 1980).
7. A. Diepenbrock, C. Neagley, D. Jeffrey, *Am. Pat. Law Assoc. Sel. Leg. Pap.* 1 (No. 2), 81 (1983).
8. *American Patent Law Association Plant Variety Protection Committee Annual Report* (1981).
9. 19 *U.S. Code*, sects. 1337 and 1337a.
10. 35 *U.S. Code*, sect. 271.
11. 7 *U.S. Code*, sect. 2541.
12. *In re Argoudelis*, 168 *U.S. Pat. Q.* 99 (Court of Customs and Patent Appeals).
13. 7 *U.S. Code*, sect. 2401(a).
14. 7 *U.S. Code*, sect. 2402.
15. 7 *U.S. Code*, sect. 2401(a)(1).
16. 7 *U.S. Code*, sect. 2401(a)(2).
17. *In re Waller* (U.S. Secretary of Agriculture decision, 14 July 1981).
18. 7 *U.S. Code*, sect. 2401(a)(3).
19. 7 *U.S. Code*, sect. 2544.
20. 7 *U.S. Code*, sect. 2543.
21. *Delta and Pine Land Co.* v. *Peoples Gin Co.*, 694 *Fed. Rep.* 2nd ser. (Fifth Circuit Court, 1983).
22. 28 *U.S. Code*, sect. 1498.
23. U.S. House of Representatives, *House Rep. No. 1129* (71st Congress, Second Session, 10 April 1930; U.S. Senate, *Senate Rep. No. 315* (71st Congress, Second Session, 3 April 1930).
24. *Graver Tank & Mfg. Co.* v. *Linde Air Products Co.*, 339 *U.S. Rep.* 605 (U.S. Supreme Court, 1950).
25. *Ex parte Jackson*, 217 *U.S. Pat. Q.* 204 (Patent and Trademark Office Board of Appeals, 1982).
26. *Regnum Veg.* 22, 30 (1961).

RESEARCH ARTICLE

A Deep 6-Centimeter Radio Source Survey

E. B. Fomalont, K. I. Kellermann
J. V. Wall, D. Weistrop

Abstract. *The Very Large Array has been used to survey a small region of sky at a wavelength of 6 centimeters down to a completeness level of 60 microjanskys—about 100 times weaker than the faintest radio sources that have been detected with other instruments. The observed source count at flux densities below 100 millijanskys converges in a manner similar to the lower frequency counts, although there is some evidence for an excess of sources weaker than 100 microjanskys. The sources in the survey are preferentially identified with faint galaxies.*

The shortest wavelength at which extensive radio source surveys have been made is 6 cm. At this wavelength surveys by the National Radio Astronomy Observatory (NRAO) and Max-Planck-Institut (MPI) have covered most of the northern sky down to a limiting flux density of 600 millijanskys (mJy), while the various Parkes surveys provide complete samples of sources down to 1 Jy (*1*). Over limited regions of the sky other single-dish surveys made at NRAO and MPI are complete to 35 mJy (*2*), 20 mJy (*3*), 15 mJy (*4*), and 14 mJy (*5*). Synthesis surveys covering even smaller regions have reached levels of 4.5 mJy at Westerbork (*6*) and 0.5 mJy at the Very Large Array (VLA) (*7*). We have used the VLA to extend the surveys to sources that are as faint as 60 μJy at 6 cm, or about 100 times weaker than levels reached with other instruments at any wavelength. Source catalogs constructed from these surveys provide the basis for further studies in the radio region and in other parts of the spectrum. Further investigation is in progress on the nature of these weak radio sources, their spatial distribution and luminosity function, and how these properties change with cosmological epoch.

Counts of radio sources made at centimeter wavelengths are of particular interest since, for the stronger sources selected at this wavelength, flat-spectrum compact sources and steep-spectrum extended sources (which dominate the long-wavelength counts) are present in roughly equal numbers (*5*, *8–10*). Previous surveys made at 6 cm for relatively bright sources show that for $S > 100$ mJy (approximately the 20,000 brightest sources in the sky) the counts are closely represented by the "Euclidean" law

$$\eta_0(S) = 90\, S^{-2.5} \qquad (1)$$

where $\eta_0(S)$ is the number of sources with flux density S per unit flux density interval.

Between 10 and 100 mJy the 6-cm counts begin to decrease in a manner qualitatively similar to the long-wavelength counts of the steep-spectrum sources (*5*, *8*, *9*). However, the extended Euclidean plateau at 6 cm differs dramatically from the long-wavelength count, which is characterized by a steep rise for strong sources (the brightest 1000 or so) followed by a rapid decrease in the density of the weaker sources.

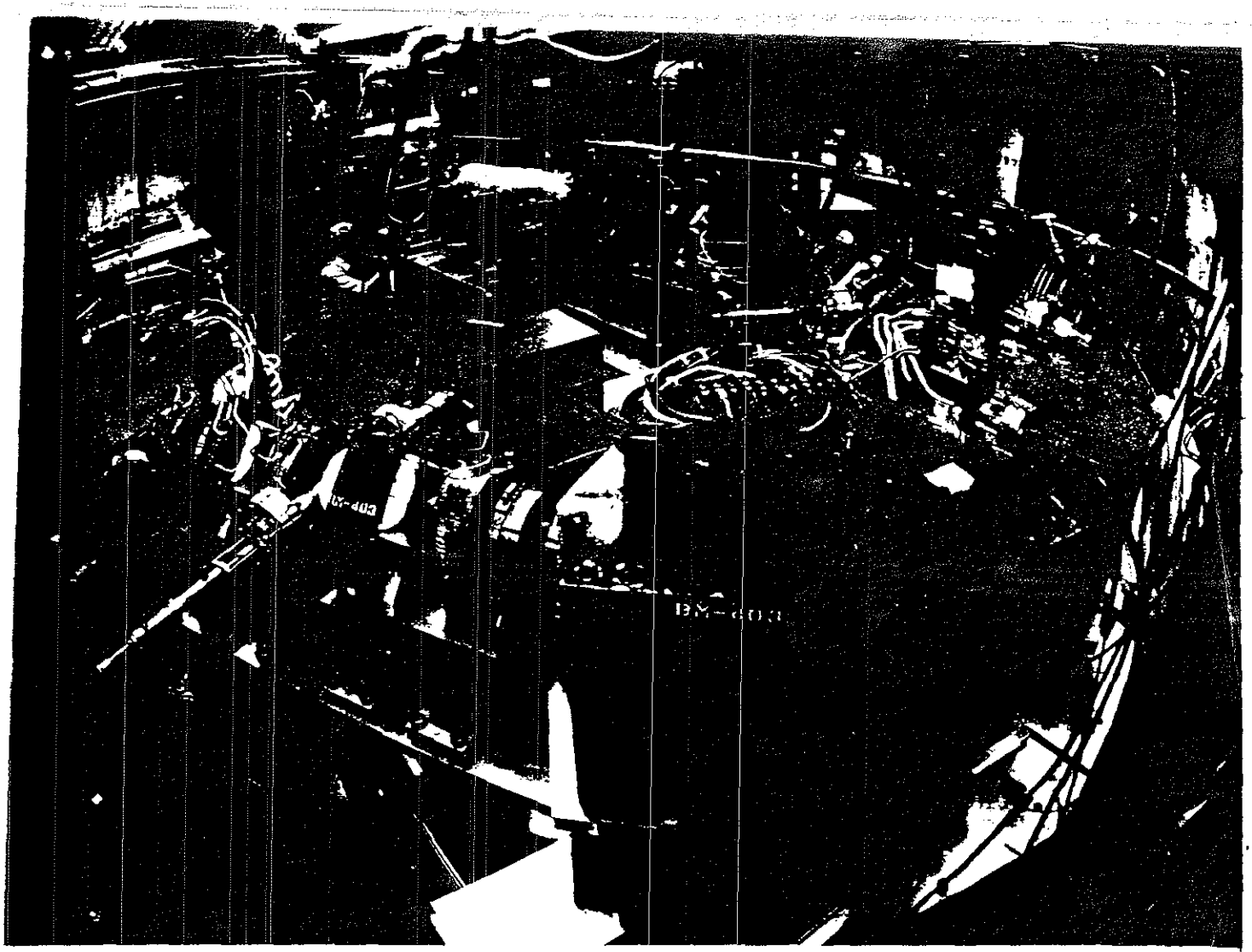
In this article we report on observations of very weak radio sources at 6 cm, and we discuss the angular size, spectra, and optical identification of these weak sources.

Observations and Reductions

In order to investigate the number density of very faint radio sources, we have mapped a small area of sky, using the VLA to detect all sources with a flux density greater than 60 μJy. These new observations include the weakest radio sources yet cataloged and reach a source density of 6×10^5 sources per steradian. Supplemental information concerning this sample of sources was obtained through (i) VLA observations at 20 cm to determine the spectral index of the sources and (ii) optical observations with the 4-m telescope at Kitt Peak National Observatory (KPNO) to aid in the identification of the sources.

The 6-cm observations were made in the D configuration of the VLA to synthesize a 700-m-diameter antenna on a field centered at right ascension (α) = $00^h15^m24^s$ and declination (δ) = 15°33′00″ (epoch 1950.0). The resolution is about 18 arc sec and no emission will be missing for sources less than 120 arc sec in size. The general area of the field

E. B. Fomalont is a system scientist at the National Radio Astronomy Observatory, Socorro, New Mexico 87801. K. I. Kellermann is a senior scientist at the National Radio Astronomy Observatory, Green Bank, West Virginia 24944. J. V. Wall is head of Astrophysics and Astrometry Division at the Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, East Sussex BN27 1RP, United Kingdom. D. Weistrop is a scientist at the Laboratory for Astronomy and Solar Physics, NASA-Goddard Space Flight Center, Greenbelt, Maryland 20771, and is a visiting astronomer at Kitt Peak National Observatory.



Experiments with free electron lasers are being conducted at Los Alamos. These high-power lasers, which scientists liken to an extension of microwave technology to the visible light spectrum, are an essential part of research on the Strategic Defense Initiative.

See 92.40+42

PRIVATIZATION PROTOTYPES

The National Laboratories

The Energy Department facilities are key to national defense. Can they also contribute to U.S. competitiveness in world trade?

BY CLAUDE BARFIELD

LOS ALAMOS, N.M.—Here on a high, remote mesa of the Jemez Mountains sits one of the most important resources the nation has in its continuing struggle for security in the nuclear age and for economic advantage in world trade.

Today, as 40 years ago, the Los Alamos National Laboratory is at the frontier of nuclear weapons research. Then, it developed and exploded the first atomic bomb. Now, it is among the leading institutions contributing to development of President Reagan's Strategic Defense Initiative (SDI).

Less than two hours' drive away, at the edge of the desert flats in Albuquerque, a sister institution, Sandia National Laboratory, likewise is making important contributions to SDI.

The two laboratories rank second and third among this state's employers, and the 10,000 scientists, engineers and technicians in their work force give New Mexico one of the highest per capita concentrations of technically trained workers in the country. The Energy Department (DOE), which owns both of the facilities, underwrites nearly 20 percent of the state's economy.

As important as they are to New Mexico, Los Alamos and Sandia—and the seven other multiprogram labs owned by DOE—are even more critical to prospects for key national policy priorities:

- Much of the nation's nuclear arsenal is designed at Los Alamos and then engineered into weapons at Sandia. On-going research on nuclear technology is financed by DOE but is also of critical interest to the Defense Department.
- Both labs are centrally involved in research and testing associated with verification technologies that would come into play if the United States and the Soviet Union ratify a nuclear arms control agreement. This aspect of their work is of interest to the Arms Control and Disarmament Agency, the Pentagon and others.
- Increasingly, Members of Congress and other government leaders are calling upon the labs to play major roles in nurturing technological innovation, which is among the leading public missions of the National Science Foundation and the Departments of Energy and Commerce. The labs tried, with mixed results, to push civilian technology forward during the energy crisis of the 1970s. Now they face demands for a broader innovative role—although two-thirds or more of their work is related to national security, and much of it is classified.

Thus the labs may be key players in two of the nation's most challenging dilemmas. As Siegfried Hecker, director of Los Alamos, said in an interview, "We face competition on two broad fronts: from the Russians on the military front, and from the Asians on the civilian front. Both pose formidable technological challenges, and it would be foolish to keep them on separate tracks." The DOE labs, he argued, offer an opportunity to merge the two tracks within a single set of institutions.

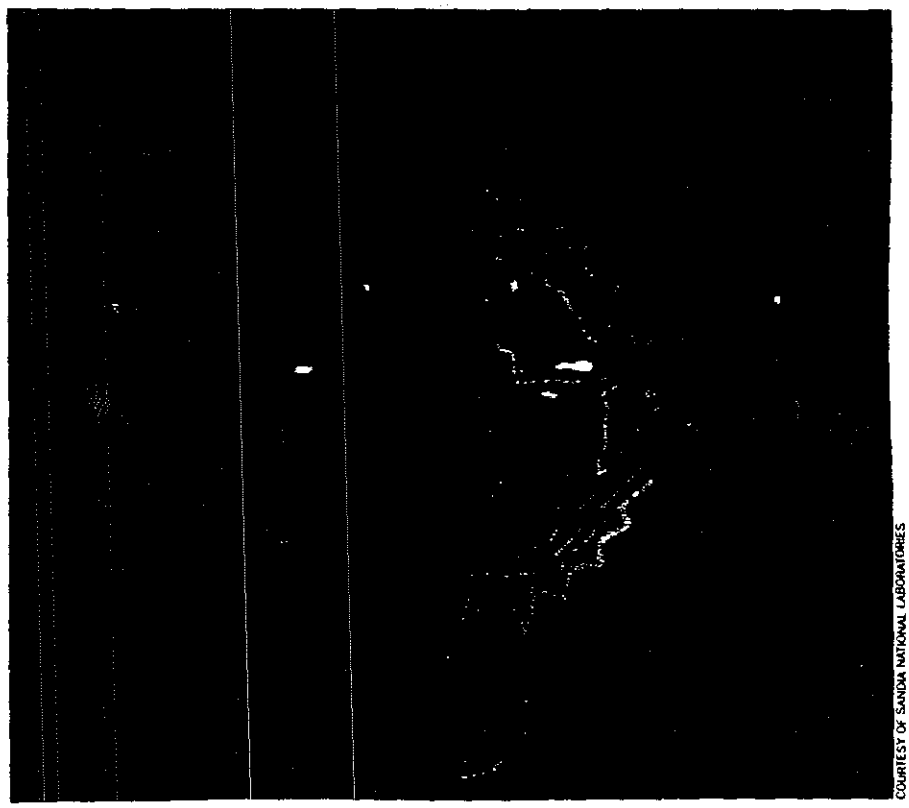
The hope that the labs could help enhance U.S. competitiveness in world trade was succinctly expressed by Sen. Pete Domenici, R-N.M. The labs are "our greatest trade secret," he said recently.

As Congress and others focus more attention on the labs' capabilities, interest will surely grow in their organizational structure. For government executives especially, the unusual, quasi-public nature of the labs is notable. From the beginning, the labs have been operated by private sector contractors that are not bound by civil service rules or pay scales, and thus they offer a long-running, if unintended, test of the privatization principles espoused by conservatives in Washington today.

As an example of the private sector's ability to manage programs for the government, the labs "have been a great success story," says James Culpepper, DOE's deputy assistant secretary for military applications.

Other close observers also attribute the labs' successes to their structure—which is known by the acronym GOCO, for "government-owned, contractor-operated." And believers in that structure argue that the GOCOs should be used in programs aimed at bolstering the nation's technological capabilities.

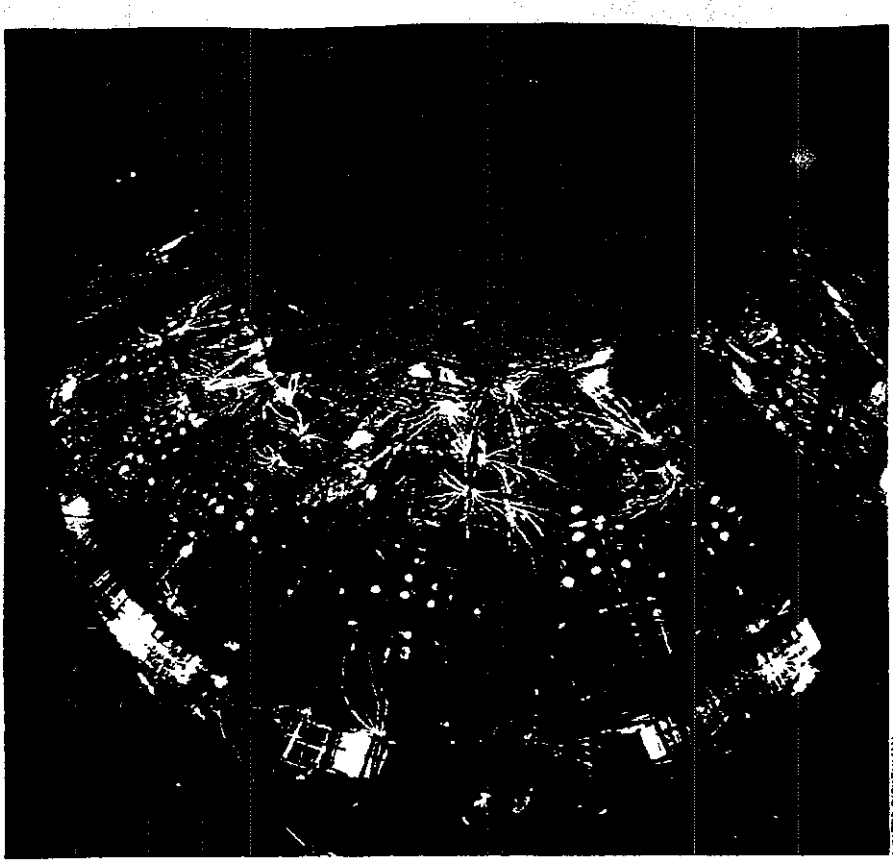
"There are a lot of people running around with ideas for new organizations to deal with



COURTESY OF SANDIA NATIONAL LABORATORIES

Optical holographic filters, under development at Sandia's Livermore, Calif., facility, will permit computers to recognize objects such as enemy missiles regardless of their angle of view. This computer-enhanced photo is a reconstruction of a drawing resembling a delta-wing aircraft.

Claude Barfield is director of science and technology policy studies at the American Enterprise Institute for Public Policy Research.



WALTER DICKENMAN

The world's most powerful particle accelerator, located in Sandia's Albuquerque facility, is used in efforts to produce a controlled fusion reaction. The 108-foot accelerator, first fired in 1985, produces at least 100 trillion watts of electricity. Experiments to implode pea-sized fusion fuel pellets should begin next year.

our competitiveness problem," said George Dacey, director of Sandia from 1981-86, in a recent interview. "But they have an excellent model right under their noses, with the GOCOs, which have responded superbly to technological challenges for 40 years. We should use them, rather than spreading money all over the place for untried organizations and ideas."

A program President Reagan proposed last January to establish new science and technology centers based at universities would not follow the GOCO model. However, DOE leaders do want the proposed $4.4 billion superconducting supercollider to be a GOCO project.

Organization and Structure

Los Alamos, Sandia and the Lawrence Livermore National Laboratory in Berkeley, Calif., are labs with dual defense and civilian missions. As such, they would be at the core of any efforts to use the labs to promote the simultaneous advance of defense and competitive capabilities. Together with six other DOE multiprogram labs whose research is confined to civilian missions, they employ more than 8,000 scientists and 7,500 engineers and have operating budgets totaling about $6 billion a year.

Organized during World War II, the labs expanded beyond defense research after the war, picking up responsibility for research on civilian nuclear power and related radiation and health effects. By the mid-1950s, several of the labs boasted capabilities in many disciplines, including physics, chemistry, biology and mathematics, as well as wide-ranging engineering expertise on making bombs from fission and fusion power. Meanwhile, the national labs also gained sway over the so-called "national trust" missions in the physical sciences, including high-energy physics and the radiobiological sciences.

When the energy crisis hit in the mid-1970s, the national labs, with mixed and controversial results, devoted substantial resources to basic and applied research and development of alternative energy technologies.

The organizational structure of the DOE national laboratories was born of Cold War exigencies and lack of governmental experience in managing large-scale scientific and technological enterprises. So it was that President Truman directed that a diverse group of contractors be enlisted to run the labs, including individual universities, university consortia and industrial firms. Los Alamos is operated by the University of California (Berkeley); Sandia, by American Telephone & Telegraph Co.; and Brookhaven National Laboratory by Associated Universities Inc.

Contractors, particularly industrial firms, were reluctant to take on the task. To allay their fears of entrapment in government red tape, the government gave them wide latitude to operate independently and to achieve a size commensurate with the challenge of their missions.

These concessions contributed much to the labs' subsequent success and high reputation, say close observers. Herman Roser, who has long been associated with the labs, and who served as Assistant Secretary of Energy for Defense Programs from 1981-84, says: "Two big factors account for their success. They have not had to operate under the Civil Service system, which meant that they could pay what the market dictated for talent and not be bound by narrow GS ratings or job descriptions. Second, they could quickly put together multidisciplinary teams from their own ranks to attack science or technology problems when they arose."

That point was also made by Orval Jones, Sandia's executive vice president, during an interview in Albuquerque. He added that another key element is "the ability, because of our size and diversity, to achieve a critical interdisciplinary mass when we attack a problem, to bring together different perspectives from electrical and mechanical engineers, high-energy physicists, chemists, biologists and math whizzes. That interaction, which we have honed to a fine degree here, is almost unique for research organizations."

The nine DOE national labs have staffs ranging in size from 2,500 to 8,500, most mixing a large number of scientific and technical disciplines.

Pay can range far above federal salary caps. Ranking managers and scientists at Sandia earn $150,000 or more.

Los Alamos and Sandia

Los Alamos and Sandia, each with payrolls exceeding 8,000 people, offer interesting case studies of the national labs' differing capabilities and responses to today's defense and competitiveness challenges.

Los Alamos was founded in 1943, and its early history is indelibly identified with J. Robert Oppenheimer and the program to develop the world's first nuclear weapon. Today its primary focus remains the science of national security, with major programs in advancing nuclear warheads, innovative weapons design, verification and control technology, nuclear material production, strategic defense research and non-nuclear munitions and weapons. Los Alamos also has conducted extensive R&D programs in energy, including work on nuclear fusion and

advanced fission reactors, and geothermal and solar energy.

The lab has also developed substantial ancillary expertise in material science, computers, and radiobiology; in September, it announced a breakthrough in computer tracking of the evolution of the AIDS virus.

Los Alamos employs almost twice as many scientists as engineers. At Sandia, on the other hand, the ratio is reversed: about one scientist for every two engineers. Sandia's defense role is largely confined to the engineering and systems integration of nuclear weapons. The lab has also done extensive work in arms control verification and advanced conventional weapons. Until 1973, Sandia's activities were 100 percent defense-related, but since then it has expanded into energy research and engineering in the areas of combustion, solar and photovoltaics research and fossil fuel extraction technology.

The approaches taken by the two labs to the defense and civilian innovation missions vary principally because of differences in their primary missions, in the nature of the contractors who run the enterprises, and in the technical backgrounds of their research staffs.

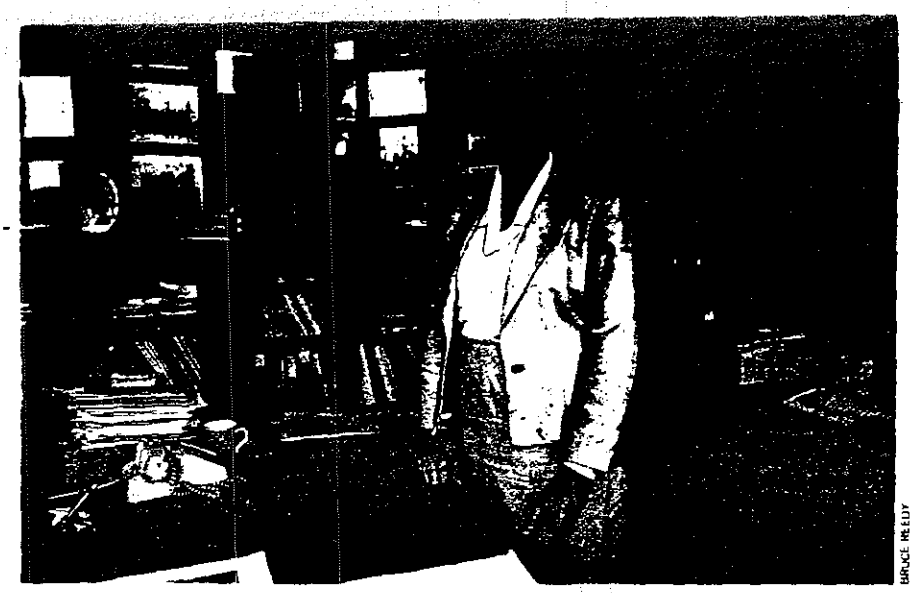
"Los Alamos has always been dominated by scientists, and its parent contractor is the University of California," says Antoinette Joseph, director of field operations in DOE's Office of Energy Research. "Thus, to some degree it resembles an academic campus, with a preference for discussions of cutting-edge science within a collegial, almost seminar-like setting. Sandia's strength is in applied engineering and systems integration—big projects with identifiable products and results."

She adds that the DOE contractors running the labs also impart "a real difference in leadership. At Sandia, the lab directors have often come directly from, and then gone back to, the AT&T corporate hierarchy. The model is more results-oriented than Los Alamos."

Roser adds, "They're more imaginative at Los Alamos, but they would chew on a problem forever if you'd let them. They really need stronger input from industry. At Sandia, on the other hand, you can count on meeting deadlines even with the most complex systems project." The two are "suprisingly complementary" and a "true national asset," he says.

Managers' Goals, Incentives

Managers in the DOE laboratories occupy an unusual position in the U.S. scientific and technological workplace. Public funds support their research and a federal department oversees their programs, yet they are not part of the federal Civil Service and enjoy wide latitude in how they achieve their defined goals.



BRUCE McELOY

"DOE protected [lab managers] for a long time from a changing world here in Washington, but that is no longer possible. Everybody second-guesses everybody else in Washington these days."

Antoinette Joseph
Office of Energy Research, DOE

The "enormous challenge of the work" and the first-rate research tools at the labs help attract an accomplished staff, says Sandia's Jones. Warren Miller, deputy director for research at Los Alamos, observes that scientists working at the labs "are much more likely to keep up with, and be a part of, the cutting edge of their profession than typical scientists working for the federal government." Dacey added that "Sandians do not think of themselves as federal bureaucrats. 'Bureaucrat' is a kind of pejorative term out here."

Ties between DOE and the labs, usually harmonious in the past, have shown signs of strain in recent years. In 1983, a prestigious White House science panel headed by David Packard, chairman of the board of Hewlett-Packard Co., criticized the department for "excessively detailed direction of laboratory R&D activities" and concluded that such 'micromanagement' has seriously impaired R&D performance at the labs. The panel blamed "lack of stability in DOE," including many personnel changes and shifting, unfocused missions, as causes of the department's deficient leadership.

While DOE has moved to remedy other criticisms in the report, managers at Los Alamos and Sandia don't see much less micromanagement now than in 1983. "If anything, says Jones, "the situation has gotten a little worse. It seems that every time we turn around there are new orders, regulations, forms and directives." That assessment is shared by Roser, himself a former DOE official with direct laboratory oversight.

Joseph, whose DOE office of energy research is not itself the subject of major criticism from the lab managers, defends the overall record of the department, arguing that there was a certain insularity and lack of political reality in the managers' criticisms. "DOE protected them for a long time from a changing world here in Washington, but that's no longer possible," she says. "Everybody second guesses everybody else in Washington these days. DOE—and the labs—have to respond to investigations and recommendations from a much larger universe—from the DOE Inspector General, from OMB, from GAO, from OTA and from heaven knows how many congressional staff members. It's easy to blame the department, and sometimes it may be at fault, but often managers here are just reacting to demands placed on them that they can't ignore or finesse."

National Security: Still Top Priority

Although leaders of the two labs want to help meet the challenge of U.S. civilian competitiveness, they say that national security programs will remain their central priority.

Defense accounts for about 70 percent of the work at Los Alamos and 80 percent at Sandia. At Los Alamos, says Hecker, non-defense work "will augment rather than be a substitute for our defense mission."

Lab officials anticipate that the composition of their defense work will change during the next decade. Jones says that Sandia's planning is "increasingly taking into account the likelihood of major arms control agreements in the next few years. They will have a real impact on the size and contents of the current U.S. nuclear stockpile. In addition, we have the largest arms control verification technology program in the nation, and under the potential new agreements, that will assume even greater importance."

E. H. Beckner, vice president for defense programs at Sandia, says the intermediate-range nuclear missile treaty under negotiation between the United States and the Soviet Union would likely produce increased demand on lab resources in two areas: conventional weapons and short-range tactical nuclear weapons.

If an agreement is signed, he says, U.S. allies, particularly West Germany, might well "demand a shoring up of weakened defenses in Europe, to give them the ability to withstand or turn back a Soviet invasion. This will mean newer, faster, more accurate tactical nuclear weapons not included in the agreement, and more sophisticated, smarter conventional weapons. For that, they would turn to the labs."

At the moment, the labs are centrally involved in the Reagan Administration's most important new defense program, the multi-billion-dollar Strategic Defense Initiative. Lawrence Livermore, Los Alamos and Sandia rank 4th, 8th and 14th among the top SDI contractors in terms of dollars awarded from 1983-87, according to a study released by the Federation of American Scientists this spring. Grouped together, they would rank first; with contracts exceeding $1.2 billion during the period.

Roger Hagengruber, Sandia's vice president for exploratory systems development, observed that the labs' budgets "look high, because so much of SDI is in a research phase; once you get to testing and development, our budgets will pale beside those of the major defense contractors."

Dacey, who headed Sandia for the first three years of SDI, says the lab had not viewed the program as a source of additional staff and had been careful to concentrate its work "only in those areas where we had unique experience and capability." Los Alamos took a similar view of its role in the SDI program, says Peter Lyons, the lab's deputy associate director of defense research programs.

Despite the caution, Hagengruber and others make it clear that the labs' scientists are excited by the formidable challenges presented by SDI technologies. "U.S. strength has always depended on the vigor of our R&D base," Hagengruber says. "SDI challenges us across a broad front of technologies, and while we cannot know the outcome or results of our efforts in every area, the payoff militarily and technologically for the nation is bound to be large."

Los Alamos, with $458 million in SDI contracts in 1983-87, is conducting research on directed energy weapons, electromagnetic launchers (railguns), nuclear back-up options in the event of Soviet abrogation of the ABM treaty, and ways to make SDI systems less vulnerable to countermeasures. Sandia, with $217 million in contracts, is working on various systems-engineering, analysis and testing projects.

The Competitiveness Challenge

In Washington's search for ways to make the product of U.S. industry more competitive in world trade, science and technology are at the center of discussion. Proposals abound

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Top managers at the national laboratories include (from left to right): Siegfried Hecker, director at Los Alamos; Orval Jones, executive vice president at Sandia; and Roger L. Hagengruber, Sandia's vice president for exploratory systems development.

for new programs and new institutional arrangements (a Technology Department, for example) to promote innovation.

After achieving large budget cuts for civilian R&D programs, the White House in 1984 began a National Science Foundation (NSF) program to create engineering research centers linking industry and universities. There are now 11 centers, and the NSF plans five or six more in the next year.

In his State of the Union address last January, Reagan proposed further steps in the interest of U.S. competitiveness: the establishment of a separate group of science and technology centers that would link industry with universities, but in this case would exploit research opportunities in key scientific disciplines.

Top officials at the DOE laboratories, along with a number of congressional leaders, are convinced that the labs should play a much more active role in fostering civilian innovation. To this end, Sen. Domenici proposed on June 9 that the national labs be assigned to lead consortia researching three items: harnessing superconductivity, mapping the human genome, and forging advanced semiconductor manufacturing techniques.

R&D centers would be created at the DOE labs, with increased authority to enter cost-sharing research agreements with industry, grant exclusive patent rights where appropriate and otherwise conclude a variety of licensing agreements with companies in the private sector. In testimony before the House Science and Technology Committee on June 10, Los Alamos director Hecker made a more specific and detailed proposal on superconductors. He suggested that Congress provide $5 million over five years to establish six to eight research centers at the labs to study superconductor technologies.

Culpepper indicated that the Administration would look skeptically on proposals to give the labs such powers as the independent right to grant patents, saying that Washington would insist on a strong hand in decisions related to national security issues.

NSF director Erich Bloch, though, has said he thinks the DOE labs could have a role to play in the new R&D centers the Administration is planning.

Earlier efforts to use the national labs to speed civilian technogical advances have had very mixed records, especially in the field of energy.

The DOE's attempts to push solar, wind, geothermal and other energy technologies to the point of commercial viability were disappointing. The labs aren't equipped to read market signals, observed Dacey. And at DOE, Joseph predicted they would run into the same problem in attempts to move beyond defense research programs that "don't have to take into account costs and bottom-line balance sheets."

Hecker recognizes the problem, but says he believes that "the realization over the last few years that we really are in a major competitive struggle has changed the attitude of both business and government toward each other. Industry is much more receptive to working with us, and the labs have made real efforts to give them meaningful access."

By defining goals modestly, emphasizing research, not product design, and targeting work to the needs and structure of the target industry, the labs can contribute to commercial innovation, he says. "We know that when we move beyond our defense role, life becomes more complex, and success is more elusive and harder to define. But given the magnitude of the challenge the United States faces in global competition, we must find better ways of utilizing the extraordinary technical resources in the national laboratories." □

SPEEDING TECHNOLOGY TRANSFER

One way in which the national laboratories could help U.S. industry compete in world trade would be to try harder to transfer the results of government-sponsored research to the private sector.

That, in fact, has been a goal Congress has pressed upon the labs for the past seven years, in the knowledge that only 5 percent of the patents granted to the federal government are ever used by industry. In contrast, 33 percent of private-sector patents are used by businesses.

As a result of a 1980 law, Los Alamos and Sandia National Laboratories each have an Office of Research and Technology Applications, with two full-time professionals working on technology transfer. Congress also has made it easier for businesses, universities and others in the private sector to secure rights to patents developed under Energy Department contracts.

Los Alamos and Sandia now regularly inventory lab technologies to identify processes and products of potential use to private industry. For example, Los Alamos identifed 190 materials technologies as having commercial value and held a seminar to present them to 49 interested companies. The labs also bring university scientists in on fellowships and conduct extensive outreach with university and corporate officials to encourage technology transfer. The labs also encourage their staffs to help start new businesses using technologies developed there.

Top managers at the labs argue that more could be done to speed technology transfer. They want the Energy Department to delegate to the labs its authority to grant exclusive patents to companies and individual entrepreneurs and to loosen some rules that prevent inventors on their staffs from pursuing commercial opportunities. And they want to cut red tape that now delays industry sponsorship of lab research.

The Academic-Industrial Complex

A host of new agreements for industrial sponsorship of academic research are the focus of a growing debate

At the Massachusetts General Hospital (MGH), Howard M. Goodman is setting up a new Department of Molecular Biology that will have a staff of 50 and ample research facilities. Its senior scientists will be recommended for faculty appointments at the Harvard Medical School, with which MGH is affiliated, but their support will come exclusively from Hoechst AG, a German pharmaceutical firm. Hoechst has founded the new department with a contractual guarantee of nearly $70 million over the next 10 years. That figure is a minimum; it could well be supplemented if Goodman's research team is productive in ways that are valuable to the company. In exchange for the $70 million, MGH has agreed to grant Hoechst exclusive worldwide licenses to any patentable developments that emerge from company-sponsored research.

At the Harvard Medical School itself, another new department is being established with substantial industrial investment. E. I. du Pont de Nemours & Company will spend $6 million over 5 years to support the new Genetics Department headed by Philip Leder. DuPont is not the sole support of the department, but it will receive licenses to market any commercially useful research for which it has paid.

At Rockefeller University, Chua Nam-Hai is conducting research on the structure and regulation of plant genes involved in photosynthesis. As of this spring, Chua's work will be supported by a 5-year, $4-million contract from the Monsanto Company, which will receive licenses to market patentable discover-

During the past 2 years, corporate investment in academic science has proliferated at major research universities throughout the United States, particularly those on the East and West coasts. From the university's point of view, the special appeal of the burgeoning industrial connection is quite simple—money. Federal support of basic research has been gradually declining for the past decade, and the situation has now been measurably worsened by the dismal state of the economy and the Reagan Administration's determination to reduce government spending. Grants from the National Institutes of Health (NIH) and the National Science Foundation, for example, are fewer in number and harder to get. For universities to turn to alternative sources of research support is not only prudent but downright essential. Scientists who 10 years ago would have snubbed their academic noses at industrial money now eagerly seek it out. University biologists who have collaborated throughout their careers only with each other are learning that collaboration with industrial scientists can be intellectually stimulating too.

From industry's point of view, its present investment in academic research arises not from some altruistic desire to help compensate for lagging federal support but rather from the very business-like judgment that universities have something corporations want to buy—research talent and technical skill. Recombinant DNA technology, for instance, which is on the verge of great commercial exploitation, has its intellectual roots on campus. But with rapid scientific advancement, the conventional distinction between basic and applied research has become blurred. The molecular biologists who have invented and developed recombinant DNA work thus have become a commodity of considerable interest to corporations. The fact is that, in nearly every case so far, industry has chosen to support specific individuals whose research talents are complementary to its needs. Industry, it is worth noting, is not bestowing large, "string-free" grants for universities to distribute on the basis of peer review. For example, when Hoechst decided it wanted to create a department for Howard Goodman to head, no MGH or Harvard Medical School committee was asked for advice. That is the norm.

Although universities have had corporate ties of one sort or another for years—traditional patterns of faculty consulting are a case in point—the present concentration of industrial interest in academic science is generating no small measure of concern about whether the academy is selling its soul. There are some common elements to these new university-industry connections, but there is no set pattern to the agreements, which take a variety of forms as attempts are made to devise ways of writing contracts that offer maximum protection to academic values. A few examples suggest the range of new linkages between industry and academe.

- Channing Robertson of Stanford University and Harvey Blanch of the University of California at Berkeley each will receive approximately $1 million over 4 years to support basic research in the development of chemical processes using genetically engineered microorganisms. The money comes from the Center for Biotechnology Research, a nonprofit organization which, in turn, is financed by a for-profit company called Engenics. Engenics was formed recently with capital from six major corporations—Bendix, General Foods, Koppers, Mead, MacLaren Power and Paper, and Elf Technologies of Société Nationale Elf Aquitaine—which see great promise in the work Robertson and Blanch are doing. Licensing agreements with the universities assure Engenics rights to commercially useful research; if Engenics flourishes, so will the nonprofit center, which will derive future income from its 30 percent equity interest in the company. The center must spend its resources on basic academic research. This unusual nonprofit/for-profit union

The recent growth of industrial investment in academic science has raised a number of ethical and legal issues applicable to the formation of university-industry relations. Throughout the United States, universities are struggling to develop guidelines that will permit collaboration to take place without seriously compromising traditional academic values. In a series of articles, News and Comment will examine some of the major new agreements and assess the implications of the academic-industrial complex.

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companies are to make nuclear exports to China.

Negotiations have been proceeding for some time and there were rumors that an agreement might be announced during Zhao's visit. The most substantial development, however, was the comment by Zhao during a formal toast at the state dinner that China "will not engage in nuclear proliferation. We will not help other nations develop nuclear weapons." The NNPA requires that U.S. nuclear technology can be sold only to countries that agree not to export nuclear weapons technology or information. Zhao's remark appeared to remove that issue from contention. Nonproliferation advocates, however, have been pressing the Administration to conclude an agreement only if the Chinese will also insist on the placing of safeguards on any nuclear technology they export.

U.S. sources expect the Administration to push to complete negotiations to make it possible for the agreement to be signed on President Reagan's scheduled trip to Peking in April.

—JOHN WALSH

Europe Eyes U.S. Model on Joint Research Rules

The ten member states of the European Economic Community (EEC), taking a cue from the Reagan Administration's effort to boost technological innovation, are considering a proposal that joint research efforts between high-technology companies in Europe be exempted from the stiff antimonopoly rules contained in the Treaty of Rome, the agreement setting out the code of economic behavior on which the community is based.

In the past, such exemptions have been permitted in individual cases. Last month, for example, the Brussels-based commission of the EEC agreed to allow three West German companies to collaborate in a joint program of research and development on coal gasification. Similar exemptions have also been negotiated for microelectronics research projects carried out under the umbrella of the European Strategic Program for Research and Information Technology (*Science*, 6 Jan., p. 28).

The commission of the EEC, in a draft regulation which is currently being circulated for discussion and is expected to be adopted by the council of ministers within the next few months, is now proposing a blanket exemption for similar research efforts in these and other fields, ranging from textiles to pharmaceuticals.

Some conditions would remain. An exemption would not be allowed, for example, for research projects involving more than one of the three largest European companies in any particular field. Nor would it be permitted when the combined turnover of the companies sponsoring the research exceeded $400 million, an attempt to ensure that the major beneficiaries of the new competition rules are medium-sized companies.

As in the United States, commission officials hope that the main effect of the proposed regulation will be to provide psychological reassurance to research managers that joint research projects will not be subject to a legal challenge from Brussels. At the same time, however, the commission is going further than the Reagan Administration in proposing that the exemption be extended to cover the joint production of new technological products arising from the research.

—DAVID DICKSON

Battelle Predicts Rise in R & D Spending in 1984

Thanks chiefly to a surge in spending by private industry, expenditures on research and development in the United States will climb to $94.2 billion in 1984, according to a forecast by the Battelle Memorial Institute. That would be an 8.9 percent increase over 1983 levels, or a 3.7 percent rise after inflation is taken into account.

According to the usually reliable Battelle figures, industry will spend $48.8 billion, a 10.3 percent increase, and the federal government will spend $42.7 billion, a 7.8 percent rise. The increased federal outlays largely reflect the continuing defense buildup. The Department of Defense is expected to account for 64.5 percent of government R & D expenditures in 1984, up from 58.9 percent in 1983.

—COLIN NORMAN

Guidelines for Artificial Heart Implants Revised

The University of Utah's review committee for research on human subjects has approved a revised and expanded protocol for implanting artificial hearts into patients. Pending review by the Food and Drug Administration, the approval opens the way for introducing an improved version of the artificial heart into patients who are healthier than was the first recipient of an artificial heart, Barney Clark. Clark died in March 1983 112 days after being implanted with such a device.

The revised procedure will allow University of Utah surgeons, directed by William C. DeVries, to select patients who are in less advanced stages of heart failure. Previously, the protocol called for waiting until the eighth week after a patient reaches what the American Heart Association designates as the fourth category of cardiomyopathy. One major difficulty in Clark's case was that his heart disease had caused considerable deterioration in other organ systems. Those complications were his immediate cause of death.

The revised protocol also has expanded the patient's informed consent form so that it now includes information gained from Clark's experiences. The new protocol removes any upper age limit for patients who undergo the experimental procedure, and it specifies that various nutritional and exercise regimes may be studied following the operation. In future implants, the synthetic heart valves will be made of solid titanium without the welds that caused problems in the model Clark received. Also, use of a portable support system during the postoperative period has been approved, potentially allowing future recipients to feel somewhat less encumbered during the recovery period than was Clark.

Two members of the review committee voted against the revised protocol, arguing that the next artificial heart recipients ought to be patients whose hearts have stopped suddenly and thus are not suffering from the multiple and potentially confounding complications seen in patients in the advanced stages of heart failure.

—JEFFREY L. FOX

Boy's Birth Is First From Embryo Transfer

By Jay Mathews
Washington Post Staff Writer

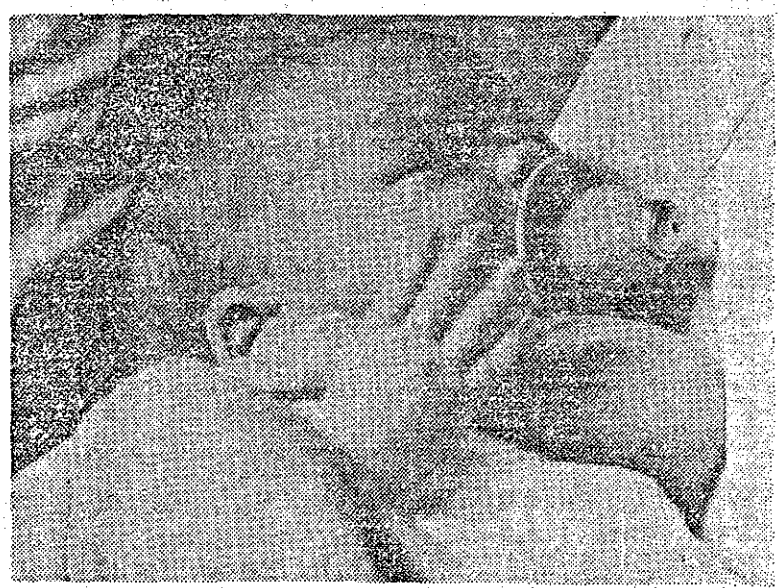
LONG BEACH, Calif., Feb. 3—A medical team today announced the first birth of a baby to a woman who received an embryo from another woman, the latest in a rapid succession of medical techniques designed to help infertile couples.

"This is an exciting day for us," said Dr. John E. Buster, head of the Harbor-UCLA Medical Center team, as he showed videotapes of the healthy boy, born about two weeks ago in Los Angeles County. Buster said that the parents, who had tried for eight years to have children, wished to remain anonymous.

Michael J. Eberhard, vice president of a company that is planning to set up a profit-making embryo transfer center here, said that 50,000 infertile American women could benefit from the procedure.

Unlike "in vitro," or in-glass fertilization, in which eggs are taken from an infertile woman and fertilized in a laboratory dish, the embryo transfer requires no surgery. It does, however, require the infertile woman to accept an egg from a donor who has been fertilized artificially with sperm from the infertile woman's husband. The child she bears, unlike in most in vitro fertilizations, will not be genetically related to her.

Australian doctors recently implanted an ovum in a woman after it had been surgically removed from another woman and fertilized in vitro, but the embryo spontaneously aborted days later. Buster said that his technique also might help a woman who could conceive but needs another woman to carry the fetus to full term.



Associated Press

Embryo-transfer baby was born two weeks ago; parents requested anonymity.

According to Buster, the woman who bore the first embryo-transfer baby had undergone three operations to try to correct several problems, including an inflammatory condition of the ovaries and the uterus, and blocked Fallopian tubes. He said that the new procedure will attract many women who do not want surgery and who want to avoid the several surgical extractions of eggs sometimes necessary before an in vitro fertilization works.

Another member of the team, Dr. Ingrid A. Rodi, said that some couples do not want to endure what may be a two-year wait at oversubscribed in vitro clinics. Internationally, about 250 babies have been born through the sometimes misnamed "test-tube" method. Forty centers in the United States are equipped for the procedure, but only a few have had regular success.

Reporters at a crowded news conference at the Memorial Medical Center here asked several members of the team, including physicist Richard G. Seed, the inventor of the transfer process, why it was considered necessary to patent the technique, as they are trying to do. Seed said that he thought that the in vitro process had not been patented because its developers did not know that they could do so.

Eberhard said that investors had spent nearly $3 million without government support to develop the transfer method and were entitled to some return. His company, Memorial Health Services, plans to set up the world's first ovum-transfer center at Memorial Medical Center this spring with the help of the Reproduction & Fertility Clinic Inc. of Chicago, which filed the patent applications. Team members indicated that the procedure would cost $4,000 to $7,000 for each attempted transfer, about the same as for in vitro attempts.

Although embryo transfer has been used with animals since 1890, doctors said that they had to develop a special method to flush the five- or six-day-old human embryo out of the donor's uterus and retrieve the ovum, still too small to see with the naked eye, so that it could be transferred to another woman.

Rodi said that the team is attempting to expand its current list of 12 ovum donors, who are paid about $250 for each month they undergo tests or ovum transfers, to about 50 women. This would make it easier to match blood type, hair and eye color, and menstrual cycle with those of the recipient.

Industrial Policy From the Grass Roots?

By Walter Olson

In Washington, the notion of "industrial policy" seems to be falling into a kind of disrepute. Recently three economists, spanning the ideological spectrum from the Brookings Institution to the American Enterprise Institute to the Heritage Foundation, jointly declared that the presumption "that politicians and government officials can 'pick winners' more efficiently than markets . . . has no basis in historical fact."

In the 50 states, however, industrial policy has met with a much more enthusiastic reception. The nation's governors and state legislators are rushing to embrace all sorts of schemes meant to direct and channel economic activity. Possibly the best known of these schemes is the proposed "Greenhouse Compact" in Rhode Island, which has been approved by the state legislature and will appear on the ballot as a referendum today. The compact is an ambitious plan (whose accompanying report takes up more than a thousand pages) for thrusting the state government deep into European-style planning of economic "winners" and "losers." Although it provides for at least $40 million in new spending, its proponents say they won't have to ask for tax boosts or cuts in other spending to pay for it; instead, taking a leaf from the supply-siders' book, they expect increased economic activity to provide a revenue re-flow big enough to pay for the program.

Rhode Island's plan is more sweeping than others, but it is no longer unique; dozens of states are experimenting with similar techniques. On May 11 and 12, representatives of various state governments met in Washington to discuss state industrial policies under the auspices of the National Commission on Industrial Innovation (NCII), a group founded and headed by former California Gov. Jerry Brown.

Would Coalition Be Desirable?

A recurrent theme of the conference, often announced as if it were a remarkable revelation, was that government, business and labor, and perhaps education too, should cooperate to solve national problems. The speakers seemed to complain that for some reason—sheer cussedness, perhaps—these groups have been fighting each other instead of working together.

Suppose it were possible to form such a "grand coalition" of the most powerful forces in the society. Would it be desirable? For any such tripartite or quadripartite consensus to endure, some proposals that would be good for productivity and innovation would have to be ruled off the agenda because they would harm the interest of one or another group. On the other hand, it may be only too easy to strike a deal satisfactory to all three or four big interests by sacrificing the interests of some unorganized or not-yet-existent group. Michael Barker of the Gallatin Institute, a Washington-based think tank, says: "The present is organized to the teeth. The future is unborn."

It should be easier to organize a grand coalition in one state than in the nation as a whole, for reasons that are familiar from the Federalist Papers. In a small state, interest groups are fewer and less diverse, and it may be possible to unite virtually the whole establishment behind a package deal. Rhode Island officials say that the only serious opposition to the Greenhouse Compact has come from a few economists at Brown University. In Washington, a large community of think tanks and policy analysts would have been picking away at the compact for months now. Even if the AFL-CIO and the Chamber of Commerce were inclined to negotiate some federal equivalent—which they are not—there is no assurance that Congress would enact the result.

The grand coalition can thrive when it finds the right victims. In Minnesota, business and labor leaders succeeded in passing legislation to discourage takeover bids for companies based in the state. Managements wanted job security, and the unions feared that out-of-state owners might close down local plants. The big losers were the shareholders, many or most of whom live in other states anyway.

Nowadays it is mostly the taxpayers who pick up the tab, since the new state industrial policies typically involve explicit or implicit subsidies to business. For states to compete for business simply by lowering taxes and cutting regulations, according to many industrial-policy advocates, is mere "smokestack chasing": Direct subsidies—which somehow escape this invidious label—are the wave of the future. These subsidies do not come free. The union and government partners get to attach strings. Most typically, a business must commit itself to provide some number of jobs—perhaps more than it strictly needs—and to forswear capital mobility by agreeing not to leave the state for some period.

Among the subsidies most commonly provided:

Job training. Little wonder that states have been rushing into this area, since it is the perfect subject of quadripartite agreement. Business gets its work force trained for free or on the cheap; educators get more work; labor gets jobs, and government officials get a new social program to take credit for. The strings attached can be significant, however. Tennessee is training workers for a new General Electric plant, but GE has to file detailed job descriptions well in advance, and the state, rather than GE, gets to take the job applications and do most of the screening of trainees.

All this competition for state money rewards grantsmanship more than entrepreneurship, especially since many businesses want nothing to do with government.

University research. Several states have developed new programs that push university research efforts toward areas with commercial potential. Advocates of industrial policy note that many European countries provide big subsidies for industrial research and product development. But doesn't the U.S., with fewer subsidies, far outcompete the Europeans in both areas? Regis McKenna, executive director of the NCII, acknowledges that it does. Then why do we need big new subsidy programs? Because, Mr. McKenna explains, research subsidies would allow business to free up its funds for marketing efforts.

California and other states have programs that invite companies to co-sponsor targeted research at universities on subjects of direct commercial value. It is ironic that Jerry Brown should be promoting this cause—and not simply because, as governor, he ruthlessly cut his state's university budgets. One of Mr. Brown's oldest political allies, the Western Center on Law and Poverty, is suing the University of California for allegedly working with business to develop farm machines that displace migrant workers.

"Incubators" and "greenhouses." For many years, university towns have been spinning off small high-tech companies. This process has come to the notice of state officials, who have decided that it would be more fruitful if they directed, organized and subsidized it. At least a half-dozen states have begun "greenhouse" programs that establish special buildings or complexes to house new businesses in one or another technical field. (A few states also operate full-fledged industrial parks.) A microelectronics greenhouse, for instance, will offer its tenants subsidized rent and perhaps other services, such as a library, copying equipment or shared computer time.

Sizable Funds

Why it is important to subsidize these costs rather than others is not clear. Cheap private quarters are available in most cities and, in any event, high-tech industry is not an especially intensive user of floor space. Still, a greenhouse is a much more visible result of a governor's efforts than a group of subsidized employers on scattered sites—and thus more gratifying to what Mr. Brown warns can be a yearning to "hang a government sign around every new job."

Mini-SBAs. The record of the federal Small Business Administration does not seem a very inspiring example. Even so, all 50 states have established their own mini-SBAs, sometimes to dispense advice to those who ask for it, sometimes to administer procurement set-asides, sometimes to furnish loans and grants. These funds can be quite sizable. On April 10, Pennsylvania's voters endorsed a $100 million fund to hold the debt of small and medium-sized firms. Montana is earmarking $30 million in coal-tax revenues for small-business loans, which is proportionally the equivalent of a federal SBA with $4.5 billion more to lend every year—something like 10 times the size of the actual federal SBA. Connecticut's Product Development Corp. extracts as its quid pro quo for grants not only a promise to provide in-state jobs but also a royalty on product sales.

All this competition for state money rewards grantsmanship more than entrepreneurship, especially since many fledgling businesses want nothing to do with government entanglements. Mr. Brown tells a story from 1977, a time when California was running a big surplus. He approached some Silicon Valley executives with a proposal to devote a chunk of the money to a "California 2000" fund to subsidize high-tech. "We don't want it," they told him. "Just get out of our way."

Mr. Olson is the associate editor of Regulation magazine, published by the American Enterprise Institute.

Emerging Soviet Emigres Raise Their Political Voice

By Igor Reichlin

This year, Ronald Reagan's bid for re-election may get unsought—but welcome—backing from a fledgling political group made up of Soviet Jews who found refuge in the U.S. in the early '70s and are now eligible to vote.

In New York City alone, there are more than 60,000 former Soviets and almost 20,000 of them already may be naturalized U.S. citizens. The emigres seem to have forceful views about the state of their new nation, and are now getting to have their say in American politics.

In 1982, almost 2,000 former Soviets (more than 75% of those eligible) voted for Brooklyn, N.Y., Rep. Stephen Solarz, a liberal Democrat who is emphatically pro-Israel and is credited with having frequently appealed to the Kremlin on the behalf of Soviet Jews.

Nevertheless, when speaking of the federal government, many of these new Americans say the Reagan administration has a realistic foreign policy and can contain communism better than the Democrats. Also, having seen the economy at the Ralph Bunche Institute, a New York-based think tank, took a nationwide poll of Soviet refugees. His recently published study suggests "The Republican Party enjoys substantial prestige with the new immigrants who consider—and approve—its stance on the law-and-order issue as firm, and its domestic and foreign policy as forthright. Their attitude places them fairly close on the right wing of the Republican Party."

In general, these emigres seem to differ drastically from those Russian Jews who came to the U.S. at the turn of the century numbering almost two million and who brought a peculiar mix of ideas on how to achieve social equality and justice that fueled the already rising trade-union movement here.

Soviet Jews, however, had already experienced what social justice and equality could mean in a socialist state and lost faith in these values. One emigre recently suggested the equation "Democrats=liberals=communists."

Coming from a totalitarian society, the emigres approach Western democracy in a ticle in our newspaper, he doesn't try to write an opposite article," said Peter Vail, then an editor of an emigre weekly New American, in a broadcast interview. "But his first wish is to close the newspaper and put us all into jail."

This interview, shown a year ago on public television in a documentary "The Russians Are Here," left few emigres indifferent. Neither did the program itself, written, directed and produced by Ofra Bikel. Almost in unison, the emigres claimed the PBS show was politically biased, portraying them as the rejects of the Soviet system and the misfits in American society.

Two ideologies clashed here, says Mr. Levkov: Ms. Bikel's own critical approach to American society, and the former Soviets' political orthodoxy. And when Ms. Bikel's film suggested the emigres were maladjusted because they failed to appreciate American freedom, they saw it as her attack on their conservative outlook.

ever performances had been scheduled. As a result, the concerts took place only in two cities out of seven and the total turnout was down to several hundred instead of the expected thousands.

The concert affair was the first political victory for the emigres, as it dealt a blow to the Soviets, who apparently had expected to win back some of the emigres' nostalgic sympathy—and dollars. It also "brought political awareness to many emigres," says Gene Sosin, director of program planning for the Radio Free Europe/Radio Liberty (a U.S. government broadcasting station), who for many years has worked with the former Soviets in Europe and the U.S. Still, the question remains: Will they be able to play any meaningful part in American politics?

Boris Velberg, New American's editor in chief, doesn't see it happening soon. "Although every three out of four emigres now say they prefer Reagan, most of them can hardly participate in political activities of

companies are to make nuclear exports to China.

Negotiations have been proceeding for some time and there were rumors that an agreement might be announced during Zhao's visit. The most substantial development, however, was the comment by Zhao during a formal toast at the state dinner that China "will not engage in nuclear proliferation. We will not help other nations develop nuclear weapons." The NNPA requires that U.S. nuclear technology can be sold only to countries that agree not to export nuclear weapons technology or information. Zhao's remark appeared to remove that issue from contention. Nonproliferation advocates, however, have been pressing the Administration to conclude an agreement only if the Chinese will also insist on the placing of safeguards on any nuclear technology they export.

U.S. sources expect the Administration to push to complete negotiations to make it possible for the agreement to be signed on President Reagan's scheduled trip to Peking in April.

—JOHN WALSH

Europe Eyes U.S. Model on Joint Research Rules

The ten member states of the European Economic Community (EEC), taking a cue from the Reagan Administration's effort to boost technological innovation, are considering a proposal that joint research efforts between high-technology companies in Europe be exempted from the stiff antimonopoly rules contained in the Treaty of Rome, the agreement setting out the code of economic behavior on which the community is based.

In the past, such exemptions have been permitted in individual cases. Last month, for example, the Brussels-based commission of the EEC agreed to allow three West German companies to collaborate in a joint program of research and development on coal gasification. Similar exemptions have also been negotiated for microelectronics research projects carried out under the umbrella of the European Strategic Program for Research and Information Technology (*Science*, 6 Jan., p. 28).

The commission of the EEC, in a draft regulation which is currently being circulated for discussion and is expected to be adopted by the council of ministers within the next few months, is now proposing a blanket exemption for similar research efforts in these and other fields, ranging from textiles to pharmaceuticals.

Some conditions would remain. An exemption would not be allowed, for example, for research projects involving more than one of the three largest European companies in any particular field. Nor would it be permitted when the combined turnover of the companies sponsoring the research exceeded $400 million, an attempt to ensure that the major beneficiaries of the new competition rules are medium-sized companies.

As in the United States, commission officials hope that the main effect of the proposed regulation will be to provide psychological reassurance to research managers that joint research projects will not be subject to a legal challenge from Brussels. At the same time, however, the commission is going further than the Reagan Administration in proposing that the exemption be extended to cover the joint production of new technological products arising from the research.

—DAVID DICKSON

Battelle Predicts Rise in R & D Spending in 1984

Thanks chiefly to a surge in spending by private industry, expenditures on research and development in the United States will climb to $94.2 billion in 1984, according to a forecast by the Battelle Memorial Institute. That would be an 8.9 percent increase over 1983 levels, or a 3.7 percent rise after inflation is taken into account.

According to the usually reliable Battelle figures, industry will spend $48.8 billion, a 10.3 percent increase, and the federal government will spend $42.7 billion, a 7.8 percent rise. The increased federal outlays largely reflect the continuing defense buildup. The Department of Defense is expected to account for 64.5 percent of government R & D expenditures in 1984, up from 58.9 percent in 1983.

—COLIN NORMAN

Guidelines for Artificial Heart Implants Revised

The University of Utah's review committee for research on human subjects has approved a revised and expanded protocol for implanting artificial hearts into patients. Pending review by the Food and Drug Administration, the approval opens the way for introducing an improved version of the artificial heart into patients who are healthier than was the first recipient of an artificial heart, Barney Clark. Clark died in March 1983 112 days after being implanted with such a device.

The revised procedure will allow University of Utah surgeons, directed by William C. DeVries, to select patients who are in less advanced stages of heart failure. Previously, the protocol called for waiting until the eighth week after a patient reaches what the American Heart Association designates as the fourth category of cardiomyopathy. One major difficulty in Clark's case was that his heart disease had caused considerable deterioration in other organ systems. Those complications were his immediate cause of death.

The revised protocol also has expanded the patient's informed consent form so that it now includes information gained from Clark's experiences. The new protocol removes any upper age limit for patients who undergo the experimental procedure, and it specifies that various nutritional and exercise regimes may be studied following the operation. In future implants, the synthetic heart valves will be made of solid titanium without the welds that caused problems in the model Clark received. Also, use of a portable support system during the postoperative period has been approved, potentially allowing future recipients to feel somewhat less encumbered during the recovery period than was Clark.

Two members of the review committee voted against the revised protocol, arguing that the next artificial heart recipients ought to be patients whose hearts have stopped suddenly and thus are not suffering from the multiple and potentially confounding complications seen in patients in the advanced stages of heart failure.

—JEFFREY L. FOX

America Dominates in Biotechnology

OTA study highlights U.S. strengths but also notes potential vulnerability to foreign competitors—especially the Japanese

The United States has a commanding lead over its industrial competitors in the development and application of biotechnology, an exhaustive study by the Office of Technology Assessment (OTA) has concluded. American dominance of the fledgling industry is so extensive, according to OTA, that U.S. companies hold an edge in virtually every area, from basic research to the ability to attract high-risk capital.

Nevertheless, the report is quick to point out that the U.S. lead, though large, is not unassailable, and it dwells at length on some potential vulnerabilities. Given the high-decibel attention currently being paid to high-technology industry is the United States, the study is likely to spark a chorus of political rhetoric about the need to stave off yet another foreign technological challenge. Japan is reckoned to be the closest competitor, followed, in order, by West Germany, the United Kingdom, Switzerland, and France.

The strengths of the U.S. biotechnology enterprise are, however, more obvious than its weaknesses. Take, for example, funding. The OTA study indicates that the private sector in the United States invested more than $1 billion in 1983 to commercialize new biological techniques, which are defined as recombinant DNA, cell fusion, and novel bioprocessing technologies. Although some large chemical and pharmaceutical companies are putting money in biotechnology, a large fraction of U.S. investment has gone to start-up companies financed by venture capital. In contrast, in Europe and Japan, where tax laws do not favor the creation of venture capital funds, virtually all of the work is being done by large pharmaceutical companies. This difference alone has given the United States a comparative advantage in the ability to capitalize rapidly on the results of basic research, OTA says.

In research funding, too, the United States is miles ahead. OTA calculates that the U.S. government spends more than $500 million a year on biotechnology-related research and development, while the Japanese government spends only about $60 million. This provides a well-developed base on which the U.S. biotechnology industry has built. Moreover, the recently established links between university scientists and biotechnology companies—themselves partly a reflection of the booming venture capital markets—have moved the technology rapidly into the private sector. University-industry links have not flourished as vigorously in Europe and Japan.

If the U.S. industry does have an Achilles heel, however, it may be the relative lack of funding to develop new engineering technologies related to the production of biotechnology products. "In the next decade, competitive advantage in areas related to biotechnology may depend as much on developments in bioprocess engineering as on innovations in genetics, immunology, and other areas of basic science," OTA argues. And it points ominously to the fact that the federal government spends only about $6.5 million a year on developing such technologies.

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Japan, in contrast, spends a relatively large fraction of its government funds for biotechnology on solving generic problems in bioengineering. "This strategy worked well in the semiconductor industry, and Japan may very well attain a larger market share for biotechnology products than the United States because of its ability to rapidly apply results of basic research available from other countries," OTA warns. What is needed to counter this approach? More federal funds for generic applied research, together with money for training grants is the stock answer.

Another potential vulnerability is the flip side of one of the strengths of the U.S. industry. All those new companies launched with venture capital will need major injections of new funds because they are likely to continue to report heavy losses in the next few years. Venture capital is good for starting up companies but not for keeping them going because the short-term returns are not so attractive. The staid, but wealthy pharmaceutical companies that are getting into biotechnology in Europe and Japan, in contrast, can use retained profits to underwrite their new ventures. OTA suggests a variety of creative tax measures to keep the money flowing into U.S. companies as they move from infancy into adolescence.

Some biotechnology companies are, however, already making good use of current tax laws to entice funds from wealthy investors. For example, limited partnerships and private stock placements are increasingly being used to fund such costly endeavors as clinical trials, scaling up processes for commercial production, and early product development. Limited partnerships alone are estimated to have channeled $500 million into biotechnology in 1983, and the figure could climb to a staggering $1.5 billion in 1984. U.S. tax laws provide much greater encouragement than those of other countries for the creation of such partnerships.

But it is clear from OTA's analysis of the products currently being pursued by the industry that an inevitable shakeout is in store. With perhaps 200 companies launched in the past few years and only about two dozen products nearing commercial introduction, there is unlikely to be room for everybody—no matter how attractive the federal government makes the tax environment.

Although the OTA report is extremely upbeat about the economic potential of biotechnology, one figure should give some pause. Only about 5000 jobs have so far been created in the industry, and the production phase is expected to be equally capital-intensive. Biotechnology companies will clearly provide few jobs for those communities that are assiduously wooing them.

What impact is the study likely to have on U.S. policy? Although it was commissioned by several congressional committees looking for ways to blunt a possible technological challenge from Japan, it is, ironically, likely to have more of an impact on the policies of the United States' competitors. Noting that the report concludes that U.S. biotechnology is, by and large, healthy, Nanette Newell, the project director, predicts that scientists and politicians in other countries may use it as ammunition to argue for domestic political and economic reforms.—COLIN NORMAN

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INSIDE: THE SCIENCE AGENCIES

WASH. POST 1/31/84

The Japanese are challenging the U.S. lead in yet another new technology—gene engineering—and that lead could vanish in the next few years if basic research isn't translated into commercial products, the congressional **Office of Technology Assessment** says in a new report.

"Biotechnology has, to date, been an American success story . . . ," said Rep. **Albert Gore Jr.** (D-Tenn.), who asked for the study. "It is imperative that we not let this advantage slip away from us, and we need to ensure that this industry is not crippled."

"U.S. efforts to commercialize biotechnology are currently the strongest in the world," said the 612-page report, citing the nation's well-developed base in the life sciences, entrepreneurial spirit and the availability of financing for high-risk ventures.

Last year, private industry spent more than $1 billion to research and develop methods of manipulating the genetic makeup of existing organisms, the technology office said.

The report said, however, that the U.S. lead may evaporate during the next decade if federal support of basic research continues to decline and if more funds are not provided to help turn laboratory successes into commercial products.

The report said that the United States has not followed through on its lead in basic research in gene engineering. It said that the technology to take gene engineering out of the lab and into the factory is complex and that not enough people here are trained to do that.

Instead of concentrating on basic research, the Japanese government has spent considerable amounts of money on industrial processes.

The report, written under the direction of the OTA's **Nanette Newell**, said the U.S. government spent about $511 million last year on basic research in biotechnology, but only about $6.4 million on applied research, such as funds to train students in commercial biological methods.

The Japanese government, on the other hand, spends a substantial proportion of its annual $60 million biotechnology budget on applied research, the report said. Specific numbers were not available for Japan, the OTA said, but the West German and British governments both spend up to 10 times more on commercial biotechnology research than does the United States.

ANTITRUST

The report suggested several options Congress could choose to try to boost the U.S. industry: funding the retraining of industrial workers, changing antitrust policy to allow companies to share workers and resources, restricting imports of biotechnology products, restricting the export of U.S. knowledge and equipment and giving federal aid to specific industries or technologies.

Gore said he would work in the House Science and Technology Committee to boost spending in the fiscal 1985 budget, but he declined to discuss specific amounts. He also called for Senate action on House-passed legislation to create a $425 million annual program of aid to states for math and science education.

The report was criticized by author **Jeremy Rifkin**, president of the Foundation for Economic Trends, which has questioned the scientific and ethical implications of practical applications of biotechnology. In a statement, Rifkin said the report "reflects a pro-industry bias" that gives "only brief consideration" to potential environmental risks.

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INDUSTRIAL RESEARCH . . . A boom in industrial research has started, according to the **National Science Foundation**. Company-financed research is expected to increase by about 11 percent in fiscal 1984 to $48 billion, according to the NSF's **Science Resource Studies Office**.

In a survey of 76 companies in six major industries, five of the industries said they were planning double-digit increases in company-funded research. From 1982-84, two of the biggest increases came in machinery (17 percent) and chemicals (12 percent). The motor vehicle industry is lagging behind, with only a 2 percent average annual increase in constant dollars.

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The United States is immune from suit under the doctrine of sovereign immunity except a sit consents to be sued. *United States v. Mitchell*, 445 U.S. 535, 538, *reh'g denied*, 446 U.S. 992 (1980); *United States v. Testan*, 424 U.S. 392, 399 (1976). Further, "[a]waiver of sovereign immunity 'cannot be implied but must be unequivocally expressed.'" *Mitchell, supra*, 445 U.S. at 538 *quoting United States v. King*, 395 U.S. 1, 4 (1969). In an action for money damages it is clear that the Administrative Procedure Act cannot serve as a basis for a waiver of the Government's sovereign immunity. *See Califano v. Sanders*, 430 U.S. 99, 104-07 (1977); *Newson v. Vanderbilt University*, 653 F.2d 1100, 1107 (6th Cir. 1981). The Federal Tort Claims Act, 28 U.S.C. §2671 et seq., which waives to some extent the Government's immunity, is of no avail to appellant's claim of waiver since §2680(c) of that Act provides an exception to a claim for relief arising from the assessment and collection of taxes. It is clear that the United States has no waived its immunity to suits of this nature. *See Stanke-vitz v. IRS*, 640 F.2d 205, 206 (9th Cir. 1981); *Mack v. Alexander*, 575 F.2d 488, 489 (5th Cir. 1978).

Appellant cites *Larson v. Domestic and Foreign Commerce Corp.*, 337 U.S. 682 (1949), as authority to abolish the doctrine of sovereign immunity. However, *Larson* does not stand for such a proposition, but, rather, the Court stated that such a repudiation was left to the will of Congress. 337 U.S. at 704-05. *See Newson, supra*, 653 F.2d at 1107.

V

Appellant's final claim is that the district court erred in dismissing her claim against Kentucky state police officer Donald Powers. Appellant avers that officer Powers conspired with the other defendants to deprive her of her constitutional rights, alleging that Powers contacted the IRS and gave erroneous information which resulted in the faulty tax assessment. Appellant also claims that Powers, under color of state law, defamed her by telling friends and associates that she was involved in drug trafficking.

In dismissing the claim against officer Powers the district court held that since he was the only remaining defendant he could not be held to conspire with himself. Although it would be in error to dismiss the conspiracy claim against powers merely because District Director McHugh was accorded qualified immunity, *see Dennis v. Sparks*, 449 U.S. 24, 28 (1980), *Macko v. Bryon*, 641 F.2d 447, 449-50 (6th Cir. 1981), the record is void of any proof as to a conspiracy between Powers and the other defendants.

The record shows that officer Powers, pursuant to his legal authority, executed a valid warrant to search the home of appellant. Further, the record demonstrates that Powers did not contact the IRS concerning appellant's alleged involvement in drug trafficking, but another police officer contacted the IRS without the approval or authority from officer Powers. While it is true that Powers, in his individual capacity, could be liable for any wrongful acts committed in his official capacity under 42 U.S.C. §1983, it is clear from the record that, beyond the bare and unsupported allegations made by the appellant, no claim can be made against this defendant. Although the appellant raises the issue that Powers defamed her by saying to her friends and associates that she had been selling narcotics, we note that the claim of defamation, standing alone, is not subject to redress under §1983, absent more tangible harm. *See Paul v. Davis*, 424 U.S. 693, 709 (1976), *reh'g denied*, 425 U.S. 985 (1976).

Accordingly, the judgments of the district court are affirmed. No costs are taxed. The parties will bear their own costs on this appeal.

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LIMITATIONS PERIOD: EXECUTOR'S LATE FILING NOT EXCUSED BY ATTORNEY'S ADVICE

An executor's late filing of the estate tax return is not excused by his reliance on an attorney. (U.S. Court of Appeals for the Eighth Circuit)

Facts: John J. Smith, the plaintiff-appellant, was appointed personal representative of the estate under the will of Ann Olson, who died on Dec. 17, 1978. Smith retained an attorney to help settle the estate. The estate tax return for Olson's estate was due nine months after her death pursuant to §6075(a). Unfortunately, Smith's attorney was under the mistaken impression that the return was not due until one year after Olson's death.

On Dec. 7, 1979—over two months after the due date—Smith filed the estate tax return for Olson's estate. The IRS assessed a late-filing penalty of $5,232 pursuant to §6651(a)(1). Smith paid the penalty, filed a claim for a refund, and upon its denial instituted this action in the district court.

Holding: Smith's reliance on his attorney did not constitute reasonable cause for his failure to file the estate tax return within the nine-month period.—CA 8; *Smith v. U.S.*, No. 82-1767, 3/29/83.

Partial Text of Opinion: Smith concedes that he failed to file the tax return for Olson's estate within nine months of her death as required by 26 U.S.C. §6075(a). Section 6651(a)(1) of the Internal Revenue Code provides that if a tax return is not timely filed, there shall be added to the tax due a five percent penalty for each month the return is unfiled, not to exceed twenty-five percent of the tax due, "*unless* it is shown that such failure is due to *reasonable cause* and not due to wilful neglect." 26 U.S.C. §6651(a) (Emphasis added.) Smith contends that he has established such "reasonable cause" for his untimely filing because he relied upon his counsel's advice regarding the due date for the estate tax return.

The district court, relying on this Court's recent decisions in *Boeving v. United States*, 650 F.2d 493 (8th Cir. 1981), and *Estate of Lillehei v. Commissioner*, 638 F.2d 65 (8th Cir. 1981), held that Smith's reliance on his counsel did not constitute reasonable cause for his failure to timely file the estate tax return within the meaning of section 6651(a)(1). We affirm.

In *Boeving v. United States, supra*, 650 F.2d at 495, this Court reversed the district court's finding that the Internal Revenue Service could not impose a penalty on an untimely estate tax return because the executrix had reasonably relied upon her attorney who was mistaken as to the required filing date. We stated:

> In our view, however, the district court's treatment of the taxpayer is precluded by the recent decision of this Court in *Estate of Lillehei v. Commissioner of Internal Revenue*, 638 F.2d 65 (8th Cir. 1981). The executor or executrix has a personal and nondelegable duty to file a timely return, and reliance on the mistaken advice of counsel is not sufficient to constitute "reasonable cause" for failing to fulfill that duty.

Id. at 495.

The district court's grant of summary judgment here against Smith was plainly proper under this Court's *Boeving* and *Estate of Lillehei* decisions. Although these decisions do not establish a rule of law that a personal representative's reliance on counsel can *never* constitute reasonable cause under section 6651(a)(1) for failing to file a timely return, Smith has not demonstrated any facts that distinguish the circumstances in this action

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from those present in *Boeving* and *Estate of Lillehei*. Thus, those cases are controlling here, and the court below did not err in finding that Smith's reliance on his attorney did not constitute reasonable cause for his failure to file the estate tax return within the nine-month deadline.

Finally, the penalty imposed by the Internal Revenue Service did not exceed the amount authorized by 26 U.S.C. §6651(a)(1). Accordingly, the district court did not err in rejecting Smith's claim that the fine was improper.

The judgment of the district court is affirmed.

-- End of Section H --

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Diurnal Variation of Stratospheric Chlorine Monoxide: A Critical Test of Chlorine Chemistry in the Ozone Layer

P. M. Solomon, R. de Zafra, A. Parrish, J. W. Barrett

Abstract. *This article reports measurements of the column density of stratospheric chlorine monoxide and presents a complete diurnal record of its variation (with 2-hour resolution) obtained from ground-based observations of a millimeter-wave spectral line at 278 gigahertz. Observations were carried out during October and December 1982 from Mauna Kea, Hawaii. The results reported here indicate that the mixing ratio and column density of chlorine monoxide above 30 kilometers during the daytime are ~ 20 percent lower than model predictions based on 2.1 parts per billion of total stratospheric chlorine. The observed day-to-night variation of chlorine monoxide is, however, in good agreement with recent model predictions, confirms the existence of a nighttime reservoir for chlorine, and verifies the predicted general rate of its storage and retrieval. From this evidence, it appears that the chlorine chemistry above 30 kilometers is close to being understood in current stratospheric models. Models based on this chemistry and measured reaction rates predict a reduction in the total stratospheric ozone content in the range of 3 to 5 percent in the final steady state for an otherwise unperturbed atmosphere, although the percentage decrease in the upper stratosphere is much higher.*

Chlorine monoxide (ClO) has for some years been recognized as a key tracer of the stratospheric ozone depletion cycle arising from natural and anthropogenic injection of chlorine-containing compounds, principally halocarbons, into the atmosphere (*1*, *2*). The reactions

$$O_3 + Cl \rightarrow ClO + O_2 \quad (1)$$

and

$$ClO + O \rightarrow Cl + O_2 \quad (2)$$

constitute the catalytic cycle by which chlorine atoms convert ozone, O_3, to diatomic O_2.

There is a strong diurnal variation expected in the concentration of ClO. After the recombination of atomic oxygen at sunset, reaction 2 ceases. At night, ClO is believed to combine in a three-body reaction with NO_2 to form chlorine nitrate,

$$ClO + NO_2 \xrightarrow{M} ClONO_2 \quad (3)$$

which is thought to be the dominant reservoir of chlorine in the absence of sunlight. During daylight hours, free chlorine is again produced from this reservoir by the photolysis of chlorine nitrate:

$$ClONO_2 + h\nu \rightarrow Cl + NO_3 \quad (4)$$

The rate of nighttime removal of ClO via reaction 3 is dependent on the NO_2 concentration and the total density, both of which decrease with altitude above 30 km: thus high-altitude ClO is expected to last through the night, while ClO at lower levels (altitude $\lesssim$ 35 km) disappears. Earlier measurements by in situ resonance fluorescence (*3*), infrared heterodyne spectroscopy (*4*), balloon-borne (*5*) and ground-based (*6*) millimeter-wave spectroscopy have established the presence, approximate quantity, and vertical distribution of daytime stratospheric ClO. A more critical test of the full complex of reactions of stratospheric chlorine may be obtained from measurements of the diurnal variation of ClO. Such observations avoid the complications and uncertainties introduced by vertical and lateral transport and long-term seasonal trends. Earlier balloon-based millimeter measurements over a limited portion of the diurnal cycle have shown a decrease in ClO at sunset and an increase after sunrise (*5*). In this article we present a complete diurnal record of ClO variation, with a time resolution of 2 hours, acquired by ground-based remote sensing of millimeter-wave line emission.

P. M. Solomon is professor of astronomy and R. de Zafra is professor of physics at the State University of New York, Stony Brook 11794. H. Parrish and J. W. Barrett are research associates at the same institution.

Observations of Emission Lines

The ClO molecule has millimeter-wave rotational spectral lines spaced approximately every 37 GHz. We have reported measurement (*6*) of the line at 204.352 GHz from the $J = 11/2 \rightarrow 9/2$ levels. Our current measurements are based on the $J = 15/2 \rightarrow 13/2$ transition at 278.630 GHz. We use a cryogenically cooled millimeter-wave heterodyne mixer receiver with a noise temperature of 1100 K, approximately 2½ times more sensitive than our earlier detector (*6*). Use of this more sensitive detector, combined with an increase by a factor of 2.4 in the theoretical line intensity for the higher frequency 278-GHz line as compared with the 204-GHz line, has led to a sixfold increase in observational sensitivity. For a fixed signal-to-noise ratio, the required measurement duration is reduced by about a factor of 6^2 or 36, allowing a relatively high time resolution to be achieved. The "back-end" spectrometer consists of a filter bank with 256 channels, each with a bandwidth of 1 MHz. The measurement technique, calibration method, and instrumental configuration described earlier (*6*) remain unchanged.

Our observations were carried out at the summit of Mauna Kea, Hawaii (elevation, 4250 m; latitude, 19.5°N) during two periods, from 8 to 11 October and from 9 to 16 December 1982. The atmospheric water vapor content, which dominates the tropospheric absorption of stratospheric emission lines at millimeter-wave frequencies, was very low and generally stable around the clock during these observation periods (*7*).

In the following discussion, we present emission intensities as brightness temperatures in kelvins. This custom, commonly used in radio astronomy, is derived from the Rayleigh-Jeans approximation for blackbody radiation, in which emitted power per unit frequency is linearly proportional to temperature. All intensities represent the values that would be observed if one were looking through one stratospheric air mass toward the zenith after removing the effect of tropospheric attenuation.

In Fig. 1, we present a sample of midday (1230 to 1630) and nighttime

for the development of new products.

That picture represents a misunderstanding. Although MITI does indeed sponsor R & D programs, such as the highly publicized ones on integrated circuits and the fifth-generation computer, the R & D tends to be basic and engineering research. In the United States, such R & D efforts are centered in our universities.

The commercial R & D successes of Japan, as opposed to efforts to develop the underlying technologies, have been driven not by MITI but by Japanese industry, even in integrated circuits. The participants in the MITI-sponsored cooperative integrated circuits program went back to their own laboratories to develop the actual commercial 64K random access memory chips that have been so successful in the marketplace. Oki Electric, the fastest growing Japanese producer of 64K chips and the first Japanese company to test a 256K chip, did not even participate in the MITI program.

The Japanese government, which has played an important role in promoting its industries' fortunes through such means as protectionist trade policies, has not been a significant force in commercial technology selection and development. The successes of Japan in businesses based on advanced technology are mainly the result of smart, persistent industrial R & D management. Private corporations in Japan make long-term R & D commitments to relatively narrow areas. They pick a target, such as video recorders, assemble large teams to pursue that target, and stick with it for as long as is necessary to bring a winning product to market. They do not try to cover the R & D waterfront, and they do not back out if the payoff is not immediate. They also practice a technique that I call "innovation by experiment," whereby they put a product out on the market, even in imperfect and sometimes expensive form, and learn from the customers how to improve it. And finally, they are aggressive in acquiring, improving, and implementing technology that they did not develop.

These strategies do not explain all of Japan's success in commercial technology, but they do indicate that the real source of that success is Japanese industry. Also, they underscore the lesson that we should learn from Japan: that the selection of the product technology and its development is best left to the people intimately familiar with the technologies and the markets. Technology selection and development should not be managed from afar.

Creating Conditions for Innovation

What role should the U.S. government play with respect to R & D? That role is not to manage technology-based commercial innovation but to create the conditions for such innovation. The government should provide an encouraging and supportive environment and infrastructure within which industries select and develop commercial technology.

There are many features of such an environment that deserve attention: a favorable tax climate exemplified by R & D tax credits, by extension of those credits to software, and by fast depreciation of R & D equipment; modified antitrust laws that encourage cooperative R & D and limit damages for civil violations; export control laws and regulations that do not disrupt the interchange of scientific and technical information that is so vital to the progress of technology; and immigration laws that permit outstanding foreign scientists to remain in the United States to do R & D.

Support for University Research

The most important role for government in creating the conditions for commercial innovation is to support universities in their efforts to generate research and provide manpower. The most crucial issue we face is a lack of skilled manpower, a shortage of faculty in universities for training that manpower, and a deteriorating research capability in our great universities because of the shortages of both faculty and modern equipment for instruction and for research.

American industry today simply cannot get enough of the people it needs in such fields as microelectronics, artificial intelligence, communications, and computer science. The universities are not turning out enough R & D people in these areas, or enough research faculty. There is little that private companies can do about this. We contribute to the support of universities, but industry will never be able to meet more than a small fraction of university R & D funding needs. Even after a decade of steadily increasing industry support for universities, industry provides only about 5 percent of total university R & D funding. Congress is considering additional incentives for industry support of universities, but the fact remains that the primary responsibility for ensuring a strong, healthy academic research system and thereby for providing an adequate supply of research and skilled people must rest with the federal government.

There is wide agreement that the federal government should support the universities, and, in fact, federal basic research obligations to universities and colleges, measured in constant dollars, have grown by more than 25 percent over the past 3 years. But this is only a start in filling the needs. Department of Defense funding of basic research, for example, has only in the past 2 years returned to the level, measured in constant dollars, that it was in 1970. The Defense Department has traditionally played a vital role in supporting basic university research. A time of rapid expansion of the defense budget is no time to abandon that tradition.

Universities have had to compete with the national laboratories for the Department of Energy's research dollars. When research is funded at a university, not only does the research get done, but also students are trained, facilities are upgraded, faculty and students get more support, and thereby better faculty and students are attracted. Moreover, the students that go into industry help in the transition of advanced research into concepts for industrial innovation. When the same research is funded at a national laboratory, most of the educational dividends are lost.

Universities should not have to compete head on with national laboratories for mission agency funds. Unless the national laboratory will do a substantially better research job, the university should get the funds. The same holds for government funding of research in industry. Those funds that advocates of industrial policy propose to invest in government-directed industrial R & D would normally be much better spent in universities, unless there is a special reason why an industrial laboratory can do it much, much better.

I am not proposing that we simply throw money at universities. We need to be selective. To borrow a phrase from the industrial policy advocates, the government should stress the growth of "sunrise science and technology." Unlike the targeting of sunrise industries, the targeting of sunrise—that is, fast moving—areas of research can be done. We can identify these technologies, even if we cannot specify in advance precisely what products or industries they will generate. But we are not doing this as well as we can and should. In microelectronics, for example, a study by the Thomas Group, a Silicon Valley consulting firm, concludes that government support of university microelectronics programs totaled only about $100 million between 1980 and 1982. To put that into

tive) from that of 17 with small-cell lung carcinoma (15 positive) is striking (see Table 1). Both cancers have common ancestry, but the former is of comparatively low malignancy and the latter is extraordinarily malignant.

5) While patients with carcinoma generally showed cellular and humoral immune responses to carcinoma-associated T antigen, the humoral response was stimulated preferentially by tubular and early lobular breast carcinomas, which had T activity comparable to other carcinomas. Significantly, these carcinoma types have a favorable prognosis among breast carcinomas (*8*, *54*).

The Tn/anti-Tn system may complement the T/anti-T system in elucidating aspects of the pathogenesis of carcinoma and in early diagnosis. While the link between Tn and carcinoma has been known for a decade (*10*), this system has not been studied in the present context. Research is complicated by the usually low concentration of anti-Tn. Tn's immunodominant structure, GalNAc-α, is also the dominant part of the blood group A and Forssman haptens, which may prevent some anti-Tn immune responses. Furthermore, Tn antigen is not readily obtainable from healthy tissues (*7*). There are, however, some highly instructive experiments by nature herself that show not only how unmasked Tn arises in hematopoietic stem cells, usually persisting indefinitely without malignant change, but that Tn, the epigenetic sequela of a rare, benign, somatic mutation, occasionally precedes and then accompanies leukemia, disappears upon chemotherapy-induced remission, and reappears in relapse (*66*).

Conclusion and Prospects

The studies described here have revealed, in a large number of carcinoma patients, a close link between malignant transformation and early, persistent changes in common carcinomas: unmasked precursor antigens T and Tn, that allow the patient's immune system to qualitatively differentiate carcinoma from noncarcinoma.

On rare occasions, demonstrable T and Tn antigens occur in premalignant lesions, which may either remain that way permanently or progress to frank malignancy. Some tissues with such changes are accessible to longitudinal study and thus aid in determining the decisive point of malignant transformation. This approach may be facilitated by manipulation of immune responses, as well as by locating incipient carcinomas with labeled mono- and polyclonal anti-T and anti-Tn reagents (*25*, *26*, *67*) [but see the introduction and (*27*)]. Our monoclonal antibodies to T and Tn were generated by desialylized human O erythrocytes. We obtained three relevant specificities: anti-T, anti-Tn, as well as a specificity directed toward a moiety shared by T and Tn haptens (*67*). The three types of antibodies reacted strongly and specifically with carcinomas in immunohistochemical analyses of surgical specimens but less well in antibody absorption studies (*27*).

Our recent observation (*68*) in carcinoma patients, but not healthy persons, of a significant increase in lymphoid cell cytolytic activity against target cells with surface-exposed T and Tn antigens supports T and Tn's importance in the malignant process—especially since there was often a concomitant decrease in natural killer cell activity. The findings discussed here, although they are in an emerging phase, indicate that uncovered T and Tn antigens endow the carcinoma cells with a multitude of novel functions. These functions may be fundamental to the multistep processes of invasion and spread of carcinoma, and clearly have a profound, measurable effect on the tumor bearer's immune system. T antigen is likely to be a powerful probe in early carcinoma detection.

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are not reasonably satisfied by the *contractor,* assignee, or their licensees;

(3) Such action is necessary to meet requirements for public use specified by Federal regulations and such requirements are not reasonably satisfied by the *contractor,* assignee, or licensees; or

(4) Such action is necessary because the agreement required by paragraph i. of this clause has not been obtained or waived or because a licensee of the exclusive right to use or sell any subject invention in the United States is in breach of such agreement.

k. Special Provisions for Contracts with Non-profit Organizations

If the *contractor* is a non-profit organization, it agrees that:

(1) Rights to a subject invention in the United States may not be assigned without the approval of the *Federal agency,* except where such assignment is made to an organization which has as one of its primary functions the management of inventions and which is not, itself, engaged in or does not hold a substantial interest in other organizations engaged in the manufacture or sale of products or the use of processes that might utilize the invention or be in competition with embodiments of the invention provided that such assignee will be subject to the same provisions as the *contractor*);

(2) The *contractor* may not grant exclusive licenses under United States patents or patent applications in subject inventions to persons other than small business firms for a period in excess of the earlier of:

(i) Five years from first commercial sale or use of the invention; or

(ii) Eight years from the date of the exclusive license excepting that time before regulatory agencies necessary to obtain premarket clearance, unless on a case-by-case basis, the Federal agency approves a longer exclusive license. If exclusive field of use licenses are granted, commercial sale or use in one field of use will not be deemed commercial sale or use as to other fields of use, and a first commercial sale or use with respect to a product of the invention will not be deemed to end the exclusive period to different subsequent products covered by the invention.

(3) The *contractor* will share royalties collected on a subject invention with the inventor; and

(4) The balance of any royalties or income earned by the *contractor* with respect to subject inventions, after payment of expenses (including payments to inventors) incidental to the administration of subject inventions, will be utilized for the support of scientific research or education.

l. Communications

(Complete According to Instructions at Part 8.b. of this Circular).

[FR Doc. 82-4860 Filed 2-18-82; 8:45 am]
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companies are to make nuclear exports to China.

Negotiations have been proceeding for some time and there were rumors that an agreement might be announced during Zhao's visit. The most substantial development, however, was the comment by Zhao during a formal toast at the state dinner that China "will not engage in nuclear proliferation. We will not help other nations develop nuclear weapons." The NNPA requires that U.S. nuclear technology can be sold only to countries that agree not to export nuclear weapons technology or information. Zhao's remark appeared to remove that issue from contention. Nonproliferation advocates, however, have been pressing the Administration to conclude an agreement only if the Chinese will also insist on the placing of safeguards on any nuclear technology they export.

U.S. sources expect the Administration to push to complete negotiations to make it possible for the agreement to be signed on President Reagan's scheduled trip to Peking in April.

—JOHN WALSH

Europe Eyes U.S. Model on Joint Research Rules

The ten member states of the European Economic Community (EEC), taking a cue from the Reagan Administration's effort to boost technological innovation, are considering a proposal that joint research efforts between high-technology companies in Europe be exempted from the stiff antimonopoly rules contained in the Treaty of Rome, the agreement setting out the code of economic behavior on which the community is based.

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INSIDE: THE SCIENCE AGENCIES

WASH. POST 1/31/84

The Japanese are challenging the U.S. lead in yet another new technology—gene engineering—and that lead could vanish in the next few years if basic research isn't translated into commercial products, the congressional **Office of Technology Assessment** says in a new report.

"Biotechnology has, to date, been an American success story . . . ," said Rep. **Albert Gore Jr.** (D-Tenn.), who asked for the study. "It is imperative that we not let this advantage slip away from us, and we need to ensure that this industry is not crippled."

"U.S. efforts to commercialize biotechnology are currently the strongest in the world," said the 612-page report, citing the nation's well-developed base in the life sciences, entrepreneurial spirit and the availability of financing for high-risk ventures.

Last year, private industry spent more than $1 billion to research and develop methods of manipulating the genetic makeup of existing organisms, the technology office said.

The report said, however, that the U.S. lead may evaporate during the next decade if federal support of basic research continues to decline and if more funds are not provided to help turn laboratory successes into commercial products.

The report said that the United States has not followed through on its lead in basic research in gene engineering. It said that the technology to take gene engineering out of the lab and into the factory is complex and that not enough people here are trained to do that.

Instead of concentrating on basic research, the Japanese government has spent considerable amounts of money on industrial processes.

The report, written under the direction of the OTA's **Nanette Newell**, said the U.S. government spent about $511 million last year on basic research in biotechnology, but only about $6.4 million on applied research, such as funds to train students in commercial biological methods.

The Japanese government, on the other hand, spends a substantial proportion of its annual $60 million biotechnology budget on applied research, the report said. Specific numbers were not available for Japan, the OTA said, but the West German and British governments both spend up to 10 times more on commercial biotechnology research than does the United States.

The report suggested several options Congress could choose to try to boost the U.S. industry: funding the retraining of industrial workers, changing antitrust policy to allow companies to share workers and resources, restricting imports of biotechnology products, restricting the export of U.S. knowledge and equipment and giving federal aid to specific industries or technologies.

Gore said he would work in the House Science and Technology Committee to boost spending in the fiscal 1985 budget, but he declined to discuss specific amounts. He also called for Senate action on House-passed legislation to create a $425 million annual program of aid to states for math and science education.

The report was criticized by author **Jeremy Rifkin**, president of the Foundation for Economic Trends, which has questioned the scientific and ethical implications of practical applications of biotechnology. In a statement, Rifkin said the report "reflects a pro-industry bias" that gives "only brief consideration" to potential environmental risks.

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INDUSTRIAL RESEARCH . . . A boom in industrial research has started, according to the **National Science Foundation**. Company-financed research is expected to increase by about 11 percent in fiscal 1984 to $48 billion, according to the NSF's **Science Resource Studies Office.**

In a survey of 76 companies in six major industries, five of the industries said they were planning double-digit increases in company-funded research. From 1982-84, two of the biggest increases came in machinery (17 percent) and chemicals (12 percent). The motor vehicle industry is lagging behind, with only a 2 percent average annual increase in constant dollars.

—Philip J. Hilts

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The commission of the EEC, in a draft regulation which is currently being circulated for discussion and is expected to be adopted by the council of ministers within the next few months, is now proposing a blanket exemption for similar research efforts in these and other fields, ranging from textiles to pharmaceuticals.

Some conditions would remain. An exemption would not be allowed, for example, for research projects involving more than one of the three largest European companies in any particular field. Nor would it be permitted when the combined turnover of the companies sponsoring the research exceeded $400 million, an attempt to ensure that the major beneficiaries of the new competition rules are medium-sized companies.

As in the United States, commission officials hope that the main effect of the proposed regulation will be to provide psychological reassurance to research managers that joint research projects will not be subject to a legal challenge from Brussels. At the same time, however, the commission is going further than the Reagan Administration in proposing that the exemption be extended to cover the joint production of new technological products arising from the research.

—DAVID DICKSON

Battelle Predicts Rise in R & D Spending in 1984

Thanks chiefly to a surge in spending by private industry, expenditures on research and development in the United States will climb to $94.2 billion in 1984, according to a forecast by the Battelle Memorial Institute. That would be an 8.9 percent increase over 1983 levels, or a 3.7 percent rise after inflation is taken into account.

According to the usually reliable Battelle figures, industry will spend $48.8 billion, a 10.3 percent increase, and the federal government will spend $42.7 billion, a 7.8 percent rise. The increased federal outlays largely reflect the continuing defense buildup. The Department of Defense is expected to account for 64.5 percent of government R & D expenditures in 1984, up from 58.9 percent in 1983.

—COLIN NORMAN

Guidelines for Artificial Heart Implants Revised

The University of Utah's review committee for research on human subjects has approved a revised and expanded protocol for implanting artificial hearts into patients. Pending review by the Food and Drug Administration, the approval opens the way for introducing an improved version of the artificial heart into patients who are healthier than was the first recipient of an artificial heart, Barney Clark. Clark died in March 1983 112 days after being implanted with such a device.

The revised procedure will allow University of Utah surgeons, directed by William C. DeVries, to select patients who are in less advanced stages of heart failure. Previously, the protocol called for waiting until the eighth week after a patient reaches what the American Heart Association designates as the fourth category of cardiomyopathy. One major difficulty in Clark's case was that his heart disease had caused considerable deterioration in other organ systems. Those complications were his immediate cause of death.

The revised protocol also has expanded the patient's informed consent form so that it now includes information gained from Clark's experiences. The new protocol removes any upper age limit for patients who undergo the experimental procedure, and it specifies that various nutritional and exercise regimes may be studied following the operation. In future implants, the synthetic heart valves will be made of solid titanium without the welds that caused problems in the model Clark received. Also, use of a portable support system during the postoperative period has been approved, potentially allowing future recipients to feel somewhat less encumbered during the recovery period than was Clark.

Two members of the review committee voted against the revised protocol, arguing that the next artificial heart recipients ought to be patients whose hearts have stopped suddenly and thus are not suffering from the multiple and potentially confounding complications seen in patients in the advanced stages of heart failure.

—JEFFREY L. FOX

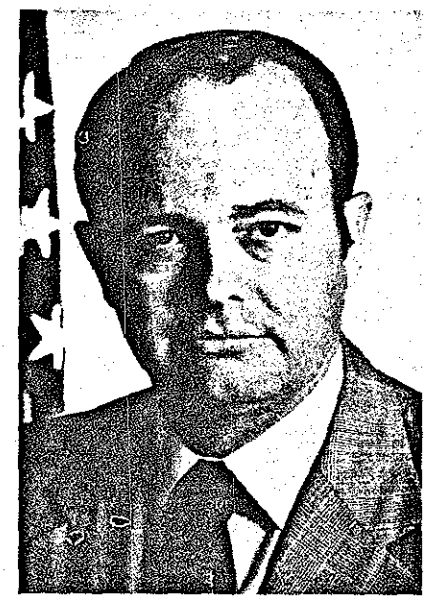
NSF's shadow director is powerful, controversial figure

To call N. Douglas Pewitt a shadow really doesn't describe the man. Pewitt can be a social charmer, but in his job as an assistant director for science policy at the White House Office of Science & Technology Policy, he is what might be called an ideological presence. "Pewitt thinks everyone left of Attila the Hun is a communist," says one who has worked with him. "He talks about leaving Washington but he is so power hungry that I doubt that he'll ever leave."

So feared is Pewitt that few sources would go on record in their comments on him. "He really is in a powerful position," comments one. "Anyone who is anyone in R&D in the Washington establishment has some reason why they wouldn't want to offend him. But he's managed to alienate himself from everyone in the Washington science community." So run the more extreme comments. It's true, too, that Pewitt wouldn't be around if he weren't effective.

Who is this Doug Pewitt? His official title is assistant director of general science, Office of Science & Technology Policy, executive office of the President. He was appointed to that job on Sept. 20, 1981, almost a year after Reagan was elected to office.

From 1979 to 1981, he worked in President Carter's Administration as deputy director of the Energy Department's office of energy research. Between 1976 and 1979 he was on the science budget staff of the Office of Management & Budget. Pewitt took collegiate training rather late in life, getting his Ph.D. in particle physics from Florida State University in 1974. He



spent the 1960s flying jets for the Navy. He currently is a commanding officer of Air Systems Program Unit 0366 in the Naval Reserve.

Pewitt undoubtedly has more than just the ear of his boss, George A. Keyworth II. When Pewitt came over from the energy department, he announced he would be deputy director of OSTP. His brashness upset Keyworth for a while. "But when it became clear to Keyworth that Pewitt saw the world in the same black and white terms," according to one source, "they began getting along." From all accounts, Pewitt is functioning as Keyworth's number two man, since Keyworth's current deputy, Ronald B. Frankum, is seen as over his head in the job.

The science education people at NSF have reason to fear Pewitt. None of them were consulted when NSF had to present its fiscal 1984 science education program to Congress. "The science education initiative was born at OSTP," says one source, "and was presented to NSF as a fait accompli."

What seems clear is that a lot of people in Washington will be happy to see Pewitt go if he keeps his promise of leaving town by August. He reportedly has told Keyworth that he doesn't intend to stay through another budget cycle. But many say he loves a sense of power, and he has it where he is now. "Pewitt has so much control at NSF," says one Pewitt detractor, "that Knapp won't put his tie on in the morning without consulting Doug."

Eloise Clark, NSF assistant director for biological, behavioral, and social sciences, thinks the criticisms are ridiculous. Although Pewitt has in the past disdained the social sciences, Clark doesn't believe he had anything to do with the initial Reagan budget cuts in this area and is in fact interested in learning more about social science.

"I think Pewitt is the kind of person who can work on a scientific issue on its own merits regardless of his personal politics," she says. And as for Pewitt's "controlling" Knapp, she defends Knapp. "I think Ed is a person who thinks independently and forms his own opinions. Furthermore, I think it's very natural that Knapp should be consulting frequently with Pewitt and OSTP."

"I'd prefer to sit and talk with people in a rational fashion," comments another NSF source. "But if you can wade through [Pewitt's] rhetoric, you find him a thoughtful person. He talks to a lot of people about NSF and does get a lot of things done for us."

more than scientific—they mainly are political. So, many are trying to convince Knapp that he will still need a core of staffers attuned to the political subtleties of international science. "People are concluding that if we didn't have an international directorate, Knapp would have to create one," says one staffer. "You need brokers who can understand international politics as well as science. Knapp doesn't understand this yet. That's why it is taking so long to implement his concept."

Those at NSF interested in international programs but who aren't involved are happy with the new plan. Says one: "The international division has been passive for years in establishing a strategic rationale for exchange programs with other countries. They never look at research in the context of our own strategic needs, either in terms of science or the economy."

The job does seem formidable and will involve a lot of staff reshuffling. For example, Clark is worrying that her staff for biological, behavioral, and social sciences will have a hard time handling any large amount of new proposals stemming from NSF's initiative for support of research in small colleges. Whereas many small colleges don't have a physics department, almost every one has a biology department. Therefore, she believes her directorate could be inundated with proposals even though it has less money than the physics section. "So my staff is worried that it will have a lot more work to do because of that broadened constituency."

Seed Money From New SBA Program Nurturing Local Innovations

By Joseph Perkins
Washington Post Staff Writer

Gentronix Laboratories Inc., a small Rockville-based company, is one of a handful of high-tech firms working to develop the "biochip," a computer wafer a billion times more powerful than the silicon chip with infinite commercial potential.

And the advances Gentronix may make in the development of this innovative technology will be attributable not only to the firm's engineers, said its Chief Executive Officer John M. Wehrung, but to the federal government as well.

Gentronix is one of the first of several hundred firms to take advantage of a new federal program requiring agencies and departments to allocate a portion of their outside research and development budgets to small companies. The Rockville firm received $200,000 from the National Science Foundation last August, during the first year of the program, and those funds "enabled us to increase our revenue base and conduct research [we] otherwise wouldn't have done," said Wehrung.

Joseph A. Lahoud, president of Greenbriar Systems Inc. at Tysons Corner, believes the new "Small Business Innovative Research" program—created after Congress amended the Small Business Act two years ago, will usher in "almost another industrial revolution."

Lahoud's four-person company is using funds from the program to develop what it calls "acoustic emission monitoring" for use by the auto industry and other manufacturers. "We've had some troubles in our three years," he said. "I think our prospects are brighter because of the SBIR."

In accepting SBIR awards from the Nuclear Regulatory Commission and the National Science Foundation, International Associates Ltd., a 60-person District consulting firm specializing in energy supply, use and conservation, broke a longstanding company policy of eschewing participation in federal programs.

"We do not normally get involved in seeking funding from the government small business programs," said International Energy Associates President John E. Gray. "But this one seems to be a cleverly designed piece of work. I admire the concept and structure of the program."

Under the innovative research program, federal agencies with outside R&D budgets in excess of $100 million are required to set aside a certain percentage of those funds for small firms. Twelve agencies currently are participating in the program. The contribution was fixed at 0.2 percent for 1983, the first year of the program, and will increase yearly until it reaches 1.25 percent in 1988.

By then Gentronix, Greenbriar, International Energy Associates and other small

See INNOVATORS, page 19

Area Small Businesses Getting Slice of Agencies' R&D Pie

INNOVATORS, from page 1

high-tech firms will be competing for half a billion federal R&D dollars. Last year, the agencies partcipating in the SBIR program received close to 9,000 proposals, and 730 were selected to receive a total of about $45 million. About 3,000 projects should be funded annually by the program's fifth year, according to an SBA report to Congress on the program's first year.

Washington-area companies have garnered a healthy share of SBIR awards. Virginia ranked third in the nation with 46 awards, worth a total of $2.3 million. Maryland was right behind Virginia with 35 for a total $1.7 million. And with six awards totaling $239,315, the District ranked ahead of 16 states. The Washington area has done so well, said Richard J. Shane, acting administrator of the SBA's Office of Innovation, Research and Development, because "that's where all the 'Beltway Bandits' are."

Only companies with 500 or fewer employes are eligible to compete for SBIR awards. The average award-winning firm has about 50 employes, the SBA reported. And last year, firms with 10 or fewer employes, such as Greenbriar, won more than a third of all awards.

There are two funding "phases" in the program. In the first, victorious proposal writers receive awards of up to $50,000, with which they are to demonstrate in a six-month period the technical merit and feasibility of their innovations. In the second phase, firms that successfully complete the first phase are awarded up to $500,000 over two years to develop their innovations further. Generally, phase-two awards go to firms that can prove the market potential of their innovations. The ultimate goal is to persuade venture capitalists to invest in the firm's work.

The two-tiered awards amount to "start-up capital" for small firms with good ideas, said Shane. "Essentially, for $50,000, you're buying one man's time for six months," he said. "He sorts the problem out and proves the practicality [of his innovation] in a verbal form." After six months, "he goes back to technical review and says, 'It looks like this . . . thing has a possibility to work.' "

At that point, Shane said, the SBA might decide to award phase-two funding. "Let's [say we] fund him $500,000 for two years. $500,000 will not bring a product to the market. What it will do is give you enough for a working model. Now venture capitalists will look at it and say, 'That's a good idea. Our experience tells us that we'd like to put in $3 million to get this son-of-a-gun off the ground and bring it to the market.' "

To ensure that firms eligible for the program are aware of it and "to mobilize the private sector" to make use of the innovations developed by these firms, a group of business people formed the Small Business High Technology Institute after the bill's enactment two years ago. The nonprofit institute is headed by former SBA chief counsel for advocacy Milton D. Stewart. "Most of us who are interested in the SBIR program are interested in how our country is doing," Stewart said. "We will do what we can to make this program succeed."



By Larry Morris—The Washington Post

Greenbriar President Joseph A. Lahoud

Before the program was created, small high-tech firms had voiced their disgruntlement with the federal government's distribution of outside research and development funds. In 1982, for example, the government spent about $40 billion on R&D. More than 95 percent of the outside allocations were made to big businesses, laboratories, universities and nonprofit organizations, according to a report by the House Small Business Committee.

The federal procurement process was "almost to the bitter exclusion of small businesses," said Shane. The government's treatment of small businesses looks even more injudicious, he said, when viewed alongside reports attributing nearly half of the major American innovations made in the last 30 years to small businesses such as Gentronix and Greenbriar.

"Small businesses are much more capable, much more practical in bringing things to fruition," said Shane. "Universities are large businesses. And nonprofits may be very well founded, and very exciting technically, but they are a little on the esoteric side. Everytime they come up with a new technology, they take 10 years, 20 years perhaps, to make it [usable], whereas hard work-oriented small firms will take two to five years.

"Alexander Graham Bell and Thomas Edison wouldn't qualify to teach in a university today," Shane asserted, adding that he hopes such inventors will be discovered through the innovative research program. "We think there are a million good ideas out there. If we hit big—say two out of 100 . . . it's got tremendous payoffs."

Gentronix thinks it may be on the verge of "hitting big," according to Wehrung, who says the company's biochip will be "a billionfold more powerful than the silicon-based or gallium arsenide systems" currently produced by computer manufacturers.

Greenbriar also is working on a project with great commercial potential, Lahoud said. The firm received about $50,000 from the Department of Energy to develop a technology that better detects defects in nuclear steam generator tubing. The same technology that Greenbriar is using to test nuclear generators—signal processing—may be used for other industrial purposes as well, Lahoud said.

Recently, Greenbriar contracted with a major auto maker to develop a signal-processing device that could test welding on autos done by robots. Because there currently is no way to ensure welding strength, auto makers must make twice as many welds as necessary to make sure a sufficient number of welds hold. By using a device that can distinguish good welds from bad, auto makers can save considerable time and millions of dollars, Lahoud said.

Greenbriar has therefore developed instruments that measure the electrical impulses of the robotic welder. After processing the "signals" from the welder, the device is able to delineate good "wiggles" from bad. Now, the object of the game, said Lahoud, is to perfect the instrument and make it small enough to fit inside the welding machine.

"We don't think we're too far away from significant growth," Lahoud said. "A year ago [before Greenbriar received two SBIR awards], I couldn't have said this. We've gone beyond the stage of having an idea in our head and a drawing on a piece of paper. We've actually done something."

Still another Washington-area firm, Advanced Technology Laboratories, believes it is close to developing a commercially salable innovation. The four-person Gaithersburg firm, which has received two SBIR awards, expects to receive a patent on a device that has the potential to greatly enhance computer memory, said Vice President Marc A. Friedlander.

The company is developing a computer part that will render the floppy disc obsolete, Friedlander said. The storage device will be no bigger than discs such as the IBM 3380—which boasts one of the largest memories available—but will have 50,000 times their capacity.

The capacity is so great, Friedlander said, because the storage device has a "photon echo memory," which stores information in three dimensions instead of the current two dimensions.

"These are high-risk, high-payoff activities," said Friedlander. Without the impetus of SBIR requirements, he added, "I really think none of the agencies we dealt with would have invested in this."

In an effort to increase the likelihood that SBIR-derived innovations will reach the market, the SBA has developed a computerized system to match program participants and potential investors. The system, which takes into account "capital technical interests, dollar thresholds, geographical considerations and time-frame elements," is expected to become fully operational this summer.

As might be expected, the innovative research program is not without its problems, said Shane. The one that concerns him most is the oversubscription of "worthy proposals." During the program's first year, about 700 proposals were deemed "worthy but not funded" by the SBA. That problem should be alleviated with the increase in federal R&D dollars earmarked for the program, he said.

Another problem some of the smaller firms mention is the length of time between phase-one and phase-two funding. Advanced Technology, which derives most of its revenue from the SBIR program, has been inactive since early March, when its phase-one award ran out, Friedlander said. He proposes that phase-two companies receive "interim funding" while they await their full award.

Apart from those areas of concern, the SBIR program has gotten good reviews, Shane said. "We still receive about two to three hundred pieces of correspondence a week," he said. "That's good proof of the pudding."

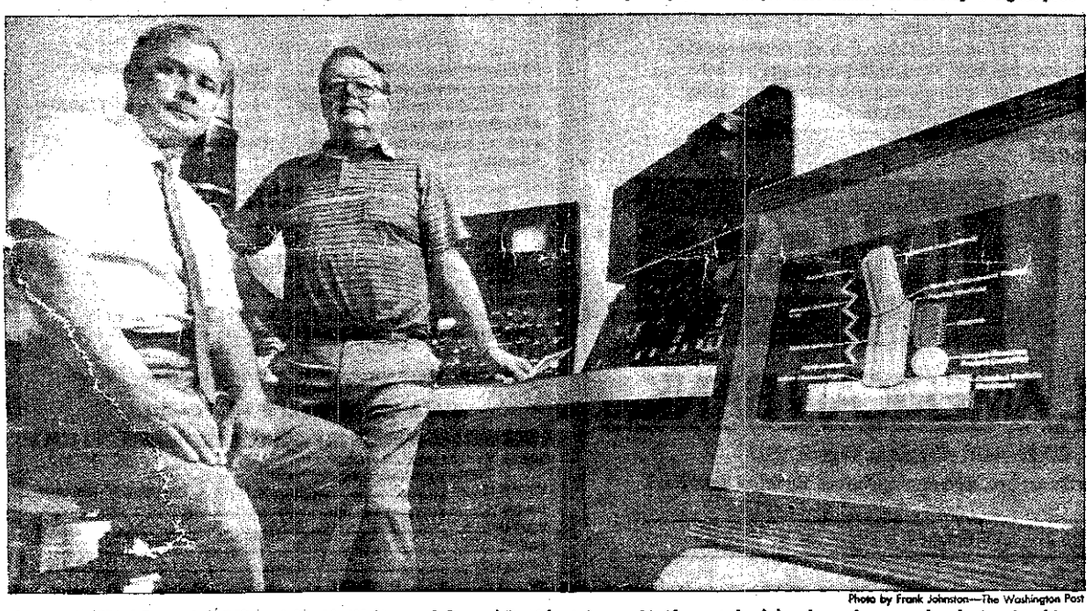


Photo by Frank Johnston—The Washington Post

Gentronix Chief Executive Officer John M. Wehrung, left, and President James McAlear at the lab where they are developing biochips.

Senior administration officials will try to end a row between government officials and universities over technological leaks to the Soviet Union and whether new secrecy rules are needed to curb them, according to **George A. Keyworth II**, head of the **White House Office of Science and Technology Policy.**

Keyworth said last week that he and other key defense and diplomatic officials wanted to switch the focus of the debate to their real concern: leaks from industry. He said a new policy statement "on the president's desk" states that the way to control the leakage of basic research is through the current classification system, not by creating a new category of "sensitive" but unclassified material.

Defense Department officials, reportedly including **Richard N. Perle**, assistant secretary for international security policy, and **Richard D. DeLauer**, undersecretary for research and engineering, have approved the policy.

"In general, the university environment does not represent an area of major leakage," Keyworth said. Of far more concern, he said, is Soviet spying and technology "leaks overseas through U.S. companies."

Keyworth said the president had spontaneously expressed his support for openness in research. "I would be extremely surprised if the academic research environment is in any way constrained" in the future, Keyworth said.

A key point in the debate over basic research came with the completion of a study by the **National Academy of Sciences**, now called the "Corson report" after the study committee's chairman, Dale R. Corson, former president of Cornell University. That report recommended that little or no action be taken to constrain scientific information, but instead that the United States stay ahead in the technology race.

Keyworth said it would be a good idea now to convene a similar panel to look at technology leakage in industry. The national academy's governing board, in fact, recently did just that.

Meanwhile, one key industry player said much work was going on behind the scenes to find common ground between Pentagon officials worried about the problem and industry officials



GEORGE A. KEYWORTH II
. . . backs university research

concerned that excessive secrecy will hurt U.S. companies in the marketplace.

☆ ☆ ☆

RECONSIDERING CYCLAMATE . . . In another step that is expected to help transform cyclamate to a legal articifical sweetener, the **Food and Drug Administration** has asked the National Academy of Sciences to check the FDA's preliminary finding that cyclamate is not harmful.

The sweetener was banned more than a decade ago because of evidence that it caused cancer in animals.

Since then, Abbott Laboratories and an industry group called the Calorie Control Council have filed new information and test results to try to get cyclamate back on the market.

The industry petition is still under review, but the FDA's Committee on Food Safety and Applied Nutrition has reviewed the scientific studies and found no reason why the cyclamate ban should continue, according to FDA spokesman **Jim Green.**

The academy will hold a public hearing this Tuesday.

Its committee is supposed to report to the FDA by December, and its findings are expected to play a crucial role in the FDA's decision.

☆ ☆ ☆

MEANWHILE . . . America's premier science journal, Science Magazine, which is published by the American Association for the Advancement of Science, has a new editor: **Daniel E. Koshland Jr.**, a biochemist at the University of California at Berkeley. Koshland succeeds **Philip H. Abelson,** the editor for 22 years.

—Philip J. Hilts

AN EDUCATOR'S OPINION



When Bureaucracies Rule, Learning Loses

By Mary Hatwood Futrell, President nea National Education Association

The bell rings. The class enters—25 students, a kaleidoscope of personalities, all unique, each a bundle of idiosyncracies, different strengths, different attitudes and aptitudes, different *needs*.

You begin the day's lesson—and a day-long dialogue with yourself: Am I moving too quickly for Jonathan? Too slowly for Janice? Does Daniel need some remedial work? Would tougher homework assignments catch Alan's attention? Or is it time to ease up? Would Anna flourish in an Advanced Placement course?

For America's teachers, these are the sorts of questions that never stop. But there's another question that we as a society need to ask: Who is most likely to have the answers to the daily questions every teacher faces?

The obvious answer is, of course, the teacher—the person on the scene, in the classroom, in *touch*. I'm firmly convinced that, in this case, the obvious answer is also the right answer. Teachers have the experience, the insight, the training to know what works in the classroom—and when.

Unfortunately, our contemporary school systems seldom recognize this obvious truth. One of the baffling ironies of modern times is, in fact, the extent to which control over classroom decisions has been wrenched from the hands of teachers and principals. Teaching methods and materials, assessment tools, disciplinary codes, and even entire curricula are frequently dictated by officials sitting in district offices comfortably at a distance from the classroom and its challenges. Decisions drop down from on high. Teachers and principals lose autonomy. Learning is the casualty. Jonathan and his classmates are the victims.

The result: a tyranny of inefficiency that's been noted—and denounced—by virtually every major education reform report over the last two years. Ted Sizer, for instance, charges that "hierarchical bureaucracy" is "paralyzing American education." And when, in the concluding chapter of *Horace's Compromise*, Sizer lists five imperatives for better schools, his primary recommendation is that we "allow teachers and principals to adapt their schools to the needs, learning styles, and learning rates of their particular students. . . . *The decentralization of substantial authority to the persons closest to the students is essential.*"

Ernest Boyer echoes Sizer's view: Heavy doses of bureaucracy, he argues in *High School*, stifle creativity and block teachers and principals from exercising their best professional judgment on matters that should be decided at the school building level.

Boyer and Sizer's critiques reflect more than a decade of research on effective schools. Derrick A. Bell, dean of the University of Oregon Law School, succinctly summarized this research when he observed that teachers at effective schools are "mavericks." They become forces for educational excellence precisely because they—like their principals—are "willing to give priority to a vision of education *even over policy decisions coming from a central board.*" They're rebels—with a cause. And the cause is an instructional program and school climate tailored to the needs of students—*not* to the demands of bureaucrats.

Surely teachers and principals should not have to risk insubordination in order to advance the cause of educational excellence. And the change that would render such rebellion unnecessary is in no way radical. Returning decision-making power to the local school is, in fact, consonant with the prescription for success put forth in Thomas Peters and Robert Waterman's *In Search of Excellence: Lessons from America's Best Run Companies.*

America's corporate leaders are learning the *decentralization* lesson that management analysts like Peters and Waterman strive to teach. They're beginning to understand that common sense demands treating employees as adults deserving of respect and capable of making intelligent judgments.

It's time centralized school district bureaucracies learned that lesson, too.

NEA ● 1201 Sixteenth Street, N.W. ● Washington, D.C. 20036 ● (202) 822-7200

Stronger ties between industry and university call for clear understanding of roles

AMERICA'S RISING RESEARCH ALLIANCE

by Lewis M. Branscomb

Wanted: University to set up lucrative partnership with business desiring research in new technologies. Millions in funding available. Contact director of corporate contributions.

The advertisement, from a recent article in *U.S. News & World Report*, is fictitious, but it dramatizes an expanding partnership between research universities and private companies.

This long and fruitful relationship has rested and continues to rest on industry's need for highly qualified new scientists and engineers, for the results of fundamental research in science and engineering—both of which are essential to a company's ability to innovate and increase its productivity.

Strong and dependable federal support for a broad spectrum of academic research is a major factor in making our universities fruitful places for industrial collaboration. On the other hand, since private investment in a competitive marketplace is the best means for allocating the scientific and engineering resources of industry, it is appropriate that government leave to industry the task of exploiting the knowledge base created by our universities.

The more effectively industry carries out this task, the greater the economic leverage of our public investment in university research. Further, exposure of professors and students to industry's knowledge needs not only helps prepare young scientists and engineers for careers and future technical leadership in industry, but also improves coverage by academic researchers of industrially relevant areas of investigation.

The National Science Board's 14th annual report to the president and Congress (on which this article is based) sets out to illuminate the complex but important processes whereby university scientists participate in the solution of important industrial problems and the industrial community avails itself of the vital public investment in academic science.

Quantitative assessment of the university-industry research connection is difficult, owing to the diverse mechanisms of exchange: contracts, grants, purchase orders, solicited and unsolicited gifts, loans of equipment or facilities, discounts on equipment purchases, personnel exchanges, scholarships

and consulting arrangements. These are just the principal forms and universities and corporations have kept track of only some, and then not necessarily consistently.

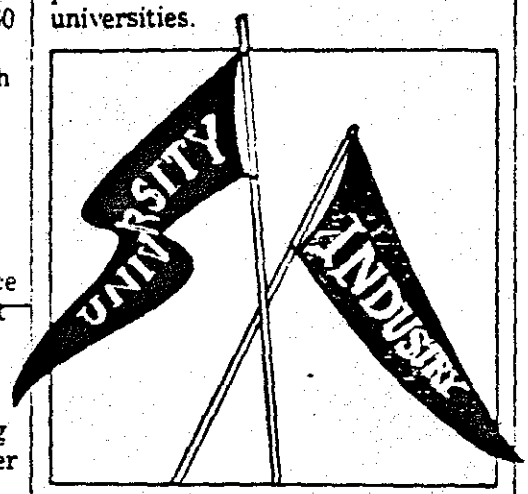
Data from National Science Foundation surveys on dollar support of research in universities—which are more or less limited to tracking grants and contracts—suggest that from 1960 (and probably from 1953) to 1965, the industrial share of university research and development support remained virtually flat in constant dollars. Industry's percentage share of support, however, fell sharply—from just over 6 percent in 1960 to below 3 percent in 1965—due primarily to rapidly growing federal support. Since 1965, industry's share has remained at 3-4 percent, but, in constant 1972 dollars, that support for university R&D has doubled.

Available data also suggest a strong variation in this support, by field. Over the past decade, for example, it appears that 6-10 percent of all academic engineering research was supported by industry.

The relative magnitude of academic research supported by corporate contracts, on the one hand, and by corporate philanthropy, on the other, is not clearly understood. An educated guess is that academic research supported by corporate gifts and grants roughly equals that supported by corporate contracts.

The signs of increased traffic between companies and campuses are numerous:

- Major chemical companies have established a Council for Chemical Research, aimed at funding academic research and forging new relationships between academic and industrial chemists and chemical engineers.
- The Semiconductor Industry Association has set up a nonprofit subsidiary, the Semiconductor Research Cooperative, designed to encourage increased efforts by manufacturers and universities in long-term semiconductor research and to add to the supply and quality of professional degree-holders in the field. Expenditures of $20 million over the next two years have been planned.
- A variety of consortialike programs in which several companies jointly provide support for focused academic research have generated a surprising amount of support. Caltech's Silicon Structures Project and Stanford's Center for Integrated Systems (*page 13*) were early examples. More recently, 12 U.S. firms joined together to form the Microelectronics and Computer Technology Corporation, a consortium that plans to pool the costs and share the results of advanced computer research, some of it conducted in universities.



- Another significant development is documented in a survey conducted by the National Governors Association. This survey of all 50 states looked for programs to spur technological innovation and productivity growth. At least 88 separate initiatives were found under way with state leadership, many involving public-private partnerships.
- In addition to these collective efforts, a number of individual companies are stepping up their support programs. IBM Corporation (an NAM member) for example, gave more than $22 million in grants to U.S. educational institutions during 1982, compared with $17 million in 1981. Our most important relationships with universities, however, arise through collaborative activities on technical problems of common interest. At last count, IBM had more than 400 such projects with 100 U.S. universities.

It seems clear, in recent times at least, that all administrations, regardless of their political and economic complexion, have viewed the university-industry research connection as a positive and desirable element in national economic policy. They have differed, however, in their concepts of the appropriate government role and in their degrees of emphasis on different means to encourage this relationship. The current administration's approach reflects the fact that effective long-term university-industry research interaction will be based on the perceived worth of the university work by the industry—not on initiatives originating in Washington by third parties.

While previous administrations had attempted to develop government-directed programs for the stimulation of research and development in general, or university-industry research interactions in particular, President Reagan's administration demanded a more limited view of government intervention in the private sector.

The principal thrust of the new policy involved provision of incentives for R&D investments through tax legislation. The Economic Recovery Tax Act of 1981 includes several provisions aimed at stimulating increased support for R&D by industry. Two sections provide specific tax incentives for gifts of research equipment to universities and for the conduct of research in universities sponsored by companies with growing R&D investments.

Why should universities and companies cooperate? Company representatives cite many reasons for their interest in establishing research interactions with universities. Mentioned most frequently in an NSB-commissioned study were

- access to manpower (students and professors),
- access to technology,
- problem solving or obtaining needed information,
- prestige or enhancement of the company's image,
- use of an economical resource,
- general support for achieving technical excellence,
- proximity, and
- access to university facilities.

Universities interact with industry mainly to acquire funding for basic research and graduate training, or to support the facilities that make research possible. In general, industrial funding is seen as involving less red tape, and reporting requirements are seen as less time-consuming than equivalent support from the federal government. Other motivating forces for a university to seek industrial support for its research are as follows:

continued

- access to scientific and technological areas where industry indisputably has special expertise,
- the opportunities through industrially sponsored research to expose students to new insights and practical research problems that may be of immediate importance to society,
- availability of some government funds for applied research where a university joins with industry, and
- job expectations for graduates.

Another potential role for university-industry relationships is improving the participation of minorities in research. Many companies, of course, are active in sponsoring minority fellowships, loaning employees to teach courses and help develop curricula, and otherwise encouraging minority enrollments in science and engineering. But only a handful so far have seized the abundant opportunity to collaborate in building research programs (of mutual benefit) at predominantly minority universities.

An historical perspective also teaches that, in different time periods, universities dominate some fundamental research areas and industry dominates others. Molecular biology and biotechnology were long creatures of academic research laboratories but are now being rapidly assimilated into industrial laboratories as their commercial potential unfolds. Research on polymers and catalysts was carried forward for years in industrial laboratories, and universities began to make contributions at a later stage. The same has been true in microelectronics and computer engineering. Thus, technical experience may flow in either direction and, more commonly, in both directions.

How do universities and companies cooperate? Assuming that the parties are sufficiently motivated, cooperation involves some key transfers:

Resources. General gifts in support of university research are highly valued because of their flexibility and because they provide benefits that greatly exceed the dollar percentage of support. Such funds, for example, may be used to begin new projects, help young scientists get started, or provide for travel to conferences.

Cooperative Research. Unlike donations of funds, equipment, research facilities or endowed contributions, cooperative research essentially involves interactions of people and offers the most creative movement. Three principal approaches are found in institutional agreements:

- The greatest dollar support to universities from industry is through individual research agreements involving university researchers. Industrial support in this mode is generally mission-oriented and specific to a research program or project, with fairly immediate benefits in mind.
- Another approach, more sweeping in scope—though not necessarily in total funding—is to broaden participation and, at the same time, create stable industrial support of university research by engaging firms through an industrial affiliates program or consortia arrangements. Emphasis is on individual contacts between the representatives of member companies and the faculty, staff and students in the program. Access to students is the prime motivation for companies to join such programs.
- A third approach to cooperative research involves the use of university facilities. Research centers and institutes, for example, help attract industry support by providing coordinated research and/or equipment in a central facility.

> "Private industry has neither the resources nor the intention to compensate for any substantial cuts in publicly funded academic research."

Personnel and Information Exchanges. Forging stronger ties between universities and industries is best accomplished by personal interactions among scientists. Informational contacts—seminars, speaker programs, consulting, personnel and publication exchanges—are the most frequent means by which a university-industry research link is forged.

The availability and desire for resources, personnel and information does not ensure that a flow in either direction will ensue from those who have to those who want it. Uncertainty, institutional sloth, rejection, disincentives of various kinds all take their toll of initiative in university-industry interactions.

Despite the fact that these exchanges are proceeding rapidly, academicians often attribute a lack of sophistication to industrial researchers, while company people are often skeptical of the capacity of academicians to produce useful and timely research. These negative stereotypes do not necessarily prevent the parties from "doing business" when mutual interests coincide, but they may inhibit seizing opportunities and unnecessarily protract negotiations.

There are also real limits to joint activity, including limits on available faculty time and industrial resources. Other limitations are imposed by the university's need to fit most research into pieces that meet the requirements for Ph.D. theses in terms of scheduling, depth, originality and sophistication of the work. Further, patent and license rights, the right to review manuscripts for possible proprietary information and other critical questions frequently cause difficulties in negotiating agreements. Fortunately, such problems can be resolved when mutually perceived needs are pursued in an atmosphere of trust and willingness.

In their pursuit of new sources of support for research and teaching, universities have been rightly concerned about protecting the freedom of inquiry that is at the heart of their real contribution to society. A critical issue for them is how to ensure that the professor's teaching and research agenda is enriched and informed by, yet not subordinated to, his contract research or his technical consulting.

What's important here is that university-industry partnerships must respect the needs of both partners. I don't believe, for example, that companies should use universities for near-term proprietary projects or for development. Generally speaking, universities should not be asked to do proprietary work and should remain free and open. Companies should control what must be controlled and not depend on universities to do it for them. The roles of industry and academia are different and we should not confuse them.

CLOSING THE GAP

NAM's agenda for high technology includes the following statement:

The advantages of increased cooperation between industry and the academic sector are most clearly seen in the rapidly burgeoning joint arrangements in commercial operations. These types of relationships have been most evident in the biotechnology, robotics and computer fields. The academic environment has led many high-tech firms to locate near a university to tap into the pool of expertise.

Yet, despite these obvious areas of common interests, the gap between university education and industry needs appears to be widening.

Funding. The major boon provided to universities in the 1960s and 1970s of increased federal support has, in a time of fiscal constraints, been eroded. At the same time, industry funding of basic research has declined on a percentage basis. This creates difficulties for universities striving to maintain standards and levels of activity.

Academic Freedom. The expanding role played by industry in academic affairs in funding and cooperative agreements has led to concern over the pursuit of knowledge and learning. Academic researchers entering into contracts with industry often are accused of violating ethical educational values, such as open communication, free dissemination of research results and independent choice of research topics.

Contractual Arrangements. Concern has also been expressed over commercial relationships governing disposition of corporate patent rights and licensing arrangements. Academic researchers feel such conditions may delay publication of research results, adversely affect the educational process and prevent promising lines of research from being pursued.

Solutions. NAM supported the passage of P.L. 96-480, the Stevenson-Wydler Technology Innovation Act, which established several cooperative programs within the Department of Commerce to improve industry-university relations. NAM supports funding of these programs at statutorily authorized levels.

☐ NAM supports tax, regulatory and other policy measures that provide incentives for limited research and development partnerships (promoted by the U.S. Department of Commerce) between industry and universities.

☐ NAM supports measures that seek to prevent disputes over the disposition of patent and licensing rights.

Despite the questions raised earlier, there is optimism about the likelihood of increased university-industry research interaction during the 1980s. Three general factors characterize this change:

First, product and process improvements in some industries have evolved to such levels of complexity that not only is an understanding of fundamental physical and biological phenomena required but also much higher levels of training in and use of basic science and engineering. Manufacturing is becoming process-oriented rather than assembly-oriented. And while this type of manufacturing is easier to automate and is more productive, it also calls for much greater involvement with the fundamental properties of the materials being worked. In microelectronics, for example, when puzzling phenomena occur, the manufacture of circuits is pushed down to ever smaller dimensions. These phenomena must be explained before further progress can be made.

Further, incremental advances in narrowly focused technical areas—characteristic of much industrial development in the past—are giving way to the use of a broad range of science and engineering disciplines on complex, often ill-defined problems, or exploitation of new analytical capabilities. Hence, it is becoming increasingly difficult for any one industrial laboratory to fully encompass the requisite expertise. A partial remedy for this situation is to seek out the pertinent skills wherever they may be found in the nation's universities.

And, finally, the rapid expansion of the nation's R&D system over the past three decades has diffused research capabilities over a much broader range of institutions—academic and industrial—than ever before. Thus, it is quite unlikely that any one company could hold and maintain a leading edge on technical advance in a given area.

It remains a fact of life that, should corporate contributions to academic research double or even treble, they would still support only a small portion of the total academic research effort, and such support would be concentrated in selected fields.

The implication is clear: If the present level of academic research is to be maintained, the principal burden will continue to fall on the public purse, federal and state.

The most essential contribution of state governments is to provide a support base for fundamental research through the expectation that professors on state salaries devote a significant portion of their work time to research. Teaching assignments should reflect this role.

The federal government supports the majority of fundamental research in the country, most of it in universities. Beyond this contribution to national strength, the role of the federal government is, and should be, limited to encouraging, not directing, university-industry relationships.

Clearly, the future paths for university-industry cooperation will depend on the way that each university and corporation perceives the essential role of the university. If the university moves nearer to a partnership with industry, more resources can become available. But the university may relinquish some of its unique freedom of action. There are no absolutes and the issues become matters of degree and common sense. The primary requirement, therefore, is not so much increased partnership, but increased understanding of each other's role. ■

Lewis M. Branscomb, vice president and chief scientist for International Business Machines Corporation (an NAM member), is chairman of the National Science Board and a member of President Reagan's National Productivity Advisory Committee. Copies of the board's 14th annual report (*see text*) may be obtained from the NSB at 1800 G Street, NW, Washington, DC 20550.

NEWS REVIEW

March 6, 1984

FROM: PUBLIC RELATIONS—F3EB

Monsanto

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FEB 16 1984

Universities Help Fill Research Gap, Says Official

By MIKE McFARLAND
Staff Writer

Joint research ventures between universities and private industry create a national resource and allow the United States to remain on the cutting edge of technology, says an official of a major American research firm.

"Without it, the United States industries will lose leadership . . . and a large opportunity to develop major new industries and thousands of jobs," said Howard A. Schneiderman, Monsanto Co. senior vice preseident for research and development, in an address on the UNC campus Wednesday night.

America could face drastic setbacks in biotechnology without joint research, he told a Venable Hall audience.

By the turn of the century, America could discover cures for several diseases and even succesfully control and prevent degenerative brain diseases, Schneiderman said.

Scientists also could discover how to genetically engineer crops, which would increase crop yields, and might eliminate the need for the use of pesticides, he said.

But, Schneiderman said, such breakthroughs will never occur without the formation of research partnerships between universities and private industry.

AND SUCH JOINT efforts will be-

Research Gap

(Continued from page 1A)

come increasingly important as countries like Japan form huge research consortiums between major corporations, he said.

From 1977 to 1981, Japan held 60 percent of the patents in biotechnology compared to the United States' 10 percent, Schneiderman said.

Federal antitrust laws prevent such consortiums in the United States, he said, and that leaves the universities to help fill the gaps in this country's ability to remain commercially competitive with the rest of the world.

"The talents of America's research universities are unsurpassed in the world. It could keep America on the leading edge of scientific adventure. It could benefit American society in terms of useful producst and find ways to meet basic human needs throughout the world."

There are risks involved in joint research ventures, probably more for the universities than for the industries, he said.

"If in the interest of short-term rewards corporations damage the (universities) . . . they will kill the goose that laid the golden egg. I am convinced America's major corporations recognize this."

As an example of one partnership that has evolved recently, Schneiderman cited a joint research program between Monsanto, a St. Louis-based chemical compay that produces synthetic fibers, plastics and other products, and Washington University's Medical School there.

The agreement, which was reached in 1982 and carries a $23.5 million price tag, has two important conditions, Schneiderman said. The university owns the patents to any discoveries while Monsanto has the authority to license the patents.

There also is a joint advisory committee — made up of four representatives each from Monsanto and the university — that decides what research will be funded under the contract, he said.

THE CASE FOR the Monsanto-Washington University agreement is even stronger when funding support nationwide is examined, Schneiderman said.

Industry contributed only $250 million (4 percent) of the $6.6 billion universities received in support of research in 1981, he said. The rest came from federal and state sources. The maximum industry will ever be able to contribute to university research will be 6 percent, Schneiderman added.

"As a nation, we cannot continue to prosper in the long-term (if we keep) assembling imported goods and exploiting imported ideas," he said.

Schneiderman's visit here is sponsored by the UNC departments of biology and chemistry. In conjuction with his visit, biotechnology research conducted at UNC will be presented in a poster session today from 2 to 4 p.m. in the Coker Hall lobby. Schneiderman will deliver another lecture, "What Biotechnology Has In Store For Us," at 4 p.m. today in the Coker Auditorium.

THE GROVES OF SILICON



Stanford University

Stanford's community of technical scholars and how it grew

by Bob Beyers

What *Fortune* magazine has described as the world's leading center for new technology—Silicon Valley—was the handiwork of the late Frederick Emmons Terman.

Terman, who joined the Stanford faculty in 1925 and was its provost from 1965-1975, also set the stage for an era of unprecedented collaboration between that university and industry.

Even before World War II, Terman was instrumental in encouraging talented students to start their own business ventures. After the war, he explicitly recognized the potential for combining federal research funds, academic programs and industrial development. And Silicon Valley was born.

In 1937, Terman encouraged two of his graduate students, William R. Hewlett and David Packard, to build an audio-oscillator, a device to generate signals of varying frequencies. Starting in a Palo Alto garage, they proceeded to build a worldwide, multi-billion dollar electronics firm.

In the same year, at Terman's suggestion, a Stanford physics professor, William W. Hansen, gave Stanford graduate student Russell Varian and his brother, Bill, work space and $100 for materials. In return, they offered the university half the royalties from any inventions they made.

Their invention of the klystron tube played a key role in improved radar for Britain during World War II, provided the basic technology for the Stanford Linear Accelerator Center and now is used in cancer treatment. The univer-

continued

sity realized millions of dollars in royalties on the patent.

Working closely with Stanford's then-president, Wallace Sterling, and others, Terman played a central role in setting up the Stanford Industrial Park in 1951. Hewlett-Packard and Varian Associates were among early tenants. Today, the park's 90 firms employ about 25,000 people on campus lands adjoining faculty housing.

Terman deliberately sought to create a "community of technical scholars." He did so by picking promising areas for basic intellectual discovery, then seeking the best people to build what he called "steeples of excellence."

Faculty were free to spend one day in seven consulting. Some were instrumental in bringing firms directly to the industrial park. Chemist Carl Djerassi, the father of the contraceptive pill, brought Syntex and later became president of Zoecon.

Terman's recruitment of William Shockley, coinventor of the transistor, from Bell Labs in the mid-1950s, eventually led to the creation of 55 electronic firms in Silicon Valley.

Stanford's recruitment of Arthur Kornberg, Joshua Lederberg and others laid the intellectual foundation for the emergence of biotechnology in the Bay area.

The driving factor was intellectual, not industrial. But individuals were free to get their hands "dirty" developing their ideas, within guidelines that assured their basic academic responsibilities were met. Computer Curriculum, Telesensory Systems, Catalytica and Failure Analysis Associates were among the many firms springing up on the basis of faculty research or consulting.

Terman created an honors cooperative program, enabling hundreds of employees, regularly admitted as graduate students, to take courses direct from campus classrooms to more than 100 firms, realizing more than $3-million annually in revenues. Most of the proceeds are plowed back in support of professors' salaries.

An innovative technique, called tutored video instruction, pioneered by Prof. James Gibbons, extends further the reach of Stanford, using a combination of videotapes, regular course materials and local talent to keep professionals up-to-date.

[illegible]ford's academic ties with industry for mutual benefit was the creation of industrial affiliate programs in more than 20 fields, ranging from applied math, chemistry and construction to synchrotron radiation and Northeast Asia policy.

Managed by faculty members, these affiliate programs enable sponsors to meet on campus and review research, obtain publications and discuss nonproprietary questions or key problems in advancing the state of the art in their field. Affiliate programs also give graduate students direct exposure to industry.

In the post-war period, both at Stanford and as general procedure elsewhere, a fairly standardized historical sequence of innovation has emerged.

The first phase is publicly funded and oriented toward the discovery and explanation of basic phenomena. It is characterized by loose, informal organization and very open communication (which includes quick publication of all details of an experiment).

The second phase is best called application. It is focused on processes and takes place in various settings: applied institutes, some university departments (of engineering, for example), nonprofits (such as SRI International or the Battelle Institute) and industrial laboratories. There is a mix of public and private funding and environments that are variable with respect to proprietary secrecy.

In the third stage—development—attention is given to practical application, including such matters as scale, rates and means of economical production. The innovation emphasis is on products; funding is by private risk capital, and the environment tends to be closed for proprietary reasons and tightly managed. All such work takes place in commercial laboratories.

Stanford President Donald Kennedy, a biologist and former commissioner of the U.S. Food and Drug Administration, points to a time of transition: "Now we are seeing a revolutionary compression of this three-stage process or innovation. The social sponsorship of discovery is being rearranged in a very fundamental way."

Kennedy believes the following factors contribute to this trend:

☐ A number of scientific disciplines are now being recognized as "ready" [illegible]pline matures in power and confidence, leaps from the laboratory to applications that once seemed intimidating become commonplace. This now appears to be the case, for example, in immunology and genetic engineering, as well as in microelectronics.

☐ There is a growing social awareness of the importance of scientific discovery to national productivity and a consequent impatience with the traditional time requirements for diffusing technology to the public.

☐ Concern is increasing in research universities—where more than two-thirds of the nation's basic science is done—about the retreat in public support for research. Federal funds for nondefense research have shrunk by about 33 percent in real dollar value since 1968. Half this decline took place in the first two years of this decade.

☐ Perhaps most unexpected of all, the venture-capital financing of small, research-intensive firms in fields such as biotechnology and microelectronics has been transformed. Since major changes were made in the capital gains tax, the investment funds available for such ventures have jumped from an estimated $70 million in the mid-1970s to about $1.5 billion in 1982.

The Stanford president tracks the developments: "Very large changes in value can take place with successive generations of private investment in high-technology firms and larger changes still when the firm goes public. At its initial public offering, for example, Genentech was valued at $38 per share. Then it soared to $80 before settling down.

"Despite some disillusionment about the soundness of biotechnology investment, Wall Street was quick to learn that in this new work, big potential is associated with early possession of an idea.

"The result is an entirely novel mixture of influences on university scientists and their institutions. For the university itself, there are new and challenging pressures on investment policy (Does the institution go into business with its own faculty?), on technology licensing (Should the university license inventions to faculty-led ventures?—to their competitors? And if yes, under what terms?), or research contracts with industry (What restrictions on communication are ac-

ceptable and should there be full disclosure of terms?), and on policies relating to consulting, faculty conflict of interest and the protection of graduate student interests."

As the Stanford president points out, "many of the problems are simply not solvable by the institution alone. For the scientists themselves, and the 'invisible colleges' that hold them together in national and international networks, there are other questions such as: How much can or should they guard against the withholding of information and exchange for proprietary reasons? How much involvement outside a faculty member's primary institutional affiliation is appropriate?

"In general, this new climate offers more opportunities than problems. What we must try to do is involve industry more productively and creatively with university research components and the division of faculty time between on and off-campus ventures."

Two promising industry-university collaborative ventures involving Stanford illustrate how these objectives can be achieved.

Stanford recently broke ground for a new Center for Integrated Systems (CIS), dedicated to fundamental explorations of what would popularly be called microelectronic chip development. Its purpose, however, is not to get a jump on the market by developing the next generation of integrated systems, but to advance the overall state of knowledge by orders of magnitude.

Without industry support, Stanford's Center for Integrated Systems would not exist. With industry support, Stanford has an exciting opportunity to discover fundamental knowledge in an area full of promise.

The basic arrangement is this: 19 leading industrial firms in microelectronics and physics each have pledged to contribute $750,000 for the construction of a building to house CIS. Once the building is completed, those firms will contribute annual dues to the center.

In return, those firms may participate in the CIS program by sending to the center one visiting scholar, approved by Stanford, to work with the CIS faculty on fundamental research.

The rules under which research is conducted at CIS are quite clear: A free and open flow of ideas and swift publications of results are a mandate.

"Industry in general gains from such ventures by assuring that fundamental work in this area will be undertaken," Kennedy emphasizes. "The particular affiliated firms gain through their exposure to new ideas in these fields and to the faculty leaders who are asking the new questions. Perhaps most important, the sponsors have a chance to become acquainted with bright students, whose education we also hope to enrich through the center."

A second arrangement, providing a rather different model for the development of new industry-university collaboration, is the new nonprofit Center for Biotechnology Research. It will fund research in genetic engineering and biotechnology, and is affiliated with a for-profit firm, Engenics Inc., which will seek to develop commercial opportunities in the same field.

> "The driving force was intellectual, not industrial. But individuals were free to get their hands 'dirty' developing their ideas."

Six major firms collaborated in financing the new entities. A unique feature of the arrangement is that the center will hold 30 percent of the equity of Engenics, and its charter provides that any capital appreciation and dividends realized on Engenics stock be devoted to the further support of basic university research as determined by the trustees of the center.

Stanford owns no equity in Engenics, nor will Stanford lay any special claim to research funds available from the center. The six sponsoring firms of the center and Engenics may have licenses to any patents developed in the center's funded projects, but these licenses will be offered at commercial rates and in accordance with existing policies at the universities.

"The novelty of the research agreements with the Center for Biotechnology comes not from any special conditions developed by the universities," explains Kennedy, "but from industry's willingness to form a new funding consortium for university-based research.

"These new forms of industry involvement in university research did not emerge easily; they evolved out of a process of hard negotiation.

"The condition under which university research flourishes—open and free exchange of ideas—is really quite different from the proper and necessary secrecy that shrouds end-product development."

Sponsoring research, Kennedy continues, "is not the same as making a charitable contribution. The same firms that make charitable contributions for philanthropic reasons, rightly insist on getting their return, even if long-term, from sponsored research.

"For their part, universities have no objection if their research benefits business. Indeed, they rather like the idea, but they are zealous about ensuring that the conditions essential to free inquiry for teaching and research are not compromised."

In congressional testimony on behalf of the Association of American Universities and the National Association of State Universities and Land Grant Colleges, Kennedy has backed tax credits for business firms that sponsor basic research at universities.

Besides providing an incentive for fundamental research that individual firms often cannot undertake alone, such tax credits would, as a critical by-product, train scientists and engineers more attuned to the needs of industry.

"We must find a way to increase the rather small proportion of industry contribution to university research—it is around 5 percent at Stanford and averages only about 3.5 percent for U.S. research universities—without launching a migration of the universities' best research talent into industry," Kennedy emphasizes.

While it cannot substitute for sustained, large-scale federal funding of basic sciences (*page 4*), increased industry support could help meet the critical need for instrumentation in university laboratories, buffer long-term research from sharp fluctuations in federal funds and further quality training of future researchers.

Hewlett-Packard recently announced a $6-million program to encourage promising graduates to continue teaching after completing their degrees—in essence, rewarding

continued

them for not coming to work on the company payroll.

If Stanford's experience is any guide, such long-term concern for academic quality—a concern that today extends far down into the primary and secondary schools—is vital for maintaining a strong, productive economy.

Innovation and entrepreneurship both remain vigorous on campus.

Stanford's faculty of 1,100 produces an average of nearly three inventions or processes a week that are reviewed for possible licensing. Gross income from technology licensing topped $2.5 million last year.

"We are in the third year of a very high rate of discoveries—two or three per week—which shows no sign of abating in the near term," notes Director Niels Reimers of the Office of Technology Licensing.

"Molecular biology and information sciences are the areas of greatest activity," he notes. In these areas, the technology often involves tangible research property (TRP), such as a piece of biological material or a computer software program. University rules make TRP promptly available to scientific colleagues while protecting its commercial value. A recently established Software Distribution Center helps meet these objectives.

Biological products of greatest research and commercial interest are hybridomas, DNA probes and plasmids. So far, researchers have made more than 100 disclosures of biological materials to the Office of Technology Licensing.

During 1981-82, Stanford received income from 56 separate technologies. Earned royalty income on sales came from such products as a biological cell sorter instrument, text-editing software, a chemical reagent, an infant hearing-detection system and an infant transporter, an insect attractant and hybridomas.

Advance payments were received on FM-sound synthesis for musical instruments, human hybridomas, acoustic microscopes, computerized axial tomography (CAT) technology, blood-flow detection systems, cryptology systems and computer-aided design software.

"The gestation period of a university discovery until significant income from sales is received is generally long," Reimers observes. "In 1981-82, more than 88 percent of the income came from cases disclosed to the Office of Technology Licensing in 1974 or earlier."

Unlike most industries and many other universities, Stanford permits individuals to retain a one-third share of net income from their inventions. Another third goes to their department and the rest to their school. While small, these funds are growing fairly rapidly and provide continued support for campus R&D.

Hundreds of students, both graduate and undergraduate, have attended student-organized conferences on entrepreneurship in the past two years, scores creating their own companies.

Computer software is the hottest single field. Other ventures range from fiber optics and new methods of drilling for oil to earthquake safety inspections for homeowners, books, chocolate-chip cookies and truffles.

There's no rigid, lock-step master plan involved.

As in Stanford's many relations with business and society generally, there's a concern for finding bright people, creating a climate where their talents can flourish in a wide variety of ways, and—hardest of all—having the patience to wait years, even decades, to see how it all comes out. ■

Bob Beyers is director of Stanford University News Service, Stanford, Calif.

SCIENCE HAS ITS DAY

by Theodore M. Hesburgh

Wouldn't the world really be a better place if we could replace the current leadership—the politicians, the philosophers, the lawyers, the humanists, and the theologians—with scientists and engineers?

I am sure that this question, on the surface, sounds somewhat preposterous, but there are scientists who profess to have an answer for everything, who have been disillusioned by political and legal forces, who often feel unduly inhibited by philosophy and theology, who legitimately bristle when they are portrayed by the humanists as the new savages, bringing the world to the brink of destruction.

One might make the point that the nonscientists acted mighty selfishly themselves when they had their day. I must resort to some oversimplification here, but I think the main point at issue will be evident.

The Greeks in their day reduced all knowledge to philosophy. A remnant of this remains, as many scientists today receive Ph.D.—doctorates of philosophy. The Romans brought to our civilization a heritage of law and political order. Many of our current legal principles were formulated long ago in the Code of Justinian, when science was fairly primitive. Renaissance man almost worshiped the arts. Science was simply a liberal art in those days.

In medieval times, theological synthesis was in highest vogue. The earliest universities turned around about the faculty of theology. The queen of the sciences was theology's most cherished title. No scientist or engineer would have had then the ascendency each enjoys today. In fact, the explosive beginnings of science and technology were most often met with resistance and misunderstanding.

Would it be any surprise then if history were to repeat itself, if those who hold the ascendancy today were to claim as their exclusive rights the center of the stage, as the philosophers, the lawyers, the humanists and the theologians did?

Would it be incomprehensible if scientists and engineers were to claim today that they, with their revolutionary new knowledge and power, could do a better job of running the world than those who preceded them in man's long history of intellectual developments?

There is historical precedent for those who answer in the affirmative and claim exclusive leadership today for scientists and engineers as the best the world may expect and need.

I could readily understand this stance, but again, in disagreeing, I would only underline one perceptive statement: that those who are merely children of their day, who do not understand history, condemn themselves to repeat all human errors of the past.

The Rev. Theodore M. Hesburgh is president of the University of Notre Dame and a former member of the National Science Board. Excerpted from *The Hesburgh Papers: Higher Values in Higher Education.*
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R&D WITH A TWIST OF HIGH TECH

The role of government is to expedite the process

The long tradition of industry-university cooperation in education and research has recently been even more closely cemented, particularly in heavily financed research agreements. How do you view this?

Skeen: I view the trend very positively. Every aspect of what we know about education and university-run research and development points to the need for greater cooperation between industry and universities. Over the past few months, we have all been alerted to the long-term decline in the quality of U.S. education, especially in the sciences. There is also the problem of a rapid change in the technologies used in the private sector—so rapid that few universities can be expected to keep up with the state of the art in training and research facilities.

Industry can benefit its own R&D operations and perform a tremendous public good by helping meet the instrumentation needs of universities and assisting in the improved quality of students' education. Everybody wins. The industry gets access to the best research capabilities in the world; the university gets financial and equipment support; and the student ends up better-educated and more qualified for the modern workplace.

Somerville: What current and future areas of industry-university cooperation do you see as most significant?

Skeen: Without doubt, I see high-technology development as the most significant area both now and in the future, specifically in the areas of education and research. My own state of New Mexico's Rio Grande Valley has become a prominent center of modern science and high-technology development, with large and varied assets in institutions of higher learning, government laboratories and industry staffed with professional and skilled personnel. To that end, I have supported the establishment of governing and administrative mechanisms to initiate and guide the active development of the Rio Grande Research Corridor (RGRC) to enhance the quality and quantity of employment in New Mexico by attracting high-technology industries.

One area where industry-university cooperation in education and research has resulted in dividends for the state is in explosives-technology research and application with emphasis on the areas of metallurgical and ceramics-materials processing, and ore-quality improvement and materials extraction for enhanced yields and reduced energy use.

New Mexico has for more than 40 years been the focus of high-technology activity in explosives applications by universities, defense-related national laboratories and industry. At the New Mexico Institute of Mining and Technology, these technologies reside side-by-side with active mining and metallurgical engineering departments and with explosives-related research in the institute's research and development division. Combining these individual efforts to develop high-technology applications of explosive energy to metallurgical and mining problems will result in an enhanced center of excellence with national and international significance.

Explosives technology is an unusual field that has been given little attention by private industry, yet New Mexico Tech now provides explosives-related research and testing services for many government agencies as well as industrial clients such as Boeing, Honeywell, Vought, McDonnell Douglas, Brunswick, Motorola, BDM, Hughes, Aerojet General and others. Four of these industrial clients have already expressed a keen interest in locating facilities in New Mexico Tech's research park area and in working cooperatively with the institute.

I feel strongly the proposed effort will provide the catalyst for combining current research efforts, in-place laboratory capabilities and industrial client relationships into a nationally important center for the application of explosives technology.

Somerville: If industry-university cooperation—in its many facets—is viewed as enhancing the U.S. research-and-development effort and providing benefits to education institutions, is there justification for government action to spur cooperation?

Skeen: Certainly—in a supportive manner. I have always felt that one of the roles of government is to assist the public good. Not to do the job in most cases, but to assist those better qualified and closer to the problem to solve it for themselves.

The most appropriate role for the federal government in this case is to remove any impediments to these cooperative agreements and then to provide as many incentives as good fiscal and public policy permit. Many bills have been introduced this session to that very end. The appropriate committees have to act on those bills before anyone can say exactly what is likely to happen.

The Reagan administration is certainly aware of and sensitive to the problem. There are, however, limits to what can be done as long as the deficit remains so large. I believe industry-university cooperation to be an important component in a program to increase our rates of innovation and productivity—leading to a stronger economy, so you cannot drop one issue to pursue the other.

Somerville: Antitrust laws have often been cited as providing a disincentive to cooperative ventures involving industry and universities. Should antitrust laws be changed to stimulate even greater cooperation? Or do you believe that antitrust limitations on research cooperatives could be changed administratively?

by Brendan F. Somerville

Skeen: I don't think current antitrust laws prevent these cooperative relationships at all. We see this same problem in joint R&D ventures among firms, especially in the high-tech area. It is easy to forget the important role antitrust policy, when first enacted, played in strengthening free enterprise in this country. Most of our industries, however, no longer compete in a national market. The international competition we now face necessitates a joining of certain industry interests—such as R&D—to better arm American industry for the market-share battle under way in world commerce.

Several major conferences have been held on the subject, one of the better ones, as a matter of fact, by the NAM in Boston last fall. The consensus seems to be that a clear policy from the Commerce Department—combined with the removal of treble damages in the antitrust regulations from the Department of Justice—might help a great deal. The Commerce Department held a high-level meeting in May on the subject and considerable progress was made.

Somerville: Several bills before the House and Senate address the capability of schools and universities to deliver more quality scientists and engineers. Do you believe that university-industry research relationships can generate new opportunities for quality education, particularly at advanced levels?

Skeen: Absolutely. In keeping with the administration's commitment to ensure our country's future strength, the director of the National Science Foundation and the secretary of education were instructed to examine the adequacy of science and engineering education for the nation's long-term needs. I highly recommend their report, "Science and Engineering Education for the 1980s and Beyond," which provides a comprehensive study of important and difficult issues facing the nation's science and engineering education system.

Somerville: Many of the issues the report raises have been partially addressed by the administration as part of its economic recovery program. The National Science Foundation, for example, is slated for an 18 percent budget increase by this administration. In addition, the president has initiated reforms in the tax system to stimulate investment and spur growth. I am hopeful these efforts will promote cooperation in research among industry, universities and government. These measures, taken together, will do much to stimulate new interest in science and engineering careers and strengthen the research-and-training base of the nation: the universities and engineering schools nationwide.

Somerville: More difficult problems than antitrust or taxes in the university-industry relationship have been raised. The ethics issue is one: take, for example, a professor's conflict between his academic responsibilities and his commitments to a company's research needs. Your subcommittee has held hearings to examine aspects of this in the biotechnology fields. What were the results?



Skeen: That depends on one's perspective, I'm afraid. Not all my colleagues on the subcommittee are as comfortable as I am with the growing trend in these agreements. Many have raised legitimate concerns, well-documented in the lay press and academic literature. Let me say that I do not think the problems are insurmountable, nor do they prompt a need for extensive government oversight. The issues are not new. Several institutions, like Stanford (*page 11*) and MIT, have a long and successful history of collaborative relationships.

The subcommittee recently held a hearing in New Mexico and examined the plans for the Rio Grande Research Corridor, which builds on the talents of the state's university system to attract industry in such fields as biotechnology and robotics. The development of the research corridor depends on a multitude of collaborative research relationships and can only improve university education, industry R&D and the local economy. Sure, there will be some problems but the benefits to all involved will prompt a quick solution. You can count on it.

Somerville: Another problem lies in data publication. Academic freedom demands extensive publication of research results, while industry is more protective of results until they are safeguarded (by patents, for example). Some believe that university-industry research cooperation is not likely to be so extensive that temporary limitations on open-data exchange would harm the overall academic need for free publication. What are your views?

Skeen: Academic freedom must be maintained. In our hearings on the decline in the quality of education in America, a number of witnesses felt that perhaps there has been too much pressure on professors to publish instead of educate. The balance between research and education is dynamic and shouldn't, in my mind, be toyed with. However, it may be that a little less emphasis on quick publication of *all* research findings and a little more emphasis on the educational advantages of collaborative research endeavors might do the universities and students some good. Again, many universities have worked out this issue with their industry partners. Both sides must make compromises; this just has to be accepted. ■

Rep. Joe Skeen (R-NM) is ranking minority member of the Science and Technology Committee's Subcommittee on Investigations and Oversight. Brendan F. Somerville is NAM director of innovation, technology and science policy.

COLLABORATION BASED ON TRUST

by Howard A. Schneiderman

The Monsanto way of forging ties with academia

Controversy provokes change. A current controversy that promises to significantly change the relationships between universities and industry stems from the increasing number of joint research contracts being developed by America's research universities and research-driven companies. What are the pros and cons?

Supporters of research collaboration between universities and corporations argue that the research talents of America's great universities are unsurpassed in the world. They suggest that these talents, coupled with the splendid technological and product development skills of American industry and our national entrepreneurial spirit, could accelerate both basic research itself and the application of basic research. They see hybrid scientific vigor emerging from such collaboration—a vigor that would keep America at the leading edge of scientific, technological and industrial change and ensure that it remains the leading scientific and economic power in the world. They also argue that without such university-industry collaboration, American industry may lose its technological leadership in key areas to industry—university-government consortia such as those established by the Ministry of International Trade and Industry (MITI) in Japan. As a consequence, key American industries may fail in the international marketplace. Finally, they point out that university-industry collaboration can provide important research funds to universities, which largely support basic research.

Detractors suspect that contracts between companies and universities threaten academic freedom by discouraging basic research and the sharing of knowledge. They believe that such collaboration will undermine our system for discovery of new knowledge and training the scientists and opinion leaders of the future. They question whether our universities are morally strong enough to withstand what is construed by some to be the corrupting influence of big business. In particular, they believe industry will encourage universities to pursue excessively utilitarian goals and to neglect long-term fundamental questions. And some of them question whether it is sensible for public companies to invest research dollars in university research, where the companies' control over conduct of the research is limited or nonexistent.

I understand the hesitation of some of my scientific colleagues in universities and their concerns about protecting academic freedom. I agree that the university must be protected and nurtured as a place for pure scholarship, a place to some extent insulated from excessively utilitarian goals.

If, in the interest of short-term rewards, corporations damage the basic intellectual structure of America's universities, they will kill the goose that lays the golden egg. I am convinced that America's major corporations recognize this and are sensitive to the importance of the university as society's main arena for the discovery of facts, explanations and ideas. Monsanto certainly understands the importance of great, independent, research universities. Yet we have become convinced that industry-university research collaborations can benefit academic institutions, industry and society.

Today, Monsanto is a participant in several research collaborations with U.S. universities. In 1982, the company announced a five-year, $23.5-million agreement with Washington University in St. Louis to conduct research on proteins and peptides that regulate cell function. Also in 1982, Monsanto signed an agreement with Rockefeller University for a five-year, $4-million basic research program in plant photosynthesis.

Since Monsanto creates and sells science and technology, our company has a vested interest in the future of the scientific endeavor in this country.

We see the nature and direction of science changing, primarily in its quickening pace—with sharp accelerations recently.

- The time between making a discovery and having it enter the commercial world is getting shorter, particularly in the life sciences.
- Technology transfer from the university is also quickening—more of what the university discovers can be applied by industry than was the case 20 years ago.
- The traditional boundary lines between basic and applied research—or between university and industrial research—are blurring rapidly.
- Funding patterns are changing. Nondefense federal research spending has slipped 38 percent in constant dollars since 1967, with nearly half this decrease over the past two years.
- International competition in high technology is becoming increasingly

intense. Japan, for instance, has legislatively created cooperative agreements among government, industries and universities.

All these factors are pushing industry and universities into a reassessment and redirection of their roles in science. We are finding ourselves becoming logical partners for scientific innovation and technology transfer.

Monsanto supports this concept of partnership because it is one means of adapting to competitive change. Market forces, for example, have led, or driven, an increasing proportion of American industry toward higher value-added products—products that rely increasingly on science and technology transfer. The lines between the chemical, agricultural, medical and drug, textile and computer industries are growing less and less distinct.

While this change offers us the opportunity for synergy between what have traditionally been different technologies and sciences, it also produces the problem of developing new and needed skills.

Molecular biology is an example. Chemical or drug companies cannot match the massive skills that have evolved in America's great research universities. But we need this science and technology to develop products that meet basic human needs. One way to accelerate this process is to work with universities.



Stephen Wagner

Monsanto's association with Washington University is part of a plan to bring original science and technology to bear on problems of great social and commercial importance. By using and supporting the research skills of this distinguished academic institution, Monsanto enhances not only its own competiveness in changing world markets but also America's.

About 15 years ago, Monsanto and Washington University entered into an agreement with the Office of Naval Research to conduct scientific investigations on high-performance composite materials. That collaboration and a later association with Harvard University served as a precedent for the recent agreement with Washington University.

Neither Monsanto nor Washington University views the agreement as a formula for other companies and universities to follow. It was designed to suit the particular cultures of these two particular institutions. It may be useful, however, to enumerate the contract elements we believe critical for undertakings of this sort.

Negotiations started two years ago, when Monsanto scientists began talking with David Kipnis, chairman of the Department of Medicine at the Washington University Medical School, and his colleagues. In those two years of careful planning, Washington University and Monsanto developed a plan for bringing the benefits of important medical discoveries to the public faster than would otherwise be the case.

The goal of the Washington University agreement is to provide society with health-care products. Yet, at the same time, it specifies that 30 percent of the research conducted is to be allocated to the pursuit of fundamental biological questions. The other 70 percent is focused on cures for as yet incurable major diseases.

Provisions were made for specific project agreements. The Washington University contract not only builds a framework for these but also establishes a joint advisory committee made up of four Monsanto representatives and four from the university to decide what research will be supported.

The presence of this committee enables the undertaking of a broad variety of research as well as a competitive situation for the awarding of research funds. The university tells the committee what research it is doing or wishes

continued

...o do. The committee selects projects it believes offer the highest promise for solving important health-care problems. If the committee elects not to support a particular research endeavor, the university probably will seek other sources of funding.

Academic researchers retain their freedom to publish; the agreement establishes a 30-day period for Monsanto to review any manuscript.

The contract also calls for an independent oversight committee of leading citizens from the scientific and academic communities and public arenas representing society's stake in the research. There is a special requirement for a scientific peer committee to review the work after a certain time and to assess its scientific merit and impact on the two institutions.

This all leads to a mutual exchange of ideas among scientists. Because of the proximity of Washington University to Monsanto (only 15 minutes away) and because of the rapid growth of biological expertise inside the company, this will be a true collaboration. Monsanto scientists will work on each project with Washington University scientists, in their labs and our labs.

Monsanto has the exclusive right to license any patents that may come from the research. This important provision is basic to how effectively this research collaboration will serve the ultimate beneficiary: the public. The forte of academic research is fundamental investigation: the R, if you will of R&D. While industry is also capable of doing highly original research, the place where it excels is in the development phase, or the D of R&D. Development is an expensive, time-consuming, high-risk process. For every research dollar spent on discovery, it takes hundreds more to develop that discovery into a useful product that can be manufactured and sold in the marketplace.

No less significant is the time commitment. A rule of thumb is that it takes at least 10 years to go from the original discovery to a product on the shelf. That was true of the Lasso and Roundup herbicides as well as the AstroTurf stadium surfaces we developed. To develop plant-growth regulators that will enhance the yield of major crops, Monsanto already has spent well over a decade and tens of millions of dollars. Yet it still has not commercialized an important plant-growth regulator.

Obviously, a company cannot afford to invest shareholders' money in this kind of high-cost, long-term development process without some guarantees that success will provide an opportunity to recoup the investment.

In the future, we may expect to see more companies and more universities forging partnerships. Hopefully, each partnership will be tailored to the particular university and corporate cultures involved. But, in all cases, the keystone to the success of the partnerships will be the regard in which each partner holds the other. Integrity and mutual trust are essential. So is a deep conviction that the rights and interests of both parties must be safeguarded.

By accelerating the processes of discovery and technology transfer, these partnerships can help university researchers better understand some of society's important needs and enhance their ability to meet those needs. Conversely, industry stands to gain through an infusion of basic knowledge that will enhance its own applied research. New perspectives and new ways of thinking should emerge from both institutions.

The controversy over industry-university collaboration is resulting in change—positive change that can enable America to remain a technological leader in a world of increasing competitive challenge. To maintain that leadership, however, we must ensure that the rights of both institutions are secured; and we must demonstrate that society is the ultimate beneficiary of these relationships. ■

Howard A. Schneiderman is senior vice president of research and development at Monsanto Company (an NAM member) in St. Louis, Mo.

ROBOTICS RESEARCH

Researchers from five corporations are working with scientists at Purdue University, Lafayette, Ind., in a major effort to develop the first factory that will be computer-controlled—from product design to the loading dock.

The Computer-Integrated Design, Manufacturing and Automation Center (CIDMAC) is a cooperative venture organized by Purdue and sponsored by Cincinnati Milacron, Inc.; Cummins Engine Co., Ind.; Ransburg Corp.; and TRW Inc. (all NAM members); and Control Data Corp. It was established "to attack problems of productivity and innovation in American industry," explains John C. Hancock, dean of Purdue's Schools of Engineering.

While acknowledging that other universities and private firms have also teamed up to tackle the productivity dilemma, Hancock claims the CIDMAC approach is unique. Center researchers will seek to integrate the traditionally separated functions of computer-aided design (CAD), computer-aided manufacturing (CAM), robotics, group technology, and simulation of product processes and management techniques for production management.

Several research projects entail designing "more intelligent" robots:

- Improved tactile sensing would make robots capable of bringing objects together—a "must" in the fully automated factory of the future.
- Sight capability would especially improve the inspection process.
- Flexible fixtures would allow a robot to automatically adjust itself to parts. At present, "cradles" for holding the parts are not flexible and must be replaced each time a different or new part is manufactured.
- Cooperative work projects would improve work flow and efficiency. Currently, robots are capable of interacting with other machines, such as computers, but cannot work with other robots to share work tasks.
- Free-moving vehicles would improve flow-time and inventory by a factor of 10 and reap dramatic improvements in productivity. At present, robot vehicles that carry parts or pick up objects are guided by cables around the plant, making direct point-to-point trips impossible.

The industry-academic coalition does not expect instant results but is confident of significant increases in productivity—without sacrificing human values.

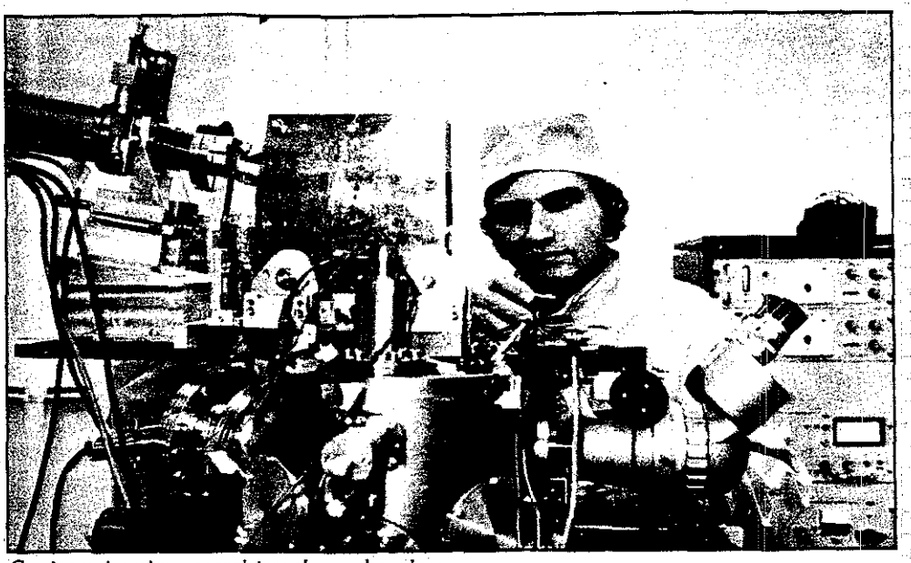
From research to reality

British universities are becoming rich hunting grounds for technology-transfer agencies. Now in the queue is the Research Corporation of the US. Laura Mazur reports

Now that the British Technology Group (BTG) no longer has the first choice of exploiting British academic research, our universities are becoming rich hunting grounds for technology-transfer agencies.

The latest to join the queue is the US's Research Corporation. It wants to apply techniques culled from 70 years experience in the US of translating academic research into market reality.

According to Dr Charles Desforges, chief executive of RCL, the part of the venture which will deal with commercial exploitation, "We will be looking for activities whereby an invention becomes innovation and then commercial reality." The surplus funds will then be circled back into Research Corporation Trust (RCT), the heart of the British organisation, which will, in turn, recycle the money into more research.



Getting university research into the market place

Steering research grants

RCT, which will steer the research grants, is being formed as a charitably-based joint venture between Investors in Industry (which is backed by a number of banks, including the Bank of England) and Research Corporation. It will kick off with £100,000, which will eventually be increased both by the growing commercial subsidiary, RCL, and (hopefully) by British commerce and industry.

The goal of RCL will be to sew up non-exclusive agreements with universities and other institutions of higher education — at first here, and then spreading to the Continent. Any tempting proposals it evaluates will become RCL's responsibility for patenting, licensing or handling in whatever way best suits the idea or invention: licensing, joint-ventures or seed-capital provision. Profits will then be split between RCT and RCL for overheads and grants, with the remainder going to the original institution.

Desforges points out that "Lots of inventions are really embryos, and they have to be nurtured toward survival or else die. Survival means funding — but they often fall into a commercial gap between research grants and venture capital. That gap needs to be filled."

Research Corporation was set up 70 years ago by a young physical chemistry professor who had made money from an invention and wanted to use it both commercially and to benefit society (see box). It has developed the twin roles of funding research on one hand, and exploiting promising inventions on the other — but does it mainly through universities to avoid getting entangled with individuals.

Desforges has already begun the round of universities here in search of agreements under which RCL will evaluate proposals sent to it. Desforges calls them "comfort agreements" — they are not onerous, and hard-pressed universities do not have to release precious funds on chancy ventures.

The British organisation will be based on its American model, which has agreements with 300 academic institutions. It feeds roughly $3 million of no-strings grants into research, while money from inventions brings in about $15 million. 60% of that goes back to the university coffers, while 40% pays Research Corporation's overheads and expenses and the $3 million of grants.

Desforges, who spent the last six years as research director for Engelhard Industries and has been a consultant to the EEC and the European Space Agency, stresses: "We want to see British academic inventions in science and technology turned into British exploitation". He believes that universities are under financial pressure, which, with the added burden of falling student numbers, has led to pressure for them to be more commercial. Moreover, because the BTG no longer has the right of first refusal over inventions from publicly-funded research, the field is wide open.

Proposal evaluators

Desforges is in the middle of hiring three people for proposal evaluation, to be raised to five by the end of the year and probably 10 within three years. Although he realises that "every inventor thinks their invention is the greatest thing ever", he looks at the US experience, where about 10% of the 300-400 disclosures a year get taken on board, with only 1% leading to significant commercial business — similar to the experience of most venture capitalists.

Desforges will also be looking for companies for licensing and exploitation. He prefers British companies, but, ultimately, licences will go where they are wanted. Target sectors include engineering and materials science, everything "bio" — indeed, "the sciences that will lead to the technology of the 21st century".

According to Desforges, the Research Corporation has been looking at Europe for some time, particularly since one-third of its income from licensing comes from outside North America. The ending of the BTG monopoly was the catalyst. Besides "Europe has so much potential, but is somewhat hidebound."

Desforges is guardedly optimistic about much-criticised attitudes here to science and technology exploitation. At the same time, it could be dangerous to future research to make universities market-driven. He maintains that Research Corporation's approach is one way to resolve the dilemma. □

Where it all began

The Research Corporation began in 1912, with money 34-year-old academic, inventor and philanthropist Frederick Gardner Cottrell made from exploiting his electrostatic precipitator. Of the 15,000 inventions evaluated over the years, 1,300 have made it and include items like cortisone, the maser-laser concept, cardiac pacemakers and a cancer detection test.

The foundation has always worked on a closed-loop principle: collecting patent royalties and licensing fees, which are in turn channelled back into the trust to fund academic research, particularly that being done by promising academics at the start of their careers.

There are about 500 projects at any one time, with about 400 inventions available for licensing to industry (government gets royalty-free licences when it has funded the original research).

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Why inventors are frustrated

By Jervis G. Webb

Creativity in science and technology may be on the rise again in America. Based on the filing of patent applications, after a decade of declining interest, invention in the United States seems to be in the early stages of new growth. For a nation that has taken its technological preeminence for granted too long, any sign that such a revival is taking place is good news indeed.

It is also heartening that Congress appears to be nurturing this movement. Recent laws, for example, have been enacted to allow inventors to keep patent rights to inventions developed with federal funds.

Another law is currently under consideraton by Congress that will protect the inventor against time lost in getting government clearance for his inventions. Still another bill creates judicial machinery for bringing more uniformity in judging the strength of a patent. It has been said that more positive patent legislation has been passed in the past two years than in the previous twenty.

It is unfortunate, however, that this legislative effort, no matter how laudable, comes nowhere close to creating an environment for a real renaissance of technological innovation. At the heart of the matter is a half-century of neglect and, at times, a misguided attack on the patent system itself. A state of deterioration has set in — a generalized condition that cannot be corrected by a few narrowly focused laws.

Consider, for example, the problem of the cost of patent litigation, which has become, for many litigants, the most expensive in the business law spectrum. Many inventors simply cannot afford to challenge infringers. If the inventor chooses to go on a court odyssey to protect his patent, he may find himself at the mercy of those who know little about his technology and the process of invention, not to mention his risk of having his patent invalidated and being fined if he loses.

Consider also the problem of simply defining what an invention is. In the early days of the system, to be patentable an invention had only to be novel and useful. Just three years ago, however, a high court said invention is an "amorphous, ephemeral, impossible-to-define term." This has led the courts to set tougher standards for inventions that combine old elements than for completely "new" inventions. Unfortunately, though they may contribute strongly to man's dominion over his environment, in the real world few inventions are totally new.

It is easy to see how creativity can be stifled in an atmosphere like this. What the country sorely needs is to study the entire patent system from top to bottom and, in light of long-term national goals, enact a comprehensive patent reform law.

In today's competitive world it makes no sense to have a patent system that hinders the pursuit of excellence.

Jervis C. Webb is president and chairman of the board of the Jervis B. Webb Company, manufacturer of custom engineered conveying systems. He and his company hold many patents.

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N.O. woman picked for trade board

Capital bureau

BATON ROUGE — A New Orleans woman has been picked to serve on the Industry Sector Advisory Committee on Wholesaling and Retailing for Trade Policy Matters, Gov. David C. Treen said Tuesday.

U.S. Commerce Secretary Malcolm Baldrige selected Naomi Damonte Marshall for the committee. She is chairman of the Louisiana State Arts Council and president of Madewood Arts Foundation. Marshall was Latin American Export Manager for Chemco Photoproducts from 1954 to 1965, and is a member of the Alliance for Arts Education of the John F. Kennedy Center for the Performing Arts.

Under President Nixon, she served on the President's Advisory Committee on the Arts.

"Your work with this program will enhance the ability of the U.S. government to pursue trade objectives which reflect the concerns and interests of the private sector," Baldrige told Marshall in his letter of appointment.

The committee is an advisory body of the Industry Consultants Program on Trade Policy Matters.

Also Tuesday, Treen said two New Orleans area doctors and one from Alexandria have been appointed to the Louisiana State Board of Psychologists.

Fred E. Davis of New Orleans, John Wakeman of Metairie and Gregory Gormanous of Alexandria were named to the board. Gormanous is an associate professor of psychology at LSU's Alexandria branch; Davis and Wakeman are in private practice.

The board is responsible for making rules for the practice of psychology and licensing and regulation of psychologists.

Treen also announced the appointments of Ronald P. Sawyer of Shreveport to the State Board of Election Supervisors and George Wilbert of Plaquemine to the Board of Commissioners of the Atchafalaya Basin Levee District.

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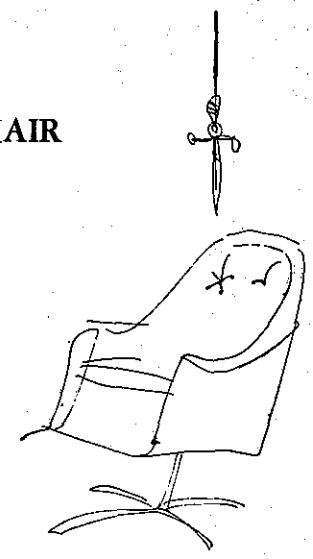
THE EASY CHAIR



How to Prevent Organizational Dry Rot

by John W. Gardner

At the time this article was written, Mr. Gardner was president of the Carnegie Corporation, a national leader of the movement for educational reform, and author of two influential books, "Excellence" and "Self-Renewal." He has since joined the Cabinet as Secretary of the Department of Health, Education and Welfare.

Like people and plants, organizations have a life cycle. They have a green and supple youth, a time of flourishing strength, and a gnarled old age. We have all seen organizations that are still going through the diseases of childhood, and others so far gone in the rigidities of age that they ought to be pensioned off and sent to Florida to live out their days.

But organizations differ from people and plants in that their cycle isn't even approximately predictable. An organization may go from youth to old age in two or three decades, or it may last for centuries. More important, it may go through a period of stagnation and then revive. In short, decline is not inevitable. Organizations need not stagnate. They often do, to be sure, but that is because the arts of organizational renewal are not yet widely understood. Organizations can renew themselves continuously. That fact has far-reaching implications for our future.

We know at least some of the rules for organizational renewal. And those rules are relevant for all kinds of organizations—U. S. Steel, Yale University, the U. S. Navy, a government agency, or your local bank.

The first rule is that the organization must have an effective program for the recruitment and development of talent. People are the ultimate source of renewal. The shortage of able, highly trained, highly motivated men will be a permanent feature of our kind of society; and every organization that wants its share of the short supply is going to have to get out and fight for it. The organization must have the kind of recruitment policy that will bring in a steady flow of able and highly motivated individuals. And it cannot afford to let those men go to seed, or get sidetracked or boxed in. There must be positive, constructive programs of career development. In this respect, local, state, and federal government agencies are particularly deficient, and have been so for many years. Their provisions for the recruitment and development of talent are seriously behind the times.

The second rule for the organization capable of continuous renewal is that it must be a hospitable environment for the individual. Organizations that have killed the spark of individuality in their members will have greatly diminished their capacity for change. Individuals who have been made to feel like cogs in the machine will behave like cogs in the machine. They will not produce ideas for change. On the contrary, they will resist such ideas when produced by others.

The third rule is that the organization must have built-in provisions for self-criticism. It must have an atmosphere in which uncomfortable questions can be asked. I would lay it down as a basic principle of human organization that the individuals who hold the reins of power in any enterprise cannot trust themselves to be adequately self-critical. For those in power the danger of self-deception is very great, the danger of failing to see the problems or refusing to see them is ever-present. And the only protection is to create an atmosphere in which anyone can speak up. The most enlightened top executives are well aware of this. Of course, I don't need to tell those readers who are below the loftiest level of management that even with enlightened executives a certain amount of prudence is useful. The Turks have a proverb that says, "The man who tells the truth should have one foot in the stirrup."

But it depends on the individual executive. Some welcome criticism, others don't. Louis Armstrong once said, "There are some people that if they don't know, you can't tell 'em."

The fourth requirement for the organization that seeks continuous renewal is fluidity of internal structure. Obviously, no complex modern organization can exist without the structural arrangements of divisions, branches, departments, and so forth. I'm not one of those who imagine that the modern world can get away from specialization. Specialization and division of labor are at the heart of modern organization. In this connection I always recall a Marx Brothers movie in which Groucho played a shyster lawyer. When a client commented on the dozens of flies buzzing around his broken-down office, Groucho said, "We have a working agreement with them. They don't practice law and we don't climb the walls."

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small Ford Motor Company which had been founded only six years earlier and was about to launch its Model T. As a company it wasn't huge or powerful, but to borrow a phrase from C. P. Snow, it had the future in its bones. (Not many of 1909's top twenty companies did—only four of them are in the top twenty today.)

Businessmen are fond of saying that, unlike other executives, they have a clear measure of present performance—the profit-and-loss statement. But the profits of today *may* be traceable to wise decisions made a good many years earlier. And current company officers may be making bad decisions that will spell disaster ten years from now.

I have collected many examples of organizations that experienced crises as a result of their failure to renew themselves. In the great majority, certainly nine out of ten, the trouble was not difficult to diagnose and there was ample warning of the coming catastrophe. In the case of a manufacturing concern that narrowly averted bankruptcy recently, the conditions that led to trouble were diagnosed by an outside consultant two years before the crisis came. In the case of another well-known organization, a published article outlined every essential difficulty that later led to disaster.

But if warning signals are plentiful, why doesn't the ailing organization take heed? The answer is clear: most ailing organizations have developed a functional blindness to their own defects. They are not suffering because they can't *solve* their problems but because they won't *see* their problems. They can look straight at their faults and rationalize them as virtues or necessities.

I was discussing these matters with a corporation president recently, and he said, "How do I know that *I* am not one of the blind ones? What do I do to find out? And if I am, what do I do about it?"

There are several ways to proceed. One way is to bring in an outside consultant who is not subject to the conditions that create functional blindness inside the organization.

A more direct approach, but one that is surrounded by subtle difficulties, is for the organization to encourage its internal critics. Every organization, no matter how far deteriorated, has a few stubbornly honest individuals who are not blinded by their own self-interest and have never quite accepted the rationalizations and self-deceptions shared by others in the organization. If they are encouraged to speak up they probably will. The head of a government agency said to me recently, "The shrewdest critics of this organization are right under this roof. But it would take a major change of atmosphere to get them to talk."

A somewhat more complicated solution is to bring new blood into at least a few of the key positions in the organization. If the top level of the organization is salted with vigorous individuals too new to be familiar with all the established ways of doing and thinking, they can be a source of fresh insights for the whole organization.

Still another means of getting fresh insights is rotation of personnel between parts of the organization. Not only is the individual broadened by the experience, but he brings a fresh point of view to his new post. After a few years of working together, men are likely to get so used to one another that the stimulus of intellectual conflict drops almost to zero. A fresh combination of individuals enlivens the atmosphere.

In the last analysis, however, everything depends on the wisdom of those who shape the organization's policy. Most policy makers today understand that they must sponsor creative research. But not many of them understand that the spirit of creativity and innovation so necessary in the research program is just as essential to the rest of the organization.

The future of this nation depends on its capacity for self-renewal. And that in turn depends on the vitality of the organizations and individuals that make it up. Americans have always been exceptionally gifted at organizational innovation. In fact, some observers say that this is the true American inventiveness. Thanks to that inventiveness we now stand on the threshold of new solutions to some of the problems that have destroyed the vitality of human institutions since the beginning of time. We have already made progress in discovering how we may keep our institutions vital and creative. We could do even better if we put our minds to it. [ ]

March 13, 1987
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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

...Continued

... 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."

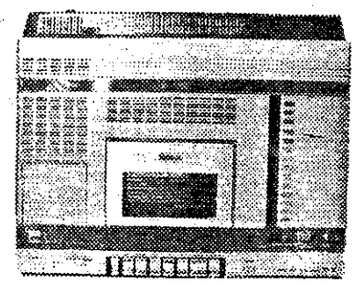
Anyone with a patented invention that has commercial application should contact the local Staff Judge Advocate for assistance. For unpatented inventions, work through the AFSC Patent Law Division, AUTOVON 858-5372.

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.

One hitch, it developed, was that the cassette would record only one hour of program. Market research showed that people wanted to get two hours on a tape, enough to record a movie. Cartri-Vision, named when cassettes were cartridges, was a one-hour machine that industry analysts say failed for that reason and because the recorder came built into a 25-inch TV set.

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.

"Around 1974 RCA aborted its VCR project," said Frank McCann of the company's Consumer Electronics Division, now owned by General Electric. "It seemed clear the consumer just wouldn't buy it. What we didn't appreciate back then was that the Japanese would keep working on the VCR."

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 1985 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.

As the costs of high-tech innovation rise, he said, the economic advantage goes to the imitator who can skip the costs of basic research, learn from the innovator's mistakes and come to market quickly with an improved version of the product.

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.

"When a country falls behind in competitiveness, the last thing they fall behind in is innovation," Harvard's Brooks said. "The first thing is manufacturing and marketing."

Although Britain invented the jet engine, U.S. imitators—doing to Britain what Japan now does to the United States—reaped most of the economic benefits.

Britain's pioneer jet airliner, the Comet 1, turned out to be a financial disaster. Only when Boeing and Douglas picked up the idea, added some improvements and manufactured it to higher standards, did jet airliners sweep the world's aviation market.

What has slipped in the United States, Rosenberg contends along with many others, is the ability of industry to capitalize on "next generation" improvements in good ideas, regardless of where the idea originated.

"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.

A related difference that yields poorer quality American products, according to a study of computer manufacturers done jointly by two experts in technology management, one an American and the other a Japanese, is that Japanese engineers move easily back and forth between R&D and manufacturing.

American R&D engineers, according to the study, not only come up with a new product idea, they produce the final specifications and simply turn them over to a separate manufacturing division. Japanese R&D engineers design only to a rough prototype stage, leaving the final specifications to manufacturing engineers.

Often a key R&D engineer will then move with the product to the manufacturing division, a step rare in the United States but part of the normal career ladder in many Japanese firms.

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.
- While many Japanese engineers are soaking up the most advanced R&D skills and knowledge in U.S. universities, far fewer American engineers go to Japan, even to learn what Japan does best, advanced manufacturing technology.
- 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.

As in many other fields, a key feature of Japan's drive is its unusual degree of cooperation among related industries and universities and the Japanese government's strong encouragement and financial support for a coherent national program in this area.

While antitrust laws prevent U.S. biotech firms from collaborating and while tradition leads many to pursue their goals apart from federal labs, Japan's Ministry of International Trade and Industry (MITI) has created a consortium of 14 major corporations to collaborate on biotech. Global domination in biotechnology is an official national goal under one of Japan's 10-year "Next Generation Projects."

Howard A. Schneiderman, vice president for R&D at Monsanto, a major biotech firm, sees his company as having to compete not just with other firms but with all of Japan.

"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.

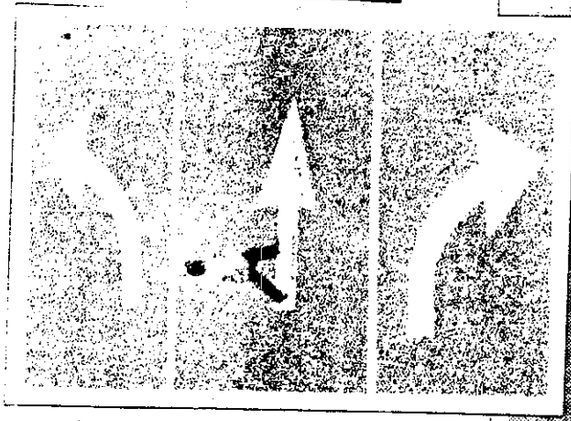
While such corporate-university collaborations are developing, there is controversy as to whether industry's need for proprietary secrecy conflicts with the traditional openness of university research.

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.

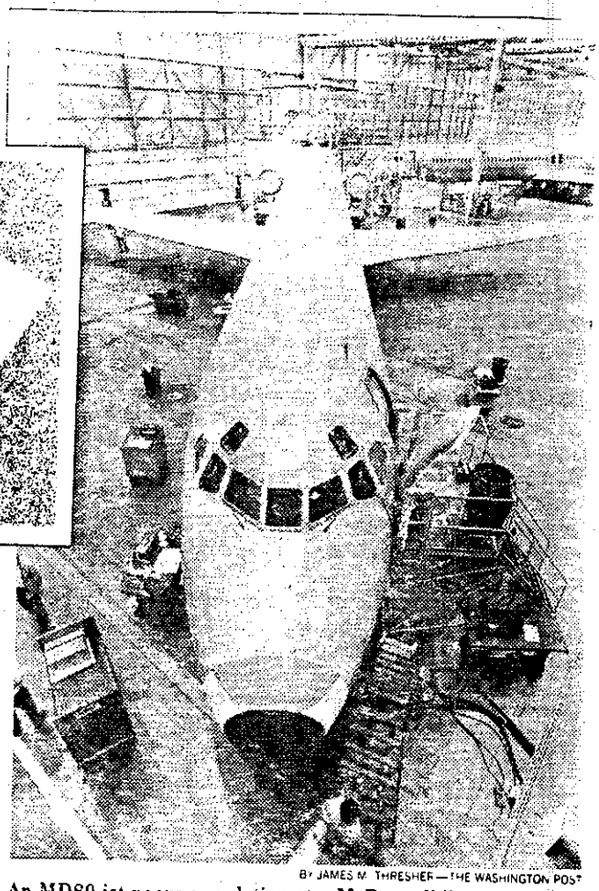
"In 10 years, if what I'm saying is correct," Cape says, "I bet we'll have hearings in Congress and a lot of American industrialists will bitch and moan about how the Japanese have done unfair things in trade. But that is not the case with biotechnology. The Japanese are doing the right thing."

NEXT: The role of education

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.

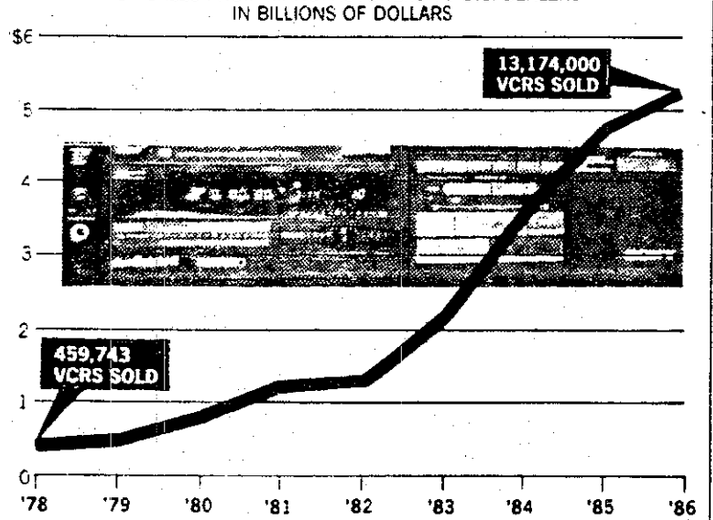


BY JAMES M. THRESHER—THE WASHINGTON POST

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

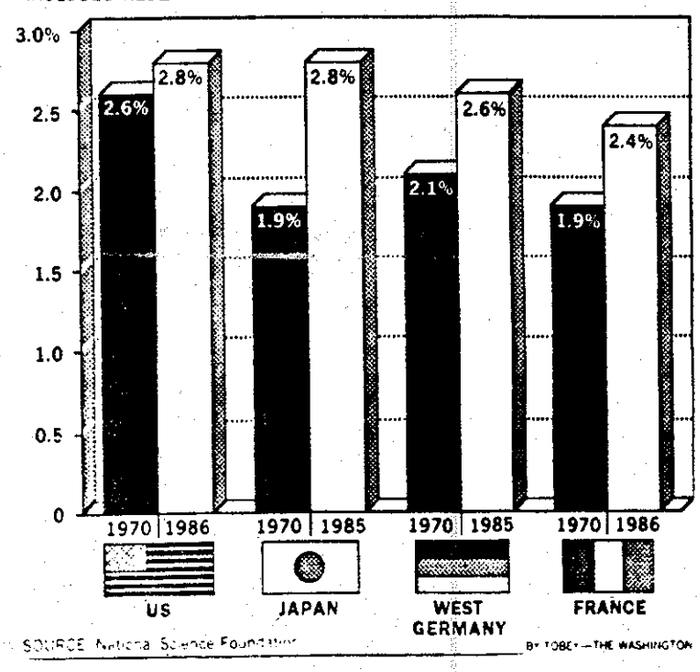


SOURCE Electronic Industries Assn.

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

THE WASHINGTON POST WEDNESDAY, APRIL 15, 1987 A17

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.

"I think the United States has got to recognize that if we can create a community of common political values and economic growth, it will be worth it even if it costs us a relative share of economic and political power," said Nau. "We may have less power today, but we live in a world that is more peaceful, more stable. We live in a better world than the 1930s."

"The rest of the world is coming of age," said William T. Archey, international vice president of the U.S. Chamber of Commerce.

How America responds to these changes is the subject of the competitiveness debate going on in academia, Congress and the executive branch of government; between business and labor as they try to define new sets of work rules to meet heightened competition from other countries, some of which have added technological advances and high degrees of education to lower wages and less opulent standards of living, and among industrialists seeking a niche in this new economic order of the world.

In Congress, much of the debate concerns changes in U.S. laws to stop what is seen as other countries' unfair trade practices. But the larger issues of competitiveness are being framed beneath the jockeying for trade legislation.

"It depends on how much we invest, how much research and development we do, how well we educate ourselves, how we use our capital," said C. Michael Aho, senior

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 fourth of six articles exploring these changes. Succeeding articles will address "competitiveness" as a political issue and the outlook for the future.

fellow of economics at the Council on Foreign Relations. "Those things never used to matter. Now that we are no longer predominant, they do matter."

The concerns stretch beyond economic vitality to the international security arena. "As we get less competitive, the burden of maintaining the U.S. policy of national security will get more onerous on the economy," said Cohen, the Berkeley economist.

National Security Concerns

Stephen Krasner, a specialist in international economics and politics at Stanford University, agreed. "You can't think of the United States as the dominant power as it was in the past," he said. "That has to have military implications. It doesn't make sense for the United States to maintain the defense commitment it has in a world in which it is not the hegemonic power in the West."

Does it pay, for instance, for the United States to increase its naval presence in the Persian Gulf, as it did this month, to protect the sea lanes so that Western Europe and Japan can get the oil their economies need? "It would be better if Japan and Europe were protecting interests that are much more vital to them than to the United States," Krasner said.

"Can the world's largest debtor nation remain the world's leading power?" asked Bergsten in his Foreign Affairs article.

"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



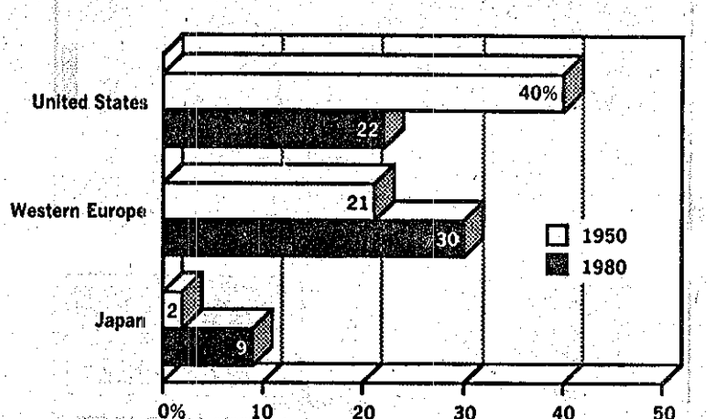
BY JAMES M. THRESHER—THE WASHINGTON POST

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

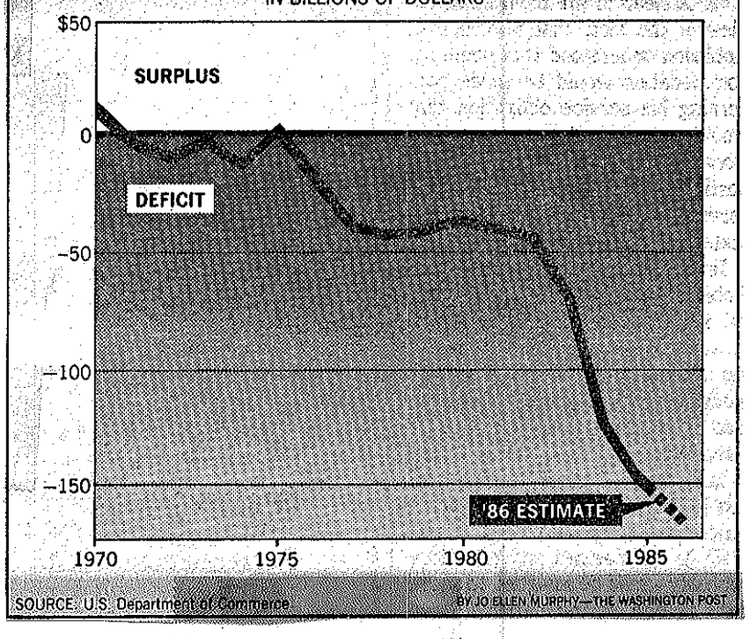
IN PERCENT



BY CLARICE BORIO—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

Does the Fear of Litigation Inhibit Innovation?

Continued From Page C1

promote safety can have hidden costs in the form of stifled creativity and abandoned ideas. The upshot, these experts say, is that products, processes and large-scale technologies may fail to be made as good, cheap and safe as possible. They say innovation can be deterred when either inventors or developers have inordinate fears of being sued over new products and technologies.

"A lot of people are interested in the phenomenon, but no one has hard data on its extent," said Deborah R. Hensler, research director of Rand's Institute for Civil Justice. One example involves researchers who are slowing efforts to test and market computers with artificial intelligence because of potential lawsuits. Their fear is that new types of liability will emerge for computers that diagnose patients, run factories, and perform other complex tasks. "Some of the state-of-the-art applications are not going forward," she said.

Dr. Matthews of the Livermore lab said one of his own efforts to develop an invention with commercial potential had recently failed at least in part because of fears of liability suits.

His idea centered on a powerful particle accelerator that is only about six feet long. Livermore uses a similar device for developing beam weapons. Dr. Matthews proposed modifying the accelerator so it could irradiate food products, killing insects, larvae and parasites that infest freshly harvested fruit and vegetables. Such irradiation could replace the chemicals used on many crops, thus eliminating the chance that poisonous fumigants might cling to produce.

But lawyers told potential investors its development was too risky, he said. "One of the factors they cited was liability," Dr. Matthews recalled. "It was too new, with no precedent to follow in a broad area of technology. They were afraid we might build in a liability that no one was aware of." In this case, liability concern was only one factor; the more general controversy over food irradiation, for example, also played a role.

Worry for Universities

A different kind of chill has been felt in universities across the country, according to Howard W. Bremer, patent counsel for the University of Wisconsin at Madison, which last year devoted about $230 million in private and Federal funds to scientific research. The fear, he said, focuses on small businesses that want to buy licenses to university patents. If such companies should be sued, plaintiffs might turn to the "deep pockets" of the university that spawned the idea. Mr. Bremer said such fears were causing universities to shy away from licensing patents to small companies. The trend is especially troublesome, he said, since small businesses are usually better than large ones at nurturing innovation.

"There's some sincere questioning of whether we should license to small businesses at all," he said.

Product liability has forced companies to be more careful, Ralph Nader says.

Yet another problem can occur, some experts assert, when public safety regulations create incentives to keep bad technologies in the marketplace, hindering innovation. The reason for this, they say, is that the adoption of a new, safer technology implicitly involves acknowledgment that the previous technology was not as safe as possible.

Nuclear reactors provide an example of "encouraged inferiority," some experts assert. For instance, engineers at the University of Texas invented a simple and effective solution for the problem of leaky welds in the pipes of some reactors. It involved a new welding technique in which powerful bursts of electricity are directed into steel pipes that abut one another, fusing them with extremely strong and uniform seams.

But the idea, little known outside of engineering circles, has been ignored by the industry in the three or so years since it was developed.

"If you admit you have a solution, then the regulatory agencies might force you to go back and retrofit," said an engineer familiar with the new technique, who spoke on condition that his name not be used.

Judging Technology

According to Dr. Huber, who holds a doctorate in engineering from the Massachusetts Institute of Technology and a degree from Harvard University Law School, the current clash of law and science boils down to a fight between technological optimists and pessimists.

"The technical community usually judges that new technologies are safer, cheaper and better for the consumer," he said. "But when you shift into Federal regulation and the law, you get suspicion of change, of innovation, of departures from the status quo. Lawyers tend to see risks, not benefits. The law is basically hostile to change and innovation."

Dr. Huber, a fellow of the Manhattan Institute for Policy Research in New York, a non-profit, private group that conducts economic research, told the conference of the National Academy of Engineering that the clash had been engendered by new interpretations of liability law and new regulatory statutes over the past two decades. "Under the old regime, which prevailed in this country for about a hundred years, the regulator's charter was that of an exorcist," Dr. Huber said. "He identified established hazards and rooted them out. Now the regulator acts as gatekeeper, charged with blocking new technologies not known to be safe and with protecting us from the ominous technological unknown."

To many public-interest groups and activists, this new role for regulators is good since the technological risks of modern life are seen as greater than in the past. Almost everywhere, they say, lurk invisible killers, from radiation to asbestos. They say tragedies such the chemical disaster at Bhopal, India, and nuclear reactor fire at Chernobyl in the Soviet Union must be avoided.

Rise in Liability Suits

"It's clearly in the corporate interest to limit liability," said Mike Johnson, an analyist for Public Citizen, a comsummer rights organization in Washington, D.C., founded by Ralph Nader. "The principal impact of product liability has been to force companies to be more careful in their products, not to limit innovation."

Indeed, the number of product liability cases filed in Federal courts, for instance, has risen to 13,554 in 1985 from 1,579 in 1975. Although most cases are settled before trial, the number of jury awards has risen over the past decade, and the cost of liability insurance has surged.

Experts have differing ideas about what steps, if any, should be taken to solve the problem. Consumer advocates say that the current system should be kept largely intact, with the possible addition of special regulatory incentives to help move safety-related innovations into the marketplace.

Dr. Huber suggested that Federal regulatory agencies, not the courts, were the right place to weigh risks and benefits of new technologies. "And these agencies should be encouraged to exercise this responsibility through good hindsight, rather than through bad foresight," he said.

David G. Owen, professor of law at the University of South Carolina, told the National Academy of Engineering that one issue will linger no matter what changes take place. "The engineer must now and hereafter give proper respect to safety," he said. "The current problems of product liability law and insurance will in the long run prove manageable for engineers and enterprises who treat safety not as a nuisance, but as an important engineering goal."

Does the Fear Of Litigation Dampen the Drive To Innovate?

By WILLIAM J. BROAD

SOME scientists and legal experts are beginning to argue that fear of safety-related litigation is holding back technical innovation in a variety of fields.

Although the dimensions of the problem are unknown and probably unknowable, experts say the blizzard of liability suits in the past decade has sent a chill through fields as diverse as computer science, food processing and nuclear engineering.

"The legal system's current message to scientists and engineers is: Don't innovate, don't experiment, don't be venturesome, don't go out on a limb," said Peter W. Huber, an attorney and engineer who has written about the problem.

However, some groups concerned with consumer issues question the severity of the problem, saying its new visibility seems part of campaign to weaken liability laws so corporations will have to worry less about public safety and be able to make higher profits.

'It's becoming difficult to get venture capital for new ideas,' said one physicist.

As the debate heats up, legal experts are trying to probe the extent of the problem even though its symptoms — foregone innovations — are by nature difficult to document. The National Academy of Engineering, a branch of the Government-chartered, private National Academy of Sciences in Washington, D.C., recently held a symposium on the subject, and the Rand Corporation in California is organizing a large study.

"There's clearly a chilling effect," said Stephen M. Matthews, a physicist at the Lawrence Livermore National Laboratory in California who has worked on establishing new commercial ventures. "It's becoming difficult to get venture capital for new ideas. People are afraid of potential liability."

Experts have long agreed that risky products and dangerous procedures should be banned from the marketplace. Recently, however, some have begun to argue that increased technical regulation and litigation designed to

Continued on Page C9

Does the Fear of Litigation Inhibit Innovation?

Continued From Page C1

promote safety can have hidden costs in the form of stifled creativity and abandoned ideas. The upshot, these experts say, is that products, processes and large-scale technologies may fail to be made as good, cheap and safe as possible. They say innovation can be deterred when either inventors or developers have inordinate fears of being sued over new products and technologies.

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

Does anyone really believe in free trade?

By Norman Gall

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

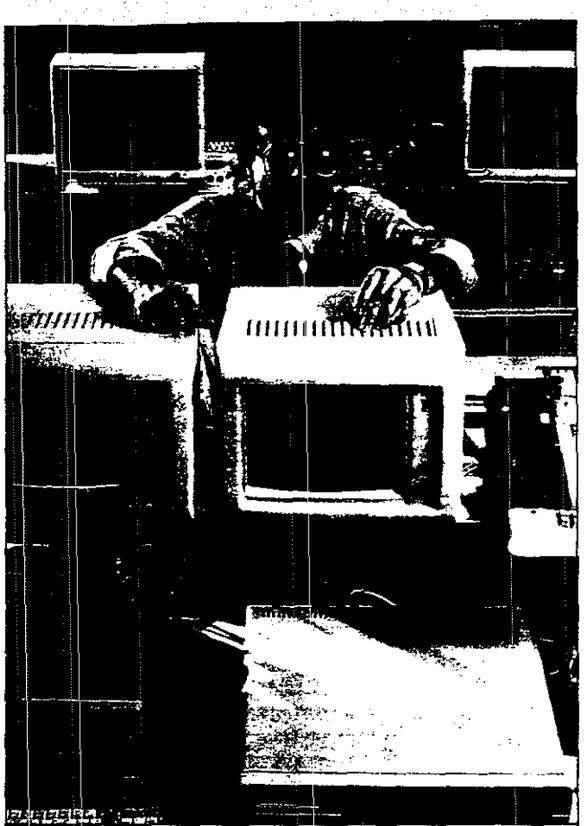
But does what happens in Brazil matter all that much? Brazil, after all, is a relatively poor country and accounts for a mere $3 billion in the U.S.' $160 billion negative trade balance. Brazil matters very much. For one thing,



Photos by Paulo Fridman/Sygma



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



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.

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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.

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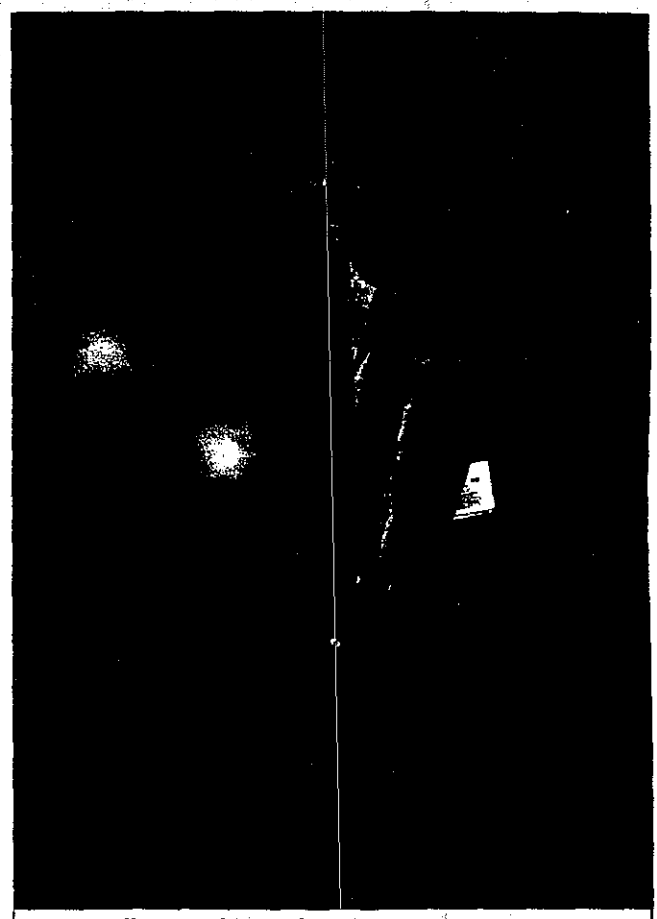

Lisiong Shu Lee of SID Informatica
Theft? No. Technology transfer? Yes.

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

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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."

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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.

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"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."

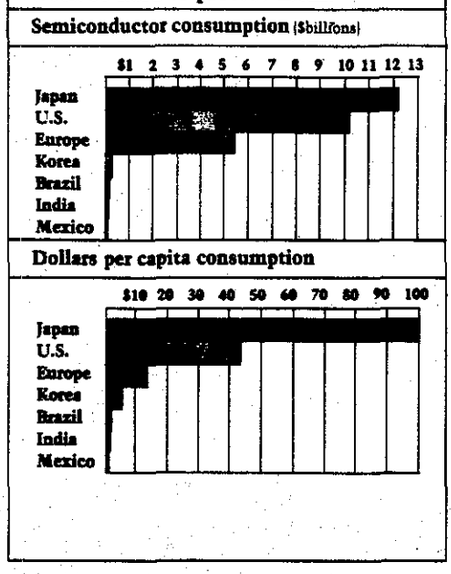
Harvard Professor Emeritus Raymond Vernon, a veteran analyst of international business, says of world technology markets: "Except for highly monopolistic situations, the buyer has a big advantage over the seller. Countries like Brazil and India can control the flow of technology across their borders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



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

Does anyone really believe in free trade?

By Norman Gall

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

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

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

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

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

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

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

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

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



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

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

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

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

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

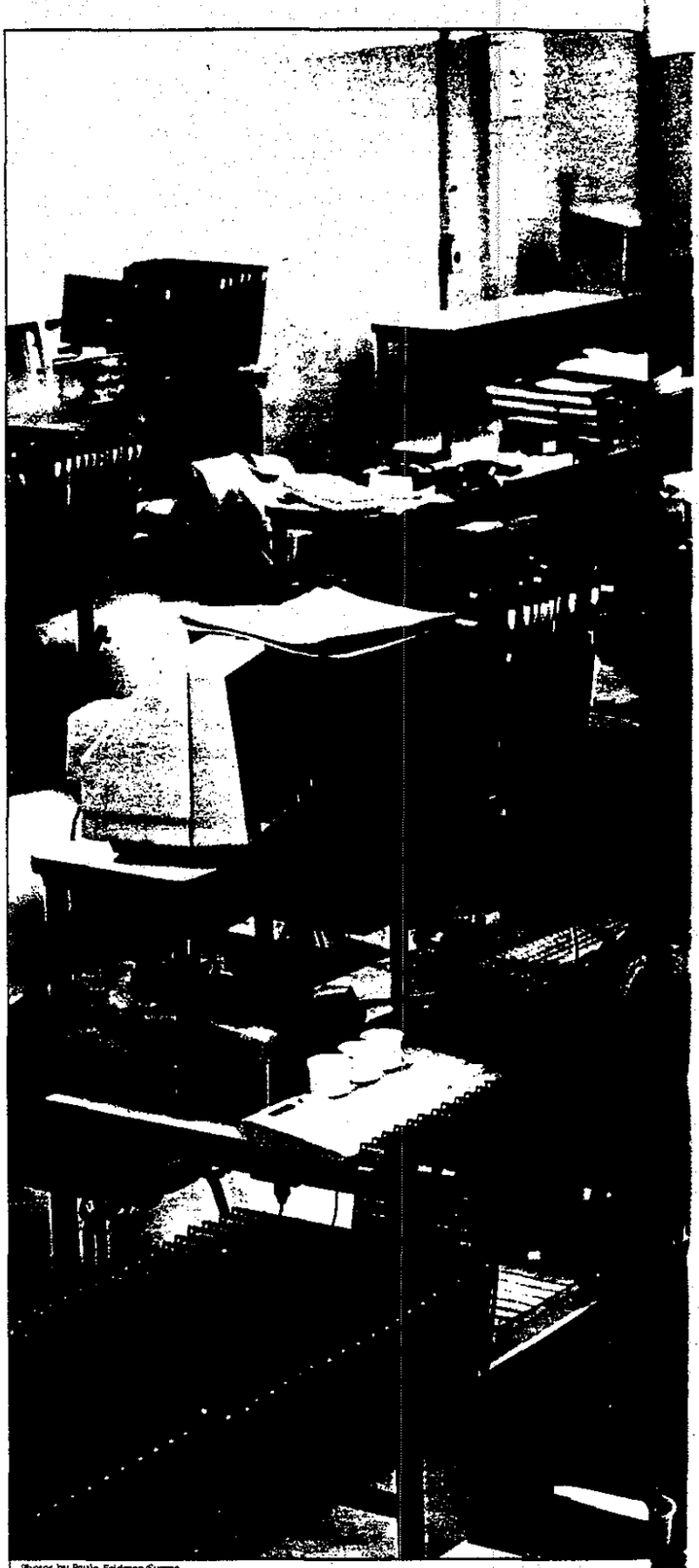
Like Microtec's Elias, Lee had learned most of what he knew from the Americans. In teaching this pair—and tens of thousands like them—U.S. industry and the U.S. academies created potential competitors who knew most of what the Americans had painfully and expensively learned. Theft? No. Technology transfer?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

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

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

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

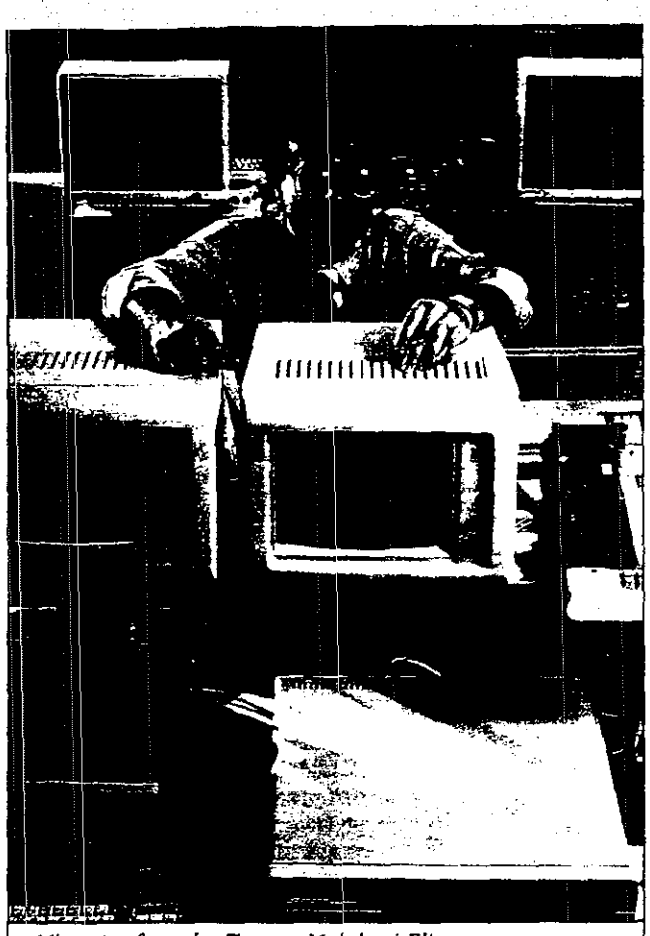
But does what happens in Brazil matter all that much? Brazil, after all, is a relatively poor country and accounts for a mere $3 billion in the U.S.' $160 billion negative trade balance. Brazil matters very much. For one thing,



Photos by Paulo Fridman/Sygma



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



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



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

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

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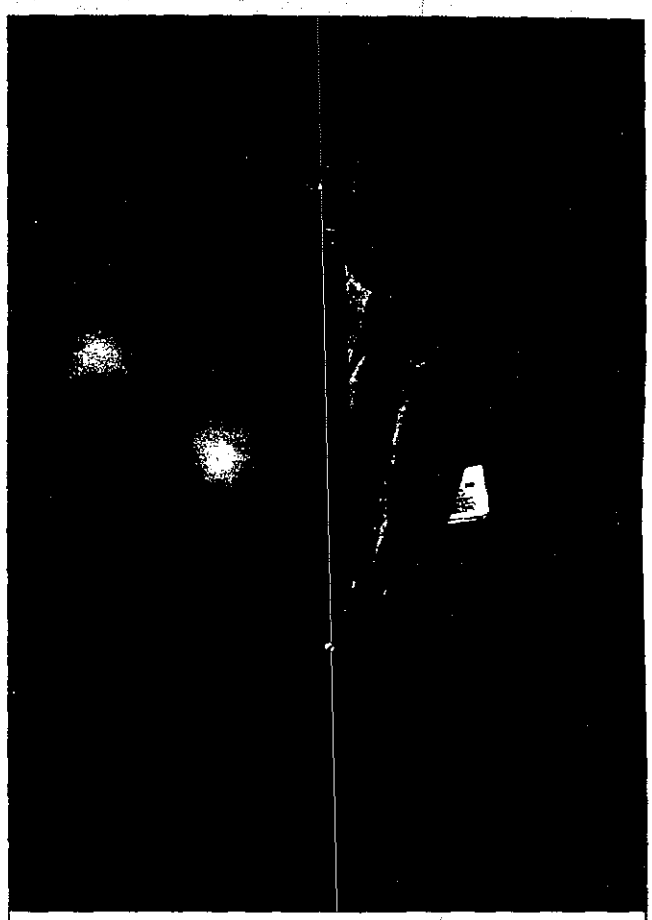

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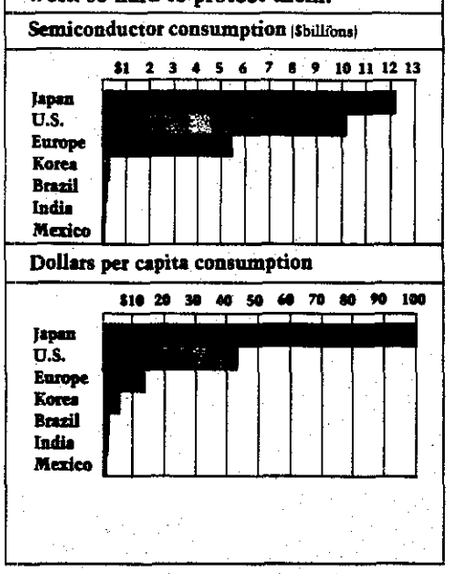

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WHITE OAK, MARYLAND

Business Bulletin

A Special Background Report On Trends in Industry And Finance

R&D SPENDING moves up smartly despite corporate turmoil.

The 100 biggest research-and-development spenders invested $41.3 billion in 1986, up 9.4% from 1985, says newsletter Inside R&D. This despite a flurry of mergers, acquisitions and restructuring, which usually have "a deadly impact on R&D," says Editor Richard Consolas. Increased spending in defense-related R&D and by smaller companies offset these dampers. To make the top 100, a company had to spend $84.6 million, up from $75 million in 1985.

More computer companies rank among the big spenders. Cray Research Inc., Minneapolis, jumped into 97th place, thanks to a 57% sales increase. It spends 15% of revenues on R&D. Despite red ink, Advanced Micro Devices Inc., Sunnyvale, Calif., ranks first in spending-to-sales, with 28.7% of sales going to R&D. "The only way to combat the large, well-established companies is with innovative products," says spokesman Elliott Sopkin.

Industry R&D spending will grow 7.1% to $62.7 billion this year and 7.9% to $67.6 billion in 1988, predicts Battelle Memorial Institute, Columbus, Ohio.

Perle cites damage from U.S.-Russian science exchanges

By Bill Gertz
THE WASHINGTON TIMES

Former Assistant Secretary of Defense Richard Perle scored the Reagan administration yesterday for failing to prevent Soviet agents from stealing U.S. technology through bilateral exchange programs.

Mr. Perle said the administration "has no policy" for dealing with scientific exchanges that are part of what he described as an aggressive Soviet program of acquiring American scientific and technical data.

He called current administration committees that deal with exchange programs "a bureaucratic morass" that has failed to protect U.S. national security interests.

"The process by which decisions are made that affect broad policy, detailed negotiations and eventual implementation of agreements for scientific and technical exchanges with the Soviet Union is a shambles, marked by indifference, incompetence and parochialism," Mr. Perle said.

His remarks came during a hearing on scientific exchanges with the Soviet Union before a House Science, Space and Technology subcommittee.

Subcommittee Chairman Rep. Ralph Hall, Texas Democrat, said a series of hearings was planned to examine possible U.S.-Soviet cooperation in space science, ocean seabed drilling and the activities of a Vienna-based research center specializing in systems analysis.

Mr. Perle, who left the Pentagon last month, said government agencies compete with each other for administration funds to carry out exchange programs on topics ranging from space stations to fusion energy with little regard for the security dimensions of the programs.

"If a pet project can't make it on scientific merit, perhaps it will get funded as a 'peace initiative,'" he said in jest.

Mr. Perle said in several instances the Defense Department — on learning at the last minute that an agreement was about to be concluded — "kicked and screamed" at the White House to review exchange programs.

One exchange effort on space cooperation would have given the Soviets access to some of the most sensitive U.S. defense-related technology, according to Mr. Perle.

Mr. Perle said U.S. officials first understood the magnitude of Soviet technology theft after extremely sensitive Soviet documents were obtained by Western intelligence services in the early 1980s.

The documents revealed that the Soviets used Western technology in some 5,000 military programs and showed, according to a 1985 U.S. intelligence report, that technology theft was far greater than previously believed.

" 'Far greater than was previously believed' strikes me as the sort of euphemism to which government officials resort when what they really mean to say is: 'We had no idea the Soviets were ripping off our technology so skillfully, so comprehensively, so effectively right under our noses. . . . Someone ought to be fired,' " Mr. Perle said.

He suggested that Congress introduce legislation that would require an interagency review of all planned U.S.-Soviet exchanges.

"Our experience during the 1970s was that the Soviets got the lion's share of the benefits from exchanges that were supposed to be mutually beneficial," he said. "Soviet secrecy prevented us from learning much of interest, while American openness — I think glasnost is the word in fashion — facilitated Soviet acquisition of American technology and know-how."



Richard Perle

Soviet students, often 45 or 50 years old, were sent to the top U.S. technical universities for training, Mr. Perle said.

In one case, he said, a Soviet student studied "synthetic aperture radar" in the United States and later applied the know-how to the Soviet copy of the U.S. "look-down, shoot-down" fire control system used on advance U.S. jet fighters.

"They don't regard exchanges as building bridges," Mr. Perle said. "They regard them as intelligence operations."

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were painfully slow to recognize.

Many American executives clung to the belief that the Japanese had no technology of worth long after that was no longer the case. Why? Tradition was one reason. Sheer arrogance was another.

After World War II, the United States Government encouraged American companies to share their technology to help rebuild the war-ravaged economies of Europe and Japan. Long after that task was accomplished, the technology outflow continued. Having dominated the world markets for so long, many American businessmen seemed incapable of seeing the Japanese as their equals let alone their superiors. Confident of their ability to stay at least one step ahead of the Japanese, they did not worry that they were helping the Japanese become formidable competitors.

Such talk can still be heard at aerospace companies such as Boeing and Pratt & Whitney, which enjoy a technological lead — at least for now. "I don't see the Japanese or anyone else developing competitive technology by associating with us," said Robert Rosati, a recently-retired Pratt & Whitney official who led its joint venture with companies from Japan and three other nations to develop jet engines. "They don't have the design or development capability to do any kind of engine, and they're not going to get them."

But plenty of humbled executives in industries ranging from chemicals and cars to semiconductors and machine tools have wised up. "Anytime you license a foreign company to manufacture and perhaps sell for you, you're in effect putting another competitor into the marketplace," said B. Charles Ames, chief executive of the Acme-Cleveland Corporation. "Anybody who doesn't realize that is pretty damn naïve."

"Giving up technology is now far more suspect," said John M. Stewart, who advises major corporations on technology issues for McKinsey & Company, the consulting firm.

ALARMED by the travails of the semiconductor industry, executives at the Ford Motor Company recently decided against entering into a venture with the Japanese to produce a high-technology component for the power train of its cars. And General Electric has become much more cautious about licensing its "best high technology" to the Japanese, said Philip V. Gerdine, a G.E. executive. General Electric's "wariness" of the Japanese "has gone up as our respect for them has gone up," he said.

The Intel Corporation, the semiconductor maker, licensed a half-dozen domestic and foreign manufacturers, including Fujitsu and NEC, to make its first microprocessor for the International Business Machines Corporation's personal computer and compatible machines. For its new third-generation microprocessor, it will license no more than two companies and maybe none.

Acme-Cleveland once licensed Mitsubishi Heavy Industries to manufacture and sell one of its machine tools only to watch Mitsubishi become its rival in the United States market. Acme-Cleveland incorrectly assumed Mitsubishi's ambitions were limited to Asia. Now, in choosing a Japanese company to make some of its telecommunications equipment, Acme-Cleveland is being "darn careful to make sure the company that is going to manufacture it for us does not have any apparent interest in getting into this market," said Mr. Ames. And Acme-Cleveland, he said, will make sure that its licensing agreements include market restrictions.

Companies that had relied on joint ventures to compete in Japan are now establishing wholly owned subsidiaries. Duracell, Kraft Inc.'s battery subsidiary, did that last November, when it canceled a venture with Sanyo Electric. E.I. du Pont de Nemours & Company is operating new businesses in Japan on its own and is shifting some activities of its existing Japanese ventures to a subsidiary, according to William H. Davidson, an associate professor at the University of Southern California's Graduate School of Business. Carl De Martino, a Du Pont group vice president, said: "Given our free choice, we would prefer to have a 100-percent-owned company anywhere."

American companies, when they do contribute technology to a venture, are demanding technology of equal value in return, something many had not done as recently as five years ago.

"There's a greater sensitivity to the need to get a two-way exchange as opposed to the one-way flow, which was fundamentally the way most joint ventures in the last 20 years were structured," said S. Allen Heininger, a vice president of Monsanto and president-elect of the Industrial Research Institute, an organization of senior research officials from major companies.

Under the terms of a new joint venture in semiconductors with the Toshiba Corporation, for example, Motorola Inc. will give Toshiba some of its microprocessor technology but will receive Toshiba's "very leading edge" technology in memory chips and manufacturing, said Keith J. Bane, Motorola's director of strategy.

To insure that the technology flows both ways, a growing number of American companies are insisting that their managers be involved in ventures in Japan. Celanese (which was bought by Hoechst of West Germany earlier this year) trained two of its employees to speak Japanese and put them into a joint venture with Daicel Chemical Industries to soak up Daicel's expertise in automotive plastics. They are now back in Detroit working to apply what they learned.

While many joint ventures in Japan have been confined to manufacturing and marketing, more American companies are insisting that they do research and development. Only 8 percent of the new ventures formed in Japan in 1973 involved research and development, but 35 percent of those formed in 1985 did, according to a study by Laurent L. Jacque, an assistant professor at the University of Pennsylvania's Wharton School.

At the very least, some American companies are using ventures as a way to master Japanese management techniques. That was a key motive for General Motors's joint venture with Toyota to make small cars in California.

UNLIKE American managers, foreign businessmen, especially the Japanese, long ago realized that they could exploit these alliances for more than just quick gains in market share or short-term profits. For them, ventures were a way to gain the technology and skills needed to achieve global leadership.

In his studies of such ventures, including five of Du Pont's in plastics, Professor Davidson found a pattern. The Japanese company would assimilate its American partner's technology or production skill and then squeeze out the American partner.

Such a squeeze led to the split-up last summer of a venture between Humphrey Instruments, a California concern, and Hoya Glass of Japan. "Hoya developed the ability to produce the machines on its own and effectively terminated the agreement," Professor Davidson said.

One reason that the Japanese often seem to end up with the upper hand is that they frequently wield total management control of the venture. Several of the Du Pont ventures that Professor Davidson studied had no American managers.

An even more basic problem, according to several experts, is that many more Japanese speak English than Americans speak Japanese.

This has made it difficult for Monsanto, the chemicals concern, to make sure it was getting as valuable technology from its Japanese partners as it is giving to them.

"We have few scientists who are proficient in Japanese," Mr. Heininger said. As a result, "we don't have the fluency to probe in detail their technical people the way they can probe in detail our technical people."

The Japanese have not been nearly as generous about sharing their technology and manufacturing expertise, contends Robert B. Reich, professor of political economy and management at Harvard University's Kennedy School of Government. In his study of 100 ventures, he found that Japanese companies almost always tried to keep the highest value-added parts of production for themselves.

If this trend continues, he worries that the Japanese will increasingly be the ones who turn American breakthroughs in basic science into useful products. Americans, he said, will become second-class assemblers and distributors of Japanese goods.

In many cases, though, American companies have had little choice but to form disadvantageous relationships to do business in Japan.

Until the mid-1970's, the Japanese prohibited Americans from setting up wholly owned subsidiaries in Japan. Instead, they had to enter into jointly owned enterprises with Japanese companies. And the price of