Does the Fear of Litigation Inhibit Innovation?

Continued From Page C1

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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.

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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

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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.

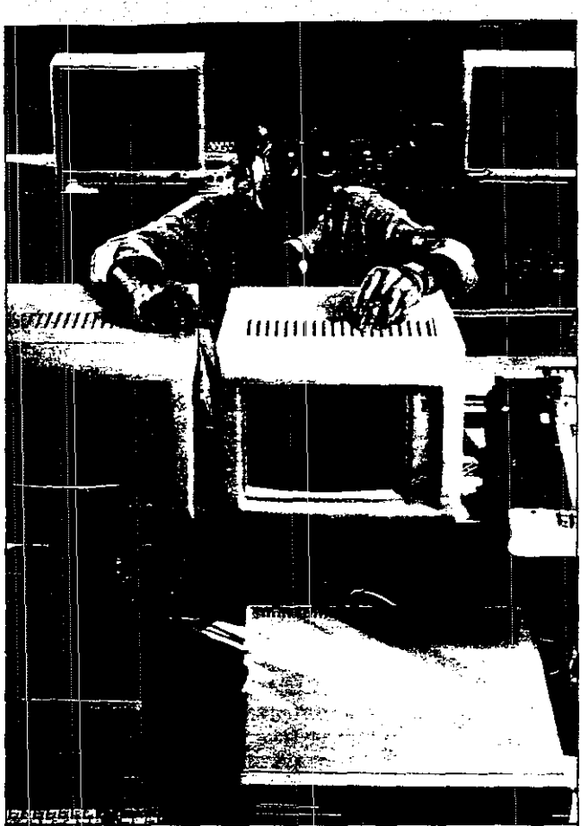
But does what happens in Brazil matter all that much? Brazil, after all, is a relatively poor country and accounts for a mere $3 billion in the U.S.' $160 billion negative trade balance. Brazil matters very much. For one thing,



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.

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

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

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

Aren't the Brazilians and the others simply doing what



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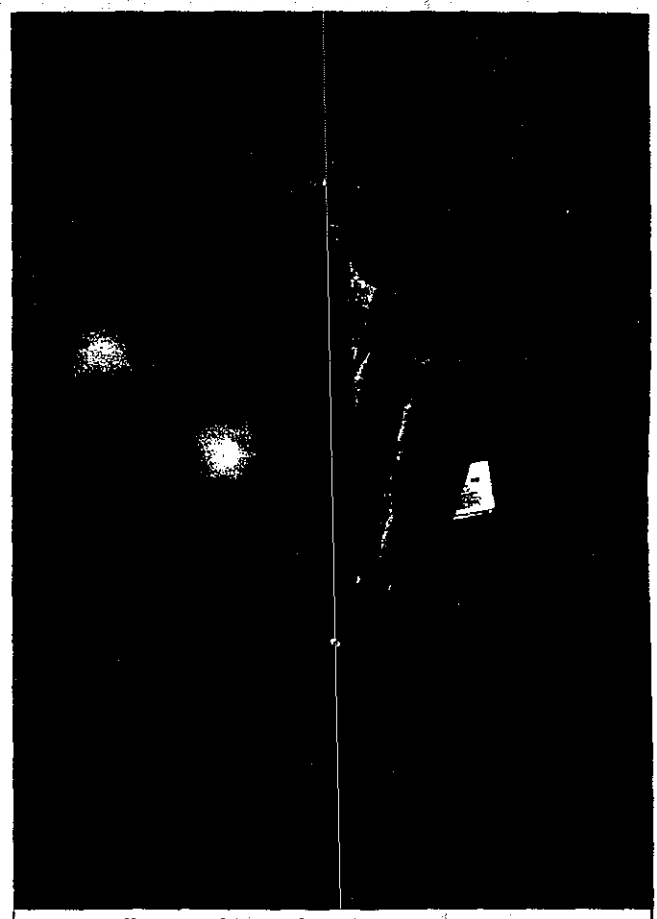


Lisiong Shu Lee of SID Informatica
Theft? No. Technology transfer? Yes.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

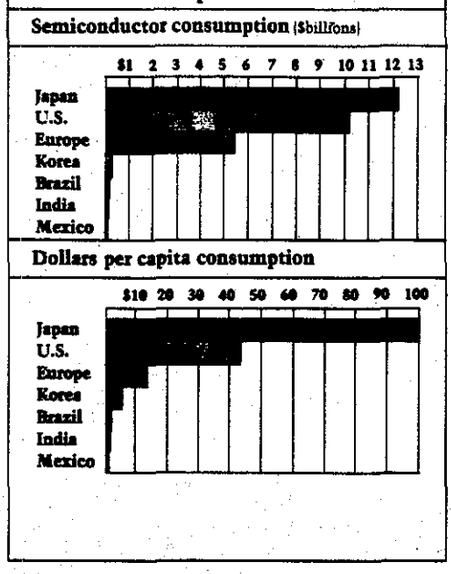
Harvard Professor Emeritus Raymond Vernon, a veteran analyst of international business, says of world technology markets: "Except for highly monopolistic situations, the buyer has a big advantage over the seller. Countries like Brazil and India can control the flow of technology across their borders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

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

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

Where the chips fall

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



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

Does anyone really believe in free trade?

By Norman Gall

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

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

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

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

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

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

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

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

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



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

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

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

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

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

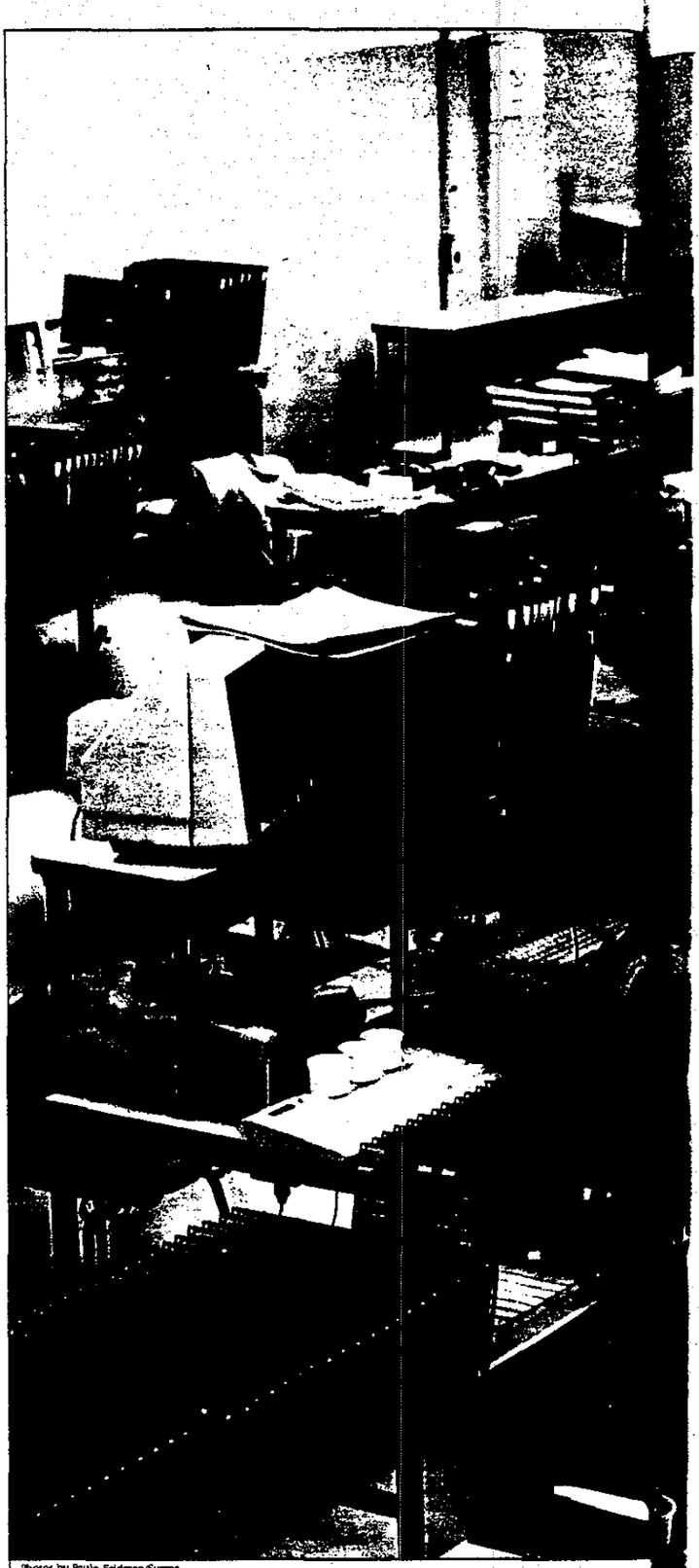
Like Microtec's Elias, Lee had learned most of what he knew from the Americans. In teaching this pair—and tens of thousands like them—U.S. industry and the U.S. academies created potential competitors who knew most of what the Americans had painfully and expensively learned. Theft? No. Technology transfer?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

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

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

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

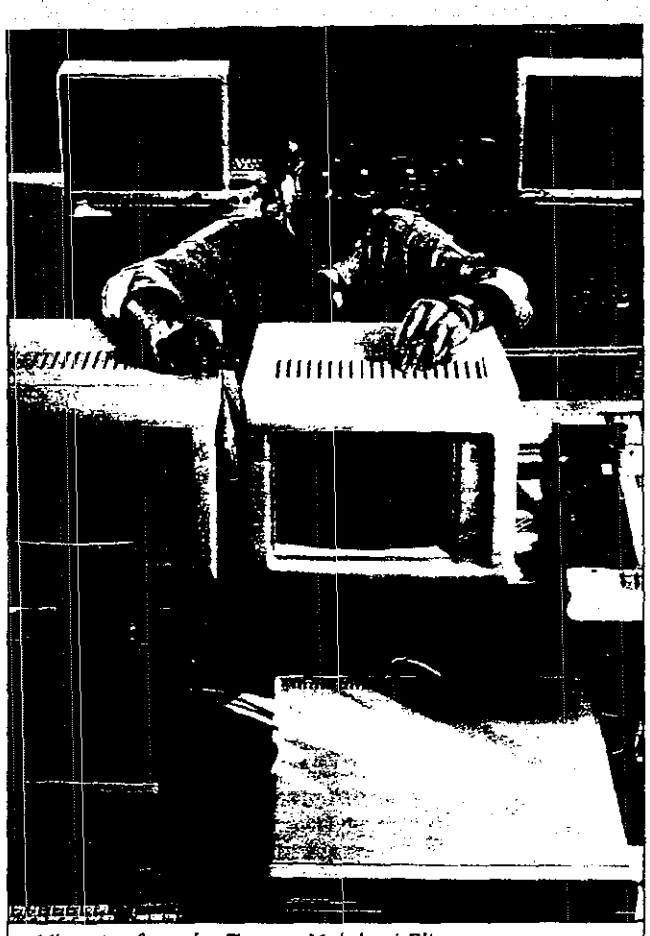
But does what happens in Brazil matter all that much? Brazil, after all, is a relatively poor country and accounts for a mere $3 billion in the U.S.' $160 billion negative trade balance. Brazil matters very much. For one thing,



Photos by Paulo Fridman/Sygma



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



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



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

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

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

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

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

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

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

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

Aren't the Brazilians and the others simply doing what



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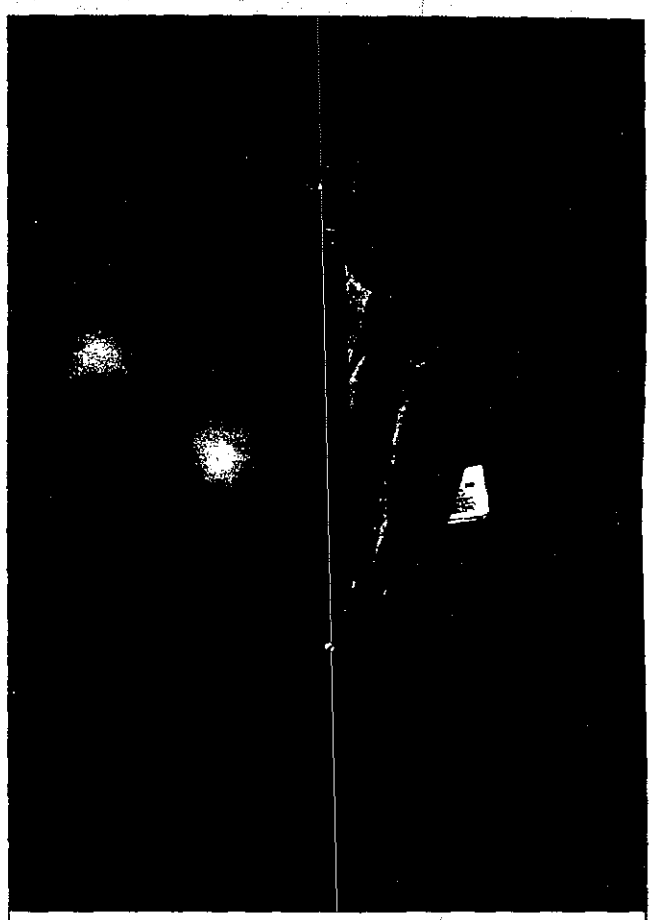


Lisiong Shu Lee of SID Informatica
Theft? No. Technology transfer? Yes.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

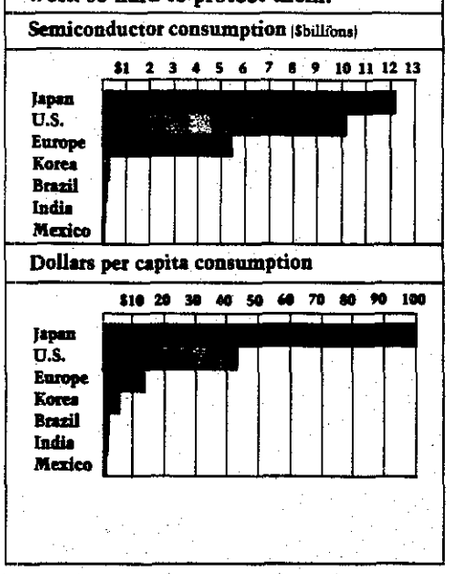
Harvard Professor Emeritus Raymond Vernon, a veteran analyst of international business, says of world technology markets: "Except for highly monopolistic situations, the buyer has a big advantage over the seller. Countries like Brazil and India can control the flow of technology across their borders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

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

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

Where the chips fall

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



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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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Continued from Page 1

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