entry into Japan included a requirement to license their technology to Japanese concerns.

Even after these laws were relaxed, American companies frequently found it difficult to break into the Japanese market on their own. This has been especially true in such expensive, technologically sophisticated products as telecommunications equipment and commercial aircraft, where the Japanese Government — like the governments of most countries — plays a big role in determining which vendor wins an order. As is still the case in most countries, including Japan, sharing technology and production with local companies is a prerequisite for winning an order.

Cultural differences have also made it virtually impossible for American companies to compete on their own in Japan.

The long-term relationships between suppliers, manufacturers and distributors so valued in Japan hinder American companies. With acquisitions frowned upon in Japan, American companies have often had little choice but to team up with a Japanese company to break into the market.

DESPITE all the dangers, strategic alliances with foreign companies, including the Japanese, seem here to stay. Indeed, even with the reassessment of ventures going on, no one expects any significant slowdown in their formation.

American inventiveness is admired throughout the world, but small companies, which account for so many discoveries, must often turn to foreign partners for help in making or distributing their products — and for the capital needed to stay alive.

Even giants, though, will continue to link up with foreign companies. General Motors, Ford and Chrysler now import not only components but entire cars from Asia. Companies in businesses ranging from appliances to photocopiers to machine tools have resorted to the same tactic. Such arrangements often force the American company to disclose vital design or product information.

Business leaders have also come to view strategic alliances as a necessity in industries where product development costs are exorbitant.

It costs $50 million to $100 million to bring a new drug to market, so pharmaceutical companies have to market it rapidly throughout the world to recoup the investment. That requires strategic alliances, said Henry Wendt, president and chief executive of the SmithKline Beckman Corporation, which has joint development and marketing agreements with Boehringer Mannheim of West Germany, Fujisawa of Japan and Wellcome P.L.C. of Britain.

Similarly, virtually no single company can afford the billions of dollars it costs to develop a new commercial jet — not to mention the $500 million to $700 million to develop the engines to power it. For that reason, international consortiums have become a way of life in the aerospace industry.

In a recent interview, Makoto Kuroda, a senior official of the Japanese Ministry of International Trade and Industry, reiterated his Government's assertion that Japan has abandoned all ambitions to become an independent power in commercial jets. At least publicly, such aerospace companies as Boeing and Pratt & Whitney, the jet engine maker, say the Japanese lack the design and systems ability and the innovativeness to threaten American leadership in aircraft or engines. But privately, industry officials are nervous, said Leslie Denend, a McKinsey consultant.

Whatever their long-term intentions might be, Japanese clout — and expertise — is clearly growing.

Boeing will allow its Japanese partners to design and produce components equal to 25 percent of the value of the 7J7, the 150-seat, fuel-efficent jet that Boeing plans to have in service in the early 1990's. That is about twice the share that the Japanese produced of the 200-seat 767.

Even if the Japanese pose no immediate threat to prime contractors such as Boeing, they are already taking business away from American component suppliers, said David C. Mowery, an aerospace expert at Carnegie-Mellon University. Eventually, they may do the same to the prime contractors, according to many experts.

SLOWLY, painfully, American managers are learning that doing business in a global economy carries enormous dangers along with opportunities. Having been burned by foreign alliances, some managers, at least, have lost the arrogance that made them such easy prey. The question is whether managers in other industries will learn from their example, or have to learn on their own. ■

The Government **Tries to Help**

Government officials are attempting to limit the dangers posed by the proliferating ties between American and foreign companies by enacting new laws and relaxing old ones.

Until a new law was enacted last year, pharmaceutical companies could not sell products for clinical testing or sale abroad unless the Food and Drug Administration had approved them for testing or sale in the United States. That forced such biotechnology companies as Genentech to license their technol to foreign companies instead of supplying their products abroad themselves. "We now have less need to transfer technology," said Thomas D. Kiley, Genentech's vice president for corporate development.

Once it was virtually impossible for American semiconductor companies to protect their mask designs — the "negatives" from which semiconductors are made — from foreign pirates. But new laws have substantially strengthened copyright protection of masks and microcoding, instructions implanted in semiconductors. Combined with the designation of a special Federal court to hear patent-infringement cases, that has had a dramatic effect: 70 to 80 percent of such suits are now upheld, up from 20 to 30 percent before.

A 1984 law enabled semiconductor makers to engage in joint research. A group of electronics companies then formed a reseach consortium, the Microelectronic and Computer Technology Corporation. A Pentagon advisory group is supporting the formation of a semiconductor consortium to develop manufacturing technology and engage in limited production of chips.

To keep the aerospace industry competitive, the President's Office of Science and Technology Policy recommended in February that American companies be allowed to collaborate not only on research for superfast aircraft but also on development — something antitrust laws now bar.

"There is no hysteria now" about the aerospace industry's competitiveness, said Crawford F. Brubaker, Deputy Assistant Secretary of Commerce. "But given what has happened in other industries, we don't want it to happen in this one." ■

The Varieties of Business Alliances

Joint Ventures involve the creation of an enterprise jointly owned by the parent companies to develop or manufacture or sell particular products often in a particular market. In many American-Japanese joint ventures, the Americans contributed the technology, only to find themselves discarded when their Japanese partner had mastered the innovation.

Licensing Agreements typically permit the licensee to manufacture and sell a product incorporating the owner's technology in return for royalty payments. But in electrical power plant equipment, color television sets, machine tools, electronic components and many other industries, agreements have not limited licensees to a given market or product application. By improving on the technology itself, capitalizing on their lower manufacturing costs or applying the technology to new products, Japanese companies have used the license to become strong competitors in the United States and abroad.

Marketing/Manufacturing/Supply Arrangements enable a partner to make or sell and service the other's products. American companies have used these arrangements to import low-cost foreign components or entire products, and to distribute American-made products in foreign markets. Because such alliances often involve sharing American technology and design specifications with the foreign partner, the result has often been one-way technology transfer.

Accusation Expanded

Continued From First Business Page

derstanding. Indeed, the S.E.C, said that Mr. Belzberg had a similar arrangment with Bear, Stearns — and a similar failure to disclose the family's stake — during its earlier attempt to acquire Hartmarx.

The memo gives this account: In January 1986, Mr. Belzberg told Mr. Greenberg that his family had acquired 4.9 percent of Hartmarx, and proposed that Mr. Greenberg buy additional shares of the apparel maker, to be held in a Bear, Stearns account for First City.

Mr. Belzberg said he would protect Bear, Stearns against any loss by agreeing to buy the stock back later. Mr. Greenberg said that he thought such an arrangement would make the Belzbergs the beneficial owner of that stock, and suggested that Mr. Belzberg check with his lawyer before proceeding.

Three hours later, after talking to his lawyers, Mr. Belzberg called back and told Mr. Greenberg that he was correct — and then suggested that Mr. Greenberg buy Hartmarx stock for his own account. Mr. Greenberg then bought up 90,000 shares for a Bear, Stearns investment account, telling Mr. Belzberg of his purchases as he made them.

'Wrong, Wrong, Wrong'

On March 4, Mr. Belzberg and the vice chairman of Hartmarx agreed, tentatively, that Hartmarx would buy back the 4.9 percent stake — and on March 4, Mr. Greenberg began selling his Hartmarx stock. By the time the buyback was officially announced March 17, Mr. Greenberg had liquidated his stake.

Although that account was based on testimony from Mr. Greenberg and Mr. Belzberg, Mr. Greenberg strongly denied several key assertions attributed to Mr Belzberg.

"It's wrong, wrong, wrong," Mr. Greenberg said last night. "Marc Belzberg never suggested that I buy for my own account. I didn't buy Hartmarx for any Bear, Stearns investment account. I didn't know they had 4.9 percent. I didn't know anything about the buyback agreement. And if the document says that, it's a typographical error. It's completely wrong. We're not involved in this, we're not implicated in any way, we've been charged with no wrongdoing. I never bought Hartmarx stock for them that wasn't subject to a put/call agreement."

The agreement Mr. Greenberg referred to was between himelf and Mr. Belzberg, dated Jan. 17, 1986, and covering Hartmarx purchases Mr. Greenberg made earlier in the month. Under the agreement, Mr. Belzberg agreed to bear the financial risk of 118,400 shares of Hartmarx stock Mr. Greenberg had bought. Those shares, added to the Belzberg holdings at the time, were what brought the Belzbergs to the 4.9 percent limit.

five managing directors based in New York.

Mr. Harris, his successor at Morgan Grenfell, is a Briton who has been in the New York office for nearly two years. Morgan Grenfell also named as managing directors Gregory T. K. Hsu, 40; Colin L. MacVeagh, 39, and Neil A. O'Hara, 34.

Morgan Grenfell's parent in London has been entangled in the financial scandal surrounding one of its

As for Mr. Harris, he's also been particularly busy. He was called out of a meeting the other day because his wife, Judy, was about to have their first baby. Mr. Harris was home yesterday, helping care for their newborn, Francesca. "This is more interesting, and more tiring, than work," he said. "It's been a remarkable few months, and this caps the whole lot of it."

NICHOLAS D. KRISTOF
DANIEL F. CUFF

EXECUTIVE CHANGES

● **American Express Co.** appointed Alan J. Lipner senior vice president, corporate tax.

● **Ampex Corp.**, Redwood City, Calif., appointed Charles A. Steinberg chairman, succeeding Arthur H. Hausman, who is retiring. Replacing Mr. Steinberg as president and chief executive is Max Mitchell.

● **Eaton Vance Distributors Inc.**, Boston, which distributes mutual funds for its parent, Eaton Vance Corp., named Wharton P. Whitaker executive vice president and national sales director.

● **Goodyear Tire and Rubber Co.**, Akron, Ohio, elected Oren G. Shaffer executive vice president of finance and planning, succeeding James R. Glass, who is retiring. It also named John M. Ross general counsel and vice president, to succeed Fredrick S. Myers, also retiring.

● **Gulf and Western Inc.** elected as a director J. Hugh Liedtke, chairman and chief executive of Pennzoil Co., Houston.

Senate Democrats Seek New Rules on Mergers

Continued From First Business Page

guished in large part because they lacked the support of the Senate Democratic leadership, particularly Mr. Proxmire.

"The chairman's bill will be the only vehicle for any takeover legislation in this session," a senior Banking Committee aide said.

For this reason, Mr. Proxmire's approach has been awaited with considerable expectation — and some trepidation — by Wall Street, and especially by the Securities Industry Association, which is likely to mount a strong lobbying effort against the proposals.

Quick Action Expected

Mr. Proxmire signaled his intention to move the bill swiftly today by scheduling several hearings later this month. He said the bill would be considered by the full committee in mid-July.

Perhaps the most striking featue of the Proxmire bill is its attempt to deter corporate raiders, investments bankers and others from "putting companies into play," which sometimes forces managers to buy back stock from the raiders at a premium price. The proposed legislation uses a number of devices to make it more difficult for these investors and others to act together without disclosing that fact.

The proposal also recommends these steps:

¶Forbidding companies that are takeover targets to give "golden parachutes" — large severance bonuses — to executives if they lose control of the company.

¶Prohibiting "greenmail," in which a company tries to fend off a hostile takeover by buying back its stock at a premium over the market price.

¶Closing the so-called 13-D window, which requires that anyone who buys 5 percent or more of a company's stock report the purchase within 10 days and specify future intentions to the Securities and Exchange commission. The Proxmire proposal would reduce the threshold to 3 percent, and require disclosure by the close of business on the next trading day.

¶Lengthening the period in which a tender offer must be kept open, to 35 business days from 20.

¶Sharply restricting "creeping tender offers" — the purchase of stock piecemeal in the open market rather than the announcement of a tender offer to all shareholders. The bill proposes that once a bidder controls 15 percent of a corporation, a tender offer must be made for additional purchases.

Increasing the maximum criminal fines for insider trading violations to $1 million from $100,000, and the maximum prison terms to ten years from five.

¶Restricting the use of so-called poison pills — provisions that foster accumulations of huge amounts of debt or otherwise make a takeover excessively costly.

In introducing the takeover legislation, Senator Riegle stressed that it was a product of compromise, and that none "of the sponsors are completely satisfied with the contents."

BITS OF OWNERSHIP

Growing computer software sales are forcing universities to rethink their copyright and patent policies

By IVARS PETERSON

Item: As a course assignment and using a university's sophisticated computer graphics system, three students create a short animated film. The film wins a prestigious international award, and the students receive lucrative offers from various movie companies. But the question of who holds the film's copyright — the students or the university — stalls possible deals.

Item: A computer science professor develops a clever computer program that a French company wants to use for research purposes. University officials claim that the professor has no right to sell or even give the software to the company without permission from the university.

Item: A graduate student writes a computer program as part of a large, ongoing research project. He copyrights the program and refuses to let other researchers in the department run the software until they agree to pay him a fee for its use.

Item: A team of faculty members and staff programmers puts together a computer program for handling library loans and other functions. The program is so successful that several dozen copies are sold to other libraries. Thousands of dollars accumulate in a bank account while the university tries to establish a policy for handling the twin questions of computer software ownership and the division of royalties.

These incidents, all of which have actually occurred at universities in the United States, reflect some of the sticky copyright issues now befuddling university administrators, faculty, staff and students. Universities are starting to review their "intellectual-property" policies, covering everything from copyrighted textbooks to patented inventions, to see where computer software fits in.

The real issue is money. Traditionally, universities have allowed faculty members who write books and create works of art to hold the copyright and keep any money earned from sales. On the other hand, most universities already enforce patent policies that call for a share of income from inventions.

The debate stems from a 1980 federal law that says computer software should be protected by copyright rather than by patent. Many university administrators, noting the increasing potential commercial value of software developed at universities, want to treat computer programs like inventions. In opposition, some professors argue that software, like any other copyrightable material, should belong to the creator.

Most universities don't yet have a comprehensive copyright policy, says Brian L. Hawkins of Drexel University in Philadelphia. "From the university's perspective, there's been money in patent policy," he says. "But copyrights, until software emerged as a copyrightable entity, didn't matter. Historically, there wasn't much money in them."

Now, universities are scrambling to catch up with technology. The issues surfaced early at places like Stanford University, the California Institute of Technology in Pasadena, Carnegie-Mellon University (CMU) in Pittsburgh and the University of Illinois at Urbana-Champaign, where software development has a long history. These and a few other institutions already have policies in place or are about to implement new policies. In many cases, the policies took years to develop. Bitter arguments often punctuated discussions.

One of the more contentious issues is the concept of "work for hire." Employees of a business usually must agree as a condition of employment to assign to the company all copyrights and patents. Even without a signed agreement, companies automatically own the copyright if the work is done on company time and with company resources.

The response of universities to this issue has been mixed. Some university officials argue that everything that takes place at a university is properly "work for hire" and really belongs to the institution. At a few universities, officials see the software copyright debate as a chance to gain greater control over everything that faculty and staff produce.

Others contend that universities are not like businesses. They say that a university's mission is the generation and dissemination of knowledge. A greedy administration and an overly restrictive copyright or patent policy can impede this function. It can also poison the atmo-

sphere on a university campus.

Several universities are actually heading completely away from the work-for-hire concept. Some policies allow not only faculty but even staff hired to write specific computer programs to collect as much as 60 percent of the income from marketed software, although the university holds the copyright.

"There are arguments on both sides of that issue," says Thomas K. Wunderlich, associate dean of research at Brown University in Providence, R.I. "We're leaning toward a nondiscriminatory policy that says we'll treat faculty, staff and students alike. If there's going to be money made, then there will be sharing whether within the computer science department or within the computer center itself."

"This is a new form of incentive within the academic institution," says Hawkins, "where a different sense of community can be created."

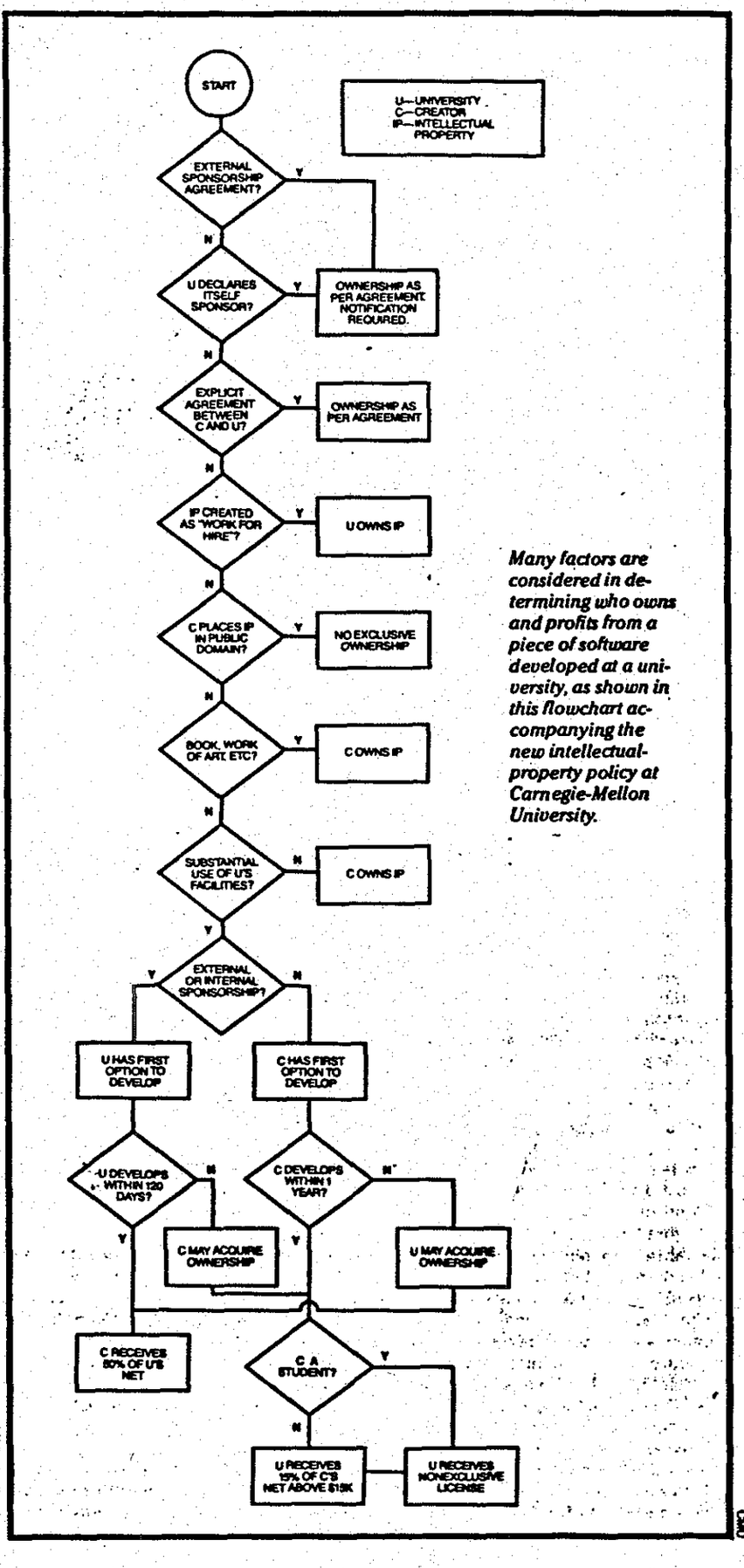
Most university software policies, however, don't go this far. More often, if faculty or staff are hired or assigned time to write a program for a specific purpose, then the university holds the copyright and the creators involved usually don't share in any income from marketing the software.

But establishing ownership can get complicated. "There are so many different scenarios under which creators can develop something," says CMU's Richard M. Stern. The CMU document includes an intricate flowchart showing all the different possibilities.

Software itself also covers a broad spectrum of creations — from "computer courseware," which is often little more than a video textbook, to programs that run scientific instruments and collect data. Also included are operating systems for computers and microcode, which converts commands in a programming language into instructions in a microprocessor chip. Some universities have chosen to divide software into two or more categories, depending on whether the software is more like a book or a patentable invention.

Another sticking point is the definition of "substantial use of university resources" in deciding whether a university holds a copyright. Brown University, in its proposed policy, takes a liberal approach. In general, unless the university's large "mainframe" computer is used extensively, the programmer holds the copyright. Exceptions would occur when research is sponsored by a government agency, industry or foundation and the contract specifically requires the university to claim ownership of any software produced for the project.

"There are concerns about use of university facilities," says Wunderlich, "but you can't police everything." The task becomes overwhelming with the proliferation of computers on campuses. "People use computers the way they would turn on a light switch," says Henry A. Scarton, a



Many factors are considered in determining who owns and profits from a piece of software developed at a university, as shown in this flowchart accompanying the new intellectual-property policy at Carnegie-Mellon University.

mechanical engineer at Rensselaer Polytechnic Institute in Troy, N.Y. "Using a computer is like having a pencil."

Nevertheless, CMU, in a quest for precision, is one university that has tried to put a dollar figure on "substantial use." In CMU's policy, "extensive" use of university facilities means that the programmer would have had to spend more than $5,000 to buy or lease equipment and services similar to those used at the university.

Wary of potential accounting problems, other schools have included a "substantial use" clause but have chosen to leave it undefined. At the Virginia Polytechnic Institute and State University (VPI) in Blacksburg, a special committee settles the matter.

Another touchy issue concerns the role of graduate and undergraduate students. At places like Ohio State University (OSU) in Columbus, the school has strongly championed students' rights by encouraging students to copyright their work, including class assignments and dissertations. In general, a student's work belongs to the student, unless the student has been hired for a specific project or makes extensive use of university facilities.

Not all universities follow this approach, partly because of differences in state laws governing contracts and related matters. VPI lawyers recently studied the question as it applies in Virginia and concluded that a submitted class assignment, for instance, becomes the property of the professor involved. Students also cannot claim a share in any university software they helped to develop unless the professor, in a written agreement, decides to give them a percentage of any royalties.

The ownership of work done by students is a tricky question, says OSU's Gary L. Kinzel, who discussed the problem at a recent meeting in Boston on computers in engineering. "Students rarely work on a significant piece of software without major supervision from a faculty member," he says, "although the faculty member may or may not actually write part of the code."

In his paper, Kinzel gives an example of what could happen: "An adviser works with a student for several years and provides many of the ideas for a software package. The adviser may also arrange for computer support, financial support through a teaching assistantship and advice on the program development. At the end of the project, the student may decide he would like to start a company based on the program. He can then copyright the program and deny the university access to the source code. Technically, the student is within his rights because he alone did most of the actual programming."

Of course, because a copyright covers only the expression of an idea and not the idea itself, the professor is free to work with another student to redo the program from scratch. "However, with research that is highly associated with computer programming," says Kinzel, "the inability to be assured access to programs for future development has a significant damping effect."

OSU/Computer Graphics Research Group

Three students at Ohio State University last year won several top international awards for their three-minute, computer-animated film "Snoot and Muttly." However, determining who owns the software that generated the images and who benefits from any proceeds from its sale turns out to be a very difficult question to resolve. Now OSU has a copyright policy that in the future may help settle such disputes.

Several new and proposed intellectual-property policies now try to circumvent such problems. At Illinois, for example, users, to get access to major university facilities, in effect agree to give the university a royalty-free license to use, within the university, any software developed using the facilities.

However, the best way to overcome these and other potential copyright problems is to come to some agreement before a project starts. "Contrary to all the good old academic traditions," says Dillon E. Mapother, associate vice chancellor for research at Illinois, "there are certain areas where you've got to put things in writing if you want to avoid trouble."

"Potential conflicts can be avoided if reasonable written agreements are made with students prior to any software development effort," says Kinzel. "Presumably, an important aspect of any such agreement would be that the university should have use of any software developed and this use should include the right to modify the source code."

More and more faculty members are taking this approach, not only with students but also in dealing with a university's administration. The CMU policy, in fact, states that because "it is frequently difficult to meaningfully assess risks, resources and potential rewards, negotiated agreements are to be encouraged whenever possible."

"The purpose of a policy is to establish the ground rules and to set the defaults — in a sense, the starting point for negotiations," says CMU's Stern. "We never really attempted to consider every possible scenario in detail." He adds, "I think it would be foolish to try to do something like that."

Although a few universities have intellectual-property policies that include computer software, most are just starting to wrestle with the problem. And new issues keep coming up.

"I don't think the debate on this is over," says Scarton. "If anything, it's only beginning." Rensselaer Polytechnic Institute started debating the issue several years ago but still has no policy. Now, a faculty committee has proposed that a modified version of CMU's policy be implemented. "CMU did a very nice job," says Scarton, "but their policy is a little bulky. We tried to streamline it a little bit."

Although policies like those at CMU and Stanford University are being used as models, the issues are complicated enough that universities are generally taking somewhat different approaches. "There's not a right way or a wrong way," says Brown's Wunderlich. You need to look for "a path of least resistance" to get a policy through at any particular university, he says.

Even universities that have policies see that changes are needed. Both the Massachusetts Institute of Technology and Stanford, which have had patent and copyright policies for years, are tinkering with their schemes. Commenting on OSU's recently adopted "interim policy," James B. Wilkens of OSU's patent and copyright office says, "This field is sufficiently complex that in two years we probably will find that we want to make a few changes."

"The main point is that if you adopt a policy that alienates the original authors [of a copyrightable piece of work]," says Mapother, "the property that you claim is largely without value." □

The New Cutting Edge In Factories: Education

Workers Lacking Math Skill Fear for Jobs

Third of a series

By Barbara Vobejda
Washington Post Staff Writer

YPSILANTI, Mich.—Lavester Frye works at an assembly table eight hours a day building automobile horns, setting a metal plate on a metal dish with one hand, adding a tiny ring with the other.

In the 22 years he has worked at the Ford Motor Co., it never really has mattered that he didn't finish high school. He always has had jobs like this one, jobs that depend more on his hands than his mind.

RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

But Frye has been told that his job soon will become more complicated. To improve productivity, the company is phasing in an intricate statistical system of quality control.

The news made Frye feel nervous and unprepared, and when he looked at the charts he would be expected to keep under the new system, he was even more troubled by what he saw: decimal points. "A long time ago at school, I had decimals, but it faded out of my mind," he said.

On this factory floor, amidst the assembly lines, the huge hulking furnaces and the din of metal on metal, the ability to put a decimal point in the proper place suddenly has become a ticket to a job.

Like thousands of other workers across the country, Frye is experiencing firsthand the transformation of the American workplace in pursuit of competitive advantage. He also sees—and feels, painfully—that, in this race to keep up with other countries, a critical and often missing factor is education.

In the national debate over declining U.S. competitiveness, education is perhaps the word most often uttered. Plant supervisors blame schools for turning out undisciplined workers whose bad habits drive down productivity. Corporate executives complain that job applicants can't read or write.

Educators warn that American students lag far behind their international counterparts in math skills, signaling trouble in the

See COMPETE, A14, Col. 1

Education: Factories' Cutting Edge

COMPETE, From A1

next generation of technicians. Also looming ahead, social scientists say, is a massive, problem-ridden underclass of high school dropouts that will drain the economy in welfare costs and lost productivity.

Education matters in this new global race because the work force matters more than machinery, more than capital, more than technology.

"Human resources—that's what gives you the competitive edge," said Pam Spence, training coordinator at the Ford plant. "Everybody's buying the high-tech equipment . . . . The only competitive edge we'll have over anyone else is our human assets."

The quality of education, experts agree, is increasingly the most important single determinant of the quality of America's work force, from the high-technology laboratories that rely on engineers with graduate degrees to the Rust Belt industries retraining workers in a struggle to revive. The skills and deficits of the employes determine productivity: an auto worker confused over decimal points slows output and probably overlooks defective products.

"Education is the foundation. If you have a weak dollar and you solve the deficit problem and all those ducks fall into place and you have a poor education system, you're still not going to compete," said Harley Shaiken, a professor who specializes in work and technology at the University of California at San Diego.

Ford's efforts to improve productivity are typical of many employers: the company is automating, introducing more sophisticated quality control and enhancing employe participation in management. And in the low-slung, red-brick building that houses the Ford plant here, there is plenty of evidence that a lot of the workers simply aren't up to it.

Les Walker came to work at the plant four decades ago as a 17-year-old high school dropout. "If you could read or write a little bit, you could get a job," he said of the booming postwar period when he was hired. "Now there's so much change . . . . "

Walker inspects the valves on shock absorbers that will be built into Ford bumpers. Soon, "statistical process control," which is designed to pinpoint and correct defects in manufacturing, will be introduced to his section of the plant. He'll need to use math skills he hasn't needed before and never learned in school: fractions, division, averaging and decimals.

When Frye and Walker complete their afternoon shift at 3, they and several others gather in a converted office off the factory floor, hunching over high school books around a cafeteria table. They have volunteered for free courses, arranged under a 1982 United Auto Workers-Ford agreement, to prepare for the high school equivalency test. They also have taken instruction in computers and basic reading and math.

As the assembly line gears up for the second shift, Frye, 48, learns how to figure a percentage. Walker, 56, scratches out ratios and proportions.

These workers, most of whom could retire in a few years, would not lose their jobs if they failed to learn statistical process control. But they know job promotions depend on their ability to adapt, and many of them believe that they will be better, more productive workers if they learn the new systems. They don't want to be left behind.

"I want to be prepared when it gets here," 55-year-old Daniel Hughes said of the new technology.

Hilton H. Schaarschmidt, who uses a computer to distribute automobile parts to be assembled by other workers, summed up his choices after more than two decades in the factory. "If I can't work the computer, someone else can; I would be back out on the [assembly] line," he said. "I don't want to be back out on the line."

Retraining Workers for the Year 2000

Three-quarters of today's work force will still be working in the year 2000, so the training and retraining of current workers is critical in reviving the nation's standing in the world economy. Many believe that the next 10 or 15 years will be the period of the most intense global competition.

"We're going to make it or break it with these workers," said Pat Choate, director of policy analysis at TRW Inc. and a noted author on the subject of American competitiveness.

But for the long term, competitiveness must rely on the quality of education being offered in elementary and secondary classrooms, to youngsters still years away from their first paycheck.

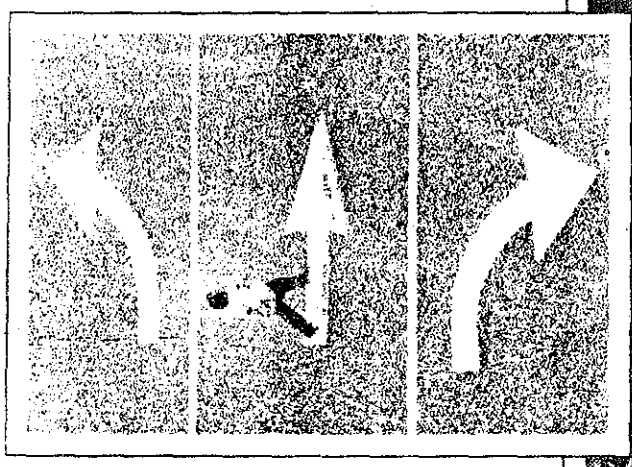
"A failure in basic education in 1987 will be extremely difficult to rectify because of the very large scale and intense kinds of technological changes we know will be taking place in the future," University of California professor Shaiken said.

American schools, however, are doing "very poorly" in supplying a broad basic education, Shaiken said. "Many students graduate from high school without any grasp of basic math or reading skills. To the extent that continues, then competitiveness is just something you talk about."

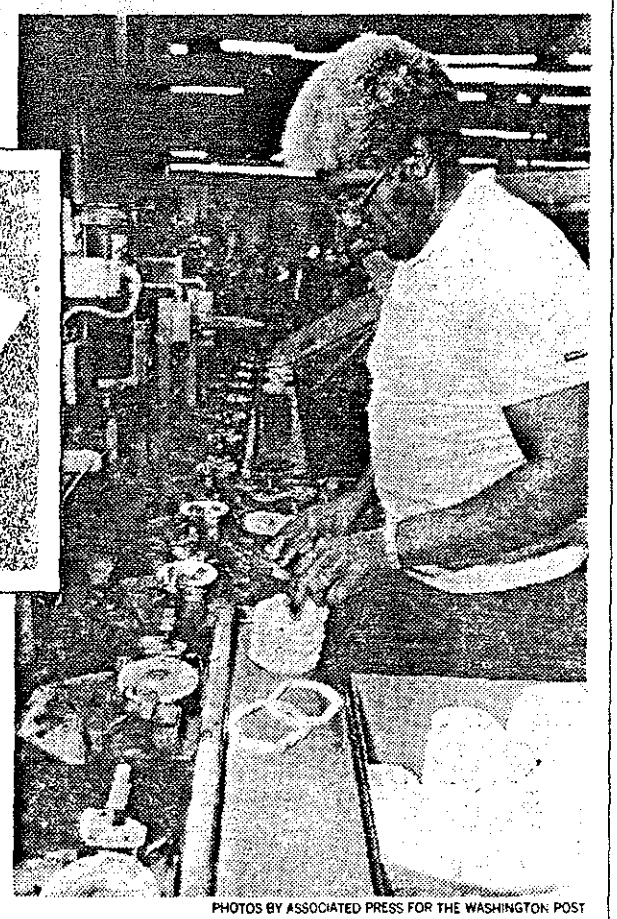
Recent studies comparing the mathematics test scores of American schoolchildren to their international counterparts support Shaiken's pessimism. While Japanese schoolchildren finished first or second in most categories, American scores ranked in the middle in comparisons of eighth-grade arithmetic and algebra skills for 20 countries. U.S. achievement dropped even lower, to the bottom quarter, in geometry and measurement. There was similar low performance among American 12th-graders in algebra and calculus.

"In school mathematics, the United States is an underachieving nation and our curriculum is helping to create a nation of underachievers," according to the

RUDE AWAKENINGS



Education matters in this new global race because the work force matters, more than machinery, more than capital, more than technology.



PHOTOS BY ASSOCIATED PRESS FOR THE WASHINGTON POST

Lavester Frye, who assembles automobile horns, will be expected to keep statistical charts once Ford Motor Co. phases in a new quality control system, and his ability to put a decimal point in the right place will be crucial.

To remedy educational deficiencies, Walker, left, and Frye volunteered to take free courses in computers, basic reading and math to prepare for a high school equivalency test. Instructor Emo Honzaki supervises afternoon class.

Les Walker inspects valves on shock absorbers for bumpers. When a system of "statistical process control" to detect and correct manufacturing defects is introduced, he will need to learn new math skills.

Second International Mathematics Study, released this year.

While most experts put heavy emphasis on education as a competitive strategy, there is a minority viewpoint, based primarily on productivity statistics, that plays down education as a factor.

"I don't think we have strong evidence at all that losing competitiveness is due to the lack of a well-educated populace," said Thomas G. Sticht, a San Diego consultant who has studied the link between literacy and productivity and participated in a recent Department of Education study of literacy. The loss of manufacturing jobs to workers overseas, he said, is due to the availability of cheap labor—not to higher educational levels abroad.

"That has nothing to do with the fact that somebody can't calculate a percentage," he said.

Henry Levin, a Stanford University professor in education and economics, agrees that education is overrated as a factor in competitiveness. He asserts that most newly created employment in this country requires relatively low-level skills in service sector jobs, such as clerical work or jobs in the electronics component industry. Few of the new positions are for engineers or highly educated technicians.

And while the sophisticated products of an increasingly high-tech economy may be designed by a few highly skilled engineers, the real profits will come when the product is produced and sold. That will not require a highly sophisticated work force, Levin said.

"It's easy to talk about education as the problem . . . [but] what is it about education that's going to make a difference?" he asked. "Education is part of the solution, but it's not as crucial a solution as people make it to be."

The Japanese Philosophy: Improvement

Down the road from Ford's Ypsilanti building, executives at a new Mazda plant in Flat Rock, Mich., say they have a very clear idea of how education can make a difference.

They want their new employes to be able to work in teams, to rotate through various jobs, to understand how their task fits into the entire process, to spot problems in production, to trouble-shoot, articulate the problem to others, suggest improvements and write detailed charts and memos that serve as a road map in the assembly of the car.

For the Japanese-owned company, it adds up to a management philosophy modeled on the Japanese concept of *kaizen*, roughly translated as "improvement." That means that every employe, executive to custodian, is expected to help find ways to build "the best car at the lowest price."

"The plant of the past required individuals . . . to perform a task within very specific parameters, very routine," said David Merchant, vice president for personnel at the Mazda facility. "The plants of the future, which are the plants of today, require people to do a lot more than that . . . . Education is important in terms of preparing people to do that."

Merchant is overseeing an extraordinary effort to create a work force—mostly American—that matches the Japanese philosophy. In preparation for its assembly line to open this fall, the company is sifting through more than 96,000 applicants to fill 3,100 hourly positions, using what it says is the most complex hiring process in the United States or Canada.

Applicants are given a two-hour written test in reading, writing and math. They are interviewed at length,

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 third of six articles exploring these changes. Succeeding articles will address the problem of world trade, the debate over "competitiveness" in the political arena and the overall outlook for the future.

asked to undergo a medical exam and given a two-step "assessment." Before they complete the process, successful applicants may have been in the pipeline for two months and will have spent up to six hours being observed in discussion groups and another six hours at a simulated team assignment, assembling an automobile part, for example.

The company, which every week tests 600 applicants and interviews and assesses more than 100, has been "a little disappointed" at the number of applicants who lack the basic math and language skills, but nevertheless has found plenty of qualified people to hire, Merchant said.

Compare that handpicked batch of fresh employes to the work force at Ford, where the average hourly worker has more than 17 years on the job. Financial hard times, largely due to foreign competition, have cut the company's hourly work force nearly in half. The remaining workers are those with the most seniority, hired at a time when little attention was paid to educational skills and the rule of thumb for hiring was, as one union official said, "FBI": friends, brothers, in-laws.

At Mazda, there has been no need to offer remedial programs in reading, writing or math to the hundreds of workers who have so far been hired. But Ford and other longtime employers have found that before they can retrain, they must help substantial numbers of employes become literate.

"It's pretty hard to give somebody computer training if they don't have the three Rs," said Mark Dillon, a spokesman for American Crystal Sugar Co. in Moorhead, Minn.

As his company added computerized testing equipment to its sugar manufacturing process, it became clear that some employes were unable to read and write and could not be trained without remedial courses. But fewer than two dozen employes signed up for the literacy classes the company began offering. "It takes a pretty big person to say, 'I have to learn to read,' " Dillon said.

Fighting U.S. Functional Illiteracy

"Functional illiteracy" among American adults often is cited as one of the biggest obstacles in the nation's efforts to improve productivity. While 95 percent of young adults are literate, there are large numbers who fail at more complicated tasks required to function effectively in most jobs.

A recent survey by the National Assessment of Educational Progress reported that only 43 percent of Americans in their early 20s could decipher a street map, for example.

Donald Fronzaglia, director of personnel for the Polaroid Corp., said his company became aware of the literacy problem years ago when a supervisor was investigating why the rate of scrap—material discarded as unusable—had gone up significantly in one section of the plant.

When the supervisor asked an employe to demonstrate how he was cutting film into sections, he found that the worker couldn't read a tape measure and was throwing away large sheets of film that could have been cut into usable pieces. The supervisor eventually discovered that other workers lacked similar basic skills.

Polaroid has introduced literacy programs, also aimed at preparing workers to participate more in problem-solving on the production line. "We believe the people closest to the problem are in the best position to understand what went wrong," Fronzaglia said. "People who don't have [basic] skills may repeat the same error."

Aside from the challenge of retraining those on the job, there is the problem of the growing number of Americans who, largely because of poor skills, will never find work or will end up moving from one menial, low-paying position to another. The financial drain on society created by this group—in welfare, drug problems, urban crime and incarceration—will have increasingly serious implications for the nation's economic health and competitive position, according to several recent studies.

A report by the National Alliance of Business warns of the dramatic change in the worker pool looming ahead over the next 10 to 15 years.

"Most striking will be the growth of less-well-educated segments of the population that have typically been the least prepared for work," the report said. "The number of minority youth will increase while the total number of youth of working age will decline. The number of high school dropouts will rise as will the number of teen-age mothers."

The report urged businesses and government to improve education, training and retraining. "No [economic] sector can afford a growing underclass that cannot get or keep jobs . . . ."

Despite the dismal predictions, economist Choate and many others argue that the immediate challenge is preparing those already on the job for the changing workplace. "Most of us still think education is for kids," he said, "[but] it's today's adults that face the intense competition." It is their performance that will determine competitive success, "not tomorrow's kids."

At Ford's Ypsilanti plant, UAW local president Bob Bowen echoes the concern for today's work force and the critical need for flexibility. "If you have an educated person, they can adapt to the change," he said, proudly listing fellow workers who have signed up to take high school courses in makeshift factory classrooms. "The only way we can be competitive is to have the best workers."

NEXT: The new world economic order

RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

Brawn Forged Into Brain

Muscles of Steel Atrophied, Pittsburgh Turns to Services

First of a series

By Dale Russakoff
Washington Post Staff Writer

PITTSBURGH—When Larry Prisbylla finished high school in 1972 and traded in childhood dreams of becoming a teacher for a life as a steelworker, he thought it would last forever.

Every vista in his native Monongahela Valley contained a mile-long mass of pipes, sheds and smokestacks where thousands of workers forged raw materials into steel. In his boyhood, the sky in the "Mon" Valley would light up red at night with fires from mill furnaces. Steel built the region, won the wars, secured his future. And it paid as well as jobs reserved for college graduates.

"We thought we were going to be typical Yuppies," said his wife, Laura. "We were going to have it all."

But in less than a decade, time ran out on the Mon Valley. In 1980, Larry Prisbylla's workweek was cut to four days. On Christmas Eve 1981, he arrived at U.S. Steel's sprawling Clairton Works to find this notice posted in his shop:

"No more work scheduled."

At first, he didn't believe it was over. Each month brought fresh rumors that he and his buddies were about to be called back. For six months, his union and government benefits paid 80 percent of his $12 an hour paycheck. When his benefits ran out, Larry Prisbylla was still waiting. One day, Laura Prisbylla came home from her job as a secretary at Pittsburgh National Bank to learn, again, that her husband had heard encouraging grapevine rumors. By now, the talk sounded hollow even to Larry.

"I just looked at him and said: *Listen* to yourself!" Laura Prisbylla said. "Wake *up*! It's *finished*! It's time to do something else."

Laura Prisbylla's warning to her husband sounds remarkably like those issuing across the country from business and labor leaders, educators and politicians as the national economy experiences its most dramatic upheaval since the Industrial Revolution.

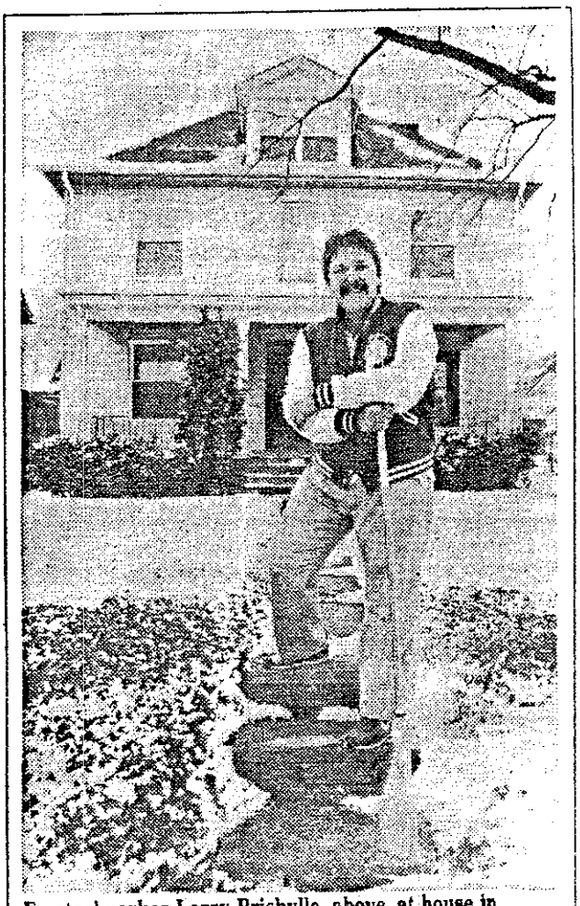
In less than a decade, the world's largest creditor nation has become its leading debtor, foreign competition has humbled America's mightiest companies, hundreds of thousands of manufacturing jobs have disappeared and middle-class living standards have declined in many communities.

On the surface, the debate is about economics, but its roots are in the nation's social fabric and its people. Families and communities are confronting unprecedented dislocations; scientists and inventors are braving frontiers, though often ignored by American managers; educators are moving from the classroom to the workplace to guide workers into a new, highly technological economy; business leaders are paying a price for decades of complacency, and politicians are reassessing the federal government's role in the economy.

See COMPETE, A12, Col. 1

BY RAY LUSTIG—THE WASHINGTON POST

Ex-steelworker Larry Prisbylla dines with his wife, Laura, and children, Sara, 2, Michael, 12.



Ex-steelworker Larry Prisbylla, above, at house in suburban Pittsburgh. Below right, at work in new profession, he checks on Daniel Martin at Mercy Hospital.

Deputy Treasury Secretary Richard G. Darman likens this collective American soul-search to the atmosphere of the late 1950s, when the Soviet Union launched the Sputnik satellite and the United States suddenly found itself No. 2 in the space race.

It is a search that Larry Prisbylla and his city began years earlier than the rest of the country.

At 28, Prisbylla faced a stark choice: Accept the end of the world as he knew it and prepare for the new one, or become resigned to a life of permanent dislocation. He opted for the first and spent four difficult years getting there, an experience that embodies lessons for the nation.

His city, former steelmaking capital of the world, is in the midst of a painful process of adaptation to the new economic order—one in which manufacturing is less important, while more resources go to services and "knowledge" industries.

Said Carnegie-Mellon University President Richard M. Cyert, a leading force in high technology here: "We are moving from a labor force called upon to use its muscle to one called upon to use its brains."

In the lingo of Washington's debate over the declining "competitiveness" of American industries, this requires what the pundits call a national "transition to a service economy," in which fewer and fewer workers, in automated plants, shoulder more and more of manufacturing output.

But "transition" is a misnomer for what happened here. More accurately, one sector declined and another arose, upending traditional notions of who wins and who loses. Even the winners have absorbed enormous shocks to values and habits.

Because the transformation is still under way, a traveler here has something of an archeologist's view: a new civilization being planted atop an old one.

On the city's eastern end, an idled Jones & Laughlin (J&L) steel plant is being bulldozed to make way for a high-tech industrial park, backed by the city and its two research-rich universities, Carnegie-Mellon and the University of Pittsburgh. The firms being lured to the park have work forces numbering in the dozens—contrasted with thousands who worked at J&L. Their employes tend to have advanced degrees; few millworkers went beyond high school.

A downtown subway stop still bears the name "Steel Plaza," but two of the three tallest towers around it, including the former U.S. Steel headquarters, are now occupied by Mellon Bank, a leader in the expanding service sector. Steel employed only 2 percent of the labor force last year, far behind health and education, the leaders of Pittsburgh's new economy.

Pittsburgh, known for blackened skies and muscular monikers—"Hell with the lid taken off" and "Forge of the universe"—now has a smaller proportion of workers employed in mills and factories than the nation as a whole. (The ratio here is 1 in 6; nationally it is 1 in 5.)

Change has not come easily. The five-county area lost 125,000 manufacturing jobs from 1979 to 1986—70,000 of them in basic steel—as Pittsburgh's key industries lost markets here and abroad. A surge in the service field and in high technology, powered by research at the city's universities, filled much of the gap. But figures compiled by Pennsylvania's Department of Labor and Industry show that almost 70,000 jobs have disappeared since 1979.

An Unusual McDonald's—It Was Closed

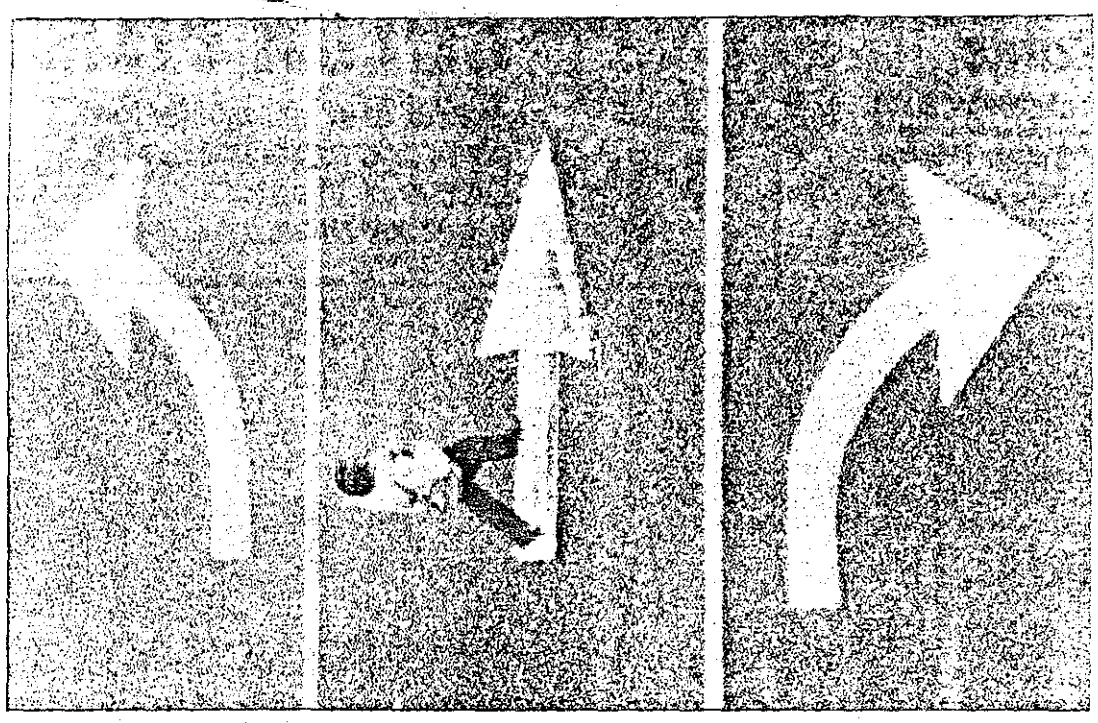
The new jobs generally have not gone to those who lost the old ones. A boomlet in openings for computer technicians at banks and local colleges was quickly oversubscribed as former steelworkers poured into technical schools, hoping to train for the new era. A Mellon Bank vice president said 50 people, at least a third of them ex-steelworkers, now apply for every computer technician opening at the bank.

While downtown Pittsburgh glistens with office towers, the Mon Valley resembles a deserted battlefield; mile after mile of mills lie mute. Mental health workers report increases in suicide, spouse abuse and other yardsticks of despair. McKeesport, site of U.S. Steel's idled National Tube Works, has the dubious distinction of being home to one of the few McDonald's ever to close down. (McDonald's says it was "relocated.") The fallen Golden Arches outlet, near two shuttered department stores, is being turned into a state unemployment office.

"It's very painful and ugly. There's nothing pleasant about it," said Thomas C. Graham, president of USX Corp., the renamed U.S. Steel. Graham's industry and its unions are widely blamed for choices that fostered the current devastation. "Transition is a slow process," Graham said.

When Larry Prisbylla began looking for work in

RUDE AWAKENINGS



Larry Prisbylla faced a stark choice: Accept the end of the world as he knew it and prepare for the new one; or become resigned to a life of dislocation. He opted for the first and spent four difficult years getting there, an experience that embodies lessons for the entire country.

1982, he had nothing to offer but a high school diploma and nine years in a mill. "I was a dime a dozen," he said. He applied for 50 jobs, with no results.

He had insulated gas and water lines for U.S. Steel so he applied to be an insulator. But he got nowhere because he had no experience on equipment used outside the mill. He also had driven trucks at the Clairton Works so he applied to be a truck driver, but lost out because he hadn't driven on roads outside the mill.

Prisbylla came to see the mill as a trap. Like many of his generation, he said, he had never wanted to work there but took the job for the money—among the highest manufacturing wages of any union, accepted by management as a price of labor peace. "Once you were in, you made as much as any college graduate," Prisbylla said. "You'd say you were going to get out, but by the time you got around to it, you had seniority. That's hard to give up."

Just having "steelworker" on his resume after 1981 was a drawback: Employers assumed he would quit at the first chance to return to the mill and higher wages. Prisbylla's only break occurred when an 11 p.m.-to-7 a.m. dishwashing detail opened up at an all-night diner called Eat 'n Park. He took it—at $3.35 an hour, less than a third of his Clairton wage. He doesn't recall thinking that the job was beneath him; after 50 rejections, he thought maybe this was his place.

College Provides a Turning Point

"We didn't know what his abilities were," Laura Prisbylla said. "All he'd done since high school was work in the mill."

In the new order of things, the hard-won money and benefits of millwork came to seem like narcotics, lulling would-be achievers into lives that never tested their limits. Now everyone was forced to go cold turkey.

The Prisbyllas' visions of life in the middle class were fading. Plans to have more children were deferred indefinitely (Laura has a son from an earlier marriage). In late 1982, their mortgage and utility bills swallowed most of their monthly earnings. (They had bought a house—at 16½ percent interest, two months before Larry's layoff—in Pittsburgh's South Hills, a working-class neighborhood being taken over by young professionals.) They looked to their mothers to bring by a bag of food now and then. Larry's parents were hit hard. His father, a machinist, lost his job when his plant closed. The elder Prisbylla later was hired as a janitor at the church Larry and Laura attend.

Many of those better off acted unconcerned, Laura Prisbylla said, as if steelworkers somehow had brought it on themselves. She solicited United Way contributions in her department at the bank and took it personally when people didn't give generously in the face of such widespread dislocation.

The turning point came in a public service announcement that flashed across Larry Prisbylla's television screen in the fall of 1983, during Pittsburgh's peak unemployment of 14.8 percent. It said the Community College of Allegheny County would retrain laid-off workers free. The county government and several private sources would pick up the tab.

The announcement ran for only a week on television and in newspapers, but almost 13,000 laid-off workers (one-eighth of the unemployed population) called the college. Larry Prisbylla was one of them.

After thinking over his future, the former steelworker decided to try to become a nurse. "My first concern was job security, so I saw two ways to go in Pittsburgh—health and computers," he recalled. "It looked like all the technical schools were pushing computers, so I picked the health industry. We've got all these hospitals, we're world-renowned for organ transplants. It seemed like nursing would give me lots of options."

Gambling everything on a career he hadn't even started, he quit the hard-won dishwashing job, making Laura the sole breadwinner. "A lot of guys had trouble doing that, but I just told everybody: She's taking care of me." They gave up all frills, including Christmas presents. Larry studied almost every night until 11:30 with six fellow students, struggling to take in chemistry, anatomy and physiology after being out of school 10 years. His first-semester grades amazed him: a perfect 4.0.

Soon after, the Prisbyllas decided to have a baby. Sara Prisbylla was born as Larry finished Nursing II. Laura, who had wanted to stay home with Sara, instead returned to work in six weeks to keep her paychecks coming. Their mothers took on the daytime child care.

When Larry Prisbylla graduated last spring as a registered nurse, hospitals throughout the area came to interview him and his classmates before they could even apply for jobs, a testament to the value of their education. "They would pump your hand and shove an application into it. What a switch!" Larry said. "I told Laura I would've loved to turn down the first five or six, just to get back at all the people who turned me down, just to see how it felt."

But the first offer he received was one he hoped for: Mercy Hospital, which had a specialty he wanted in orthopedics. He took it, at $28,000 a year, about the same as he was getting in the mill on Christmas Eve 1981.

Larry Prisbylla's story is a rare one—few former steelworkers land service-industry jobs at their old pay—but his experience says much about Pittsburgh's shifting values and the price of economic change.

The new jobs that pay well—in finance, health and high technology—generally require advanced degrees; at the least, high school plus vocational education. Some advanced technology firms require a doctorate plus business experience.

Bruce Davis, 33, who retrained as a computer technician after being laid off by U.S. Steel, repairs electronic equipment for Mellon Bank at wages about one-third lower than he was paid in the mill. A college graduate who took a mill job largely for the money, Davis said he will pass this lesson to his son, born the day of his layoff: "There's no easy job anymore when you get out of high school. You have to know exactly what you want to do because there's nothing to fall back on to support a family. That's gone."

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 first of six articles exploring these changes and their causes. Succeeding articles will address the problems of scientific research and development, education, trade, the "competitiveness" debate in the political arena and the long-term economic questions that lie ahead.

Photos by Ray Lustig—The Washington Post

Twice a week Prisbylla attends community college at night to keep pace with changes in nursing. Education was a key to regaining employment after being laid off.

For Lack of Assistance, No Retraining

The anxiety of falling behind was palpable on a recent night at a packed McKeesport union hall across the street from the stilled National Tube Works, where a banner still proclaims to an empty parking lot: "Help Curb Imported Steel." There, the Mon Valley Unemployed Committee—organizing arm of laid-off steelworkers whose slogan is, "If you think the system is working, ask someone who isn't"—held a meeting of workers who had been denied federal retraining benefits, which were supposed to help those displaced by competition from imports.

More than 600 men and women, all of them laid off in the last six years from the Tube Works, turned out. Some remained unemployed, but most were working part-time or full-time for much lower pay. Most said they wanted to be retrained. But without extra assistance, they couldn't afford to stop work to be retrained because their families needed two paychecks to pay the bills. Some tried retraining, only to find no jobs at the other end.

Here is what has become of a sample of them:

Tom Buck, 34, laid off 1982 as a tool and die maker at $10.50 an hour, now a computer programmer at $7 an hour; Ron Janicki, 31, laid off 1982 at $10.50 an hour as a pipe inspector, now working six months a year as a bakery production-line worker making $11.25 an hour; Mike Jacobs, 30, laid off 1982 at $10 an hour ("Get this: I was operating a lathe for U.S. Steel that was made in Japan"), now working five days as a carpenter at $5 an hour, two days as a janitor at $3.60 an hour; Don Hodge, 30, laid off as a crane operator in 1982 at $14 an hour, now a maintenance worker at a county hospital at $7 an hour. ("It's the best-paying job in McKeesport. You have to know somebody to get in. I knew a county commissioner," Hodge said.) Ernie Zsemko, 47, laid off 1982 at $12.82 an hour, now a machine repairman for a boiler-tube company, making $7.25 an hour. All of them had generous health benefits as steelworkers; now they have none.

Downtown leaders emphasize that the metropolitan area's unemployment rate fell below 7 percent last December, a dramatic drop from the 1983 peak of 14.8 percent. But the new figure overlooks those whose unemployment benefits have expired or who have given up looking for work. Nor does it distinguish between those in high-paid jobs and those in part-time, minimum-wage work.

As the pace of economic change quickens nationally, such dislocations are becoming more common. In Pittsburgh, where everyone was hit by the steel collapse or knows someone who was, there is keen awareness of the costs of change and who bears them.

"There isn't any question that in our society, blue-collar workers have been forced to absorb the uncertainty of the economy," Cyert said. "Part of being free also means taking some of the risks of uncertainty, and all of us as individuals have to learn to live with it. But when there's a lot of uncertainty, we tend to shove it off on blue-collar workers, and I think there are ways we can all share it a little more effectively."

Expanded Commitment to Education

"The facts of life are that when turmoil like this occurs, the companies are already in pretty desperate shape," said Graham, who led USX through a one-third reduction of its steelmaking capacity. "To ask Wheeling-Pitt or LTV [two steelmakers now reorganizing under the bankruptcy laws] what are their overarching social obligations to the communities they've abandoned is a pretty hollow question . . . . We are involved in a 24-hour-a-day struggle to survive. It's that brutal; it's that simple."

The solution embraced by almost everyone here is an expanded commitment to education. Economist Jean-Jacques Servan-Schreiber, a former French cabinet minister and now international chairman at Carnegie-Mellon University, said: "Education, including of course computer literacy, must reach everyone and it will have to go all through life. If you stop, you become obsolete, you cease to be competitive. You lose your talent, you lose your value. Constantly up-dated, educated people, on the other hand, find new jobs as the economy changes."

Even for those who weather it, though, economic transition is wrenching. Consider Larry Prisbylla, who made the move from a steel mill to a nursing station after five years of uncertainty. Now that he is reestablished, he finds himself thinking about trade-offs.

True, the mill job was deadly dull, but it took only eight hours a day. Nursing, by contrast, requires constant study. Prisbylla now takes pathophysiology two nights a week and expects to be taking courses as long as he stays in the field, trying to keep pace with change. "I'm not able to spend the time I want with my family. That's the part I regret," he said.

Two bookshelves in his living room tell the story of his changed life: One is filled with well-thumbed novels by Stephen King, his evening entertainment while in the mills; the other displays such titles as "General Chemistry" and "Microbiology," his current preoccupation. The latest Stephen King novel, a Christmas present from Laura, has not been touched.

The steel experience has made Prisbylla as skeptical of relying on the hospital as he did on U.S. Steel. He and his wife are setting up their own pensions, in case he leaves this job. He also plans to take courses in administration and in education, in case he revives his dream of becoming a teacher.

Prisbylla said it was not hard to shift to a "caring" profession from one known for brawn. The stereotype of the macho steelworker was overdone anyway, he said, as is the stereotype of the nurse as a motherly female. What tempers the bias, he said, is a collective desire by people here to recover from hard times.

"Patients look at you sort of funny at first and they'll say, 'How come you're a nurse?' " Prisbylla said. "They act like something's wrong with you. That's when I use my old steelworker stereotype. I sort of puff up my chest and say, 'Well, when I lost my job in the mill five years ago . . . .'

"And they sit up and say, 'Wow, you were a *steel*worker? And you found a good job? That's *great*!"

NEXT: The VCR and competitiveness

RUDE AWAKENINGS

UNITED PRESS INTERNATIONAL

For decades, blast furnaces along the Monongahela River lit Pittsburgh's night skies, above; today, no longer the steelmaking capital of the world, the city is becoming a center for industries based on service and brainpower.

THE OLD

'Life Was Simple' When Mills Roared

McKEESPORT, Pa.—Ray Piechowicz, 50, had spent his adult life working in a steel mill. Large and proud, with bushy, white eyebrows that bristle defiantly over the top of his glasses, he gives this description of the world as he knew it:

"Men went to work, women had babies and if politicians didn't take care of us, we threw 'em out of office. Life was simple."

Life began and ended in those days in the Monongahela Valley, where 10 huge steel mills belched smoke and fire along 23 miles of the "Mon" River east of Pittsburgh. Now most of the mills are silent, casting long shadows in towns that once depended on them. Piechowicz says the valley has lost more than jobs.

"People don't work with their hands anymore, and that's sad for this country," he said.

"Look at this—a once-proud union," he said on a recent night, waving his hand across the crowded local union hall of the United Steelworkers of America, where more than 600 laid-off workers had gathered after being denied federal retraining benefits. A collection plate was passed for a soup kitchen for laid-off workers.

"Look at 'em—collecting money to feed their old members. My heart thumps when I think of the destruction of our unions. They're taking it away from us."

Piechowicz, who went to work straight out of high school, is sending his children to the University of Pittsburgh on money saved from his steel wages. His wife works part-time as a dental assistant to help pay tuition and bills.

"I told my kids, 'Education is like a union card. It doesn't mean you know anything. It means they have to talk to you.' We had to get a union card to get in the door. They have to get an education .... I told those kids: 'Get out of this valley and don't look back.' Do you know how that hurts? I hate it; it's a sin. But it's no good for them here. There was a day when this whole place was lit up in the middle of the night with fire from these mills: National, Duquesne, Homestead, J&L. Now it makes me cry just riding down there. They're just dark and dead. It's pathetic, pathetic."

Piechowicz, like many others in the room, blamed "politicians," in particular President Reagan, for the downfall of basic manufacturing. He does not buy the argument that steelworkers' high wages were a significant factor.

"I'm sure this was all guided by a handful of people behind closed doors far away, figuring out how we're going to live down here," Piechowicz said. "The powers that be have plans for this valley: They're going to level it. A once-proud community!"

A 30-year veteran of U.S. Steel's National Tube Works here, Piechowicz was laid off in 1983. At the time he was being paid $14 an hour as a mechanic, specializing in the repair of hydraulic machinery. Now he is head of security at the Community College of Allegheny County, being paid $6 an hour. "I hire people every day at $3.50 an hour," he said. "It's terrible; it's exploitation."

BY RAY LUSTIG—THE WASHINGTON POST

"I told my kids, 'Education is like a union card. It doesn't mean you know anything. It means they have to talk to you.' We had to get a union card to get in the door. They have to get an education."

—Ray Piechowicz

THE NEW

Artificial Intelligence And Flexible Time

PITTSBURGH—The "new Pittsburgh" of booming banks, thriving hospitals, expanding universities and more than 600 advanced-technology companies bears little resemblance to the factories and mills that dominated the city's past.

Walk into the headquarters of Carnegie Group, founded by four computer science professors at Carnegie-Mellon University to market "artificial intelligence" to manufacturers. Through "AI," as it is known, computers are programmed to behave autonomously: diagnosing problems on a factory floor, prescribing repairs for faulty cars, even pinpointing human illness.

Carnegie Group is developing artificial intelligence systems for Ford, Boeing, Digital Equipment Corp. and other manufacturers—in the name of making them more productive and thus more competitive. Carnegie Group's "knowledge engineers" interviewed Ford's top mechanics, dissected their know-how and created an "expert system"—putting the knowledge of an expert mechanic in a computer—to guide repairs at dealerships. The system aims to cut warranty costs, according to Larry Geisel, former president of the firm, and to improve customer satisfaction.

The decor at Carnegie Group's headquarters is Danish modern superimposed on a turn-of-the-century railroad freight depot overlooking the Monongahela River. Clock-punching has given way to flex time. And, in contrast to the factory work force, whose jobs are under siege, here it is the executives who fear the loss of employes—scientists with multiple degrees whose expertise is coveted in the United States and abroad.

"We are a $16 million company with a $60 million research and development program," said Geisel, referring to the firm's open line to Carnegie-Mellon's computer science department, a pioneer in AI. "After working here for a very short time, our employes know more than all but a handful of people in the world. These people get very valuable very quickly."

The company is growing rapidly, but American manufacturers are not the only users of its technology. Carnegie Group has established an arm in Japan, selling systems to Japanese manufacturers and training engineers from that country in artificial intelligence. Geisel, who recently left the firm to start another, acknowledged that this may look to some like aiding the adversary, since the United States has a techological lead over Japan in AI. But to him, it reflects a new economic world order.

"There are two problems: competitiveness and balance of trade," Geisel said. "The solution is not to say, 'Nobody sell to Japan.' Whether we make Japanese firms more competitive is another matter. We are open for business. To the extent American firms aren't interested, somebody else . . . is."

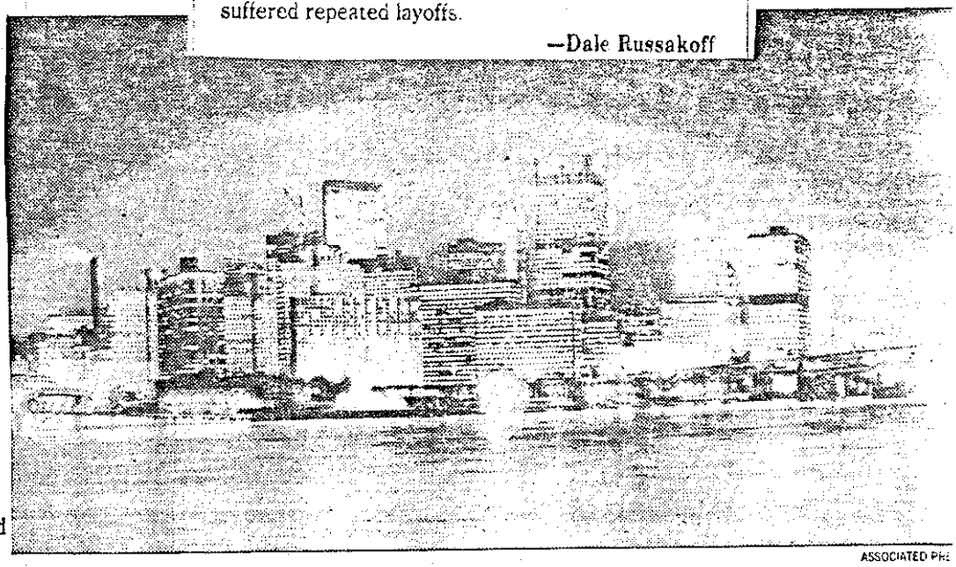
"In our marketplace, there's a major new release every year," said Glen F. Chatfield, president and cofounder of Duquesne Systems Inc., a fast-growing $29 million-a-year company that custom designs software to make IBM mainframe computers run more efficiently. "No matter what the new product is, if we don't make it better, we're a sitting target. If you're constantly improving, you're a moving target. And it can come from anywhere, Australia, Germany, anywhere."

An important catalyst to the growth of high technology here is the presence of two major universities: Carnegie-Mellon, pioneer of computer science, robotics and artificial intelligence, and the University of Pittsburgh, a leader in biotechnology with a world-renowned medical center.

Mellon Bank has taken over data processing for 450 banks round the country, and in the last five years has hired 400 computer technicians to service its equipment. These jobs average about $23,000 a year plus benefits, according to George P. DiNardo, a Mellon executive vice president.

"My main goal was to get with a big company that wouldn't lay people off," said Cathie Williamson, 27, a recently hired Mellon computer technician whose father, a construction worker, has suffered repeated layoffs.

—Dale Russakoff



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Japan's Closed Door Brings Hard Knocks

By William McGurn

TOKYO — When Commodore Matthew Calbraith Perry sailed home from this bay in 1854, his fleet of seven men-of-war carried an accord that put the first crack in Japan's centuries of self-imposed isolation. Four years later the efforts of America's first consul here, Townsend Harris, led to a commercial treaty between the two nations. All without firing a shot.

Today, alas, Washington appears to have neither the vision of the commodore nor the horse sense of the consul, if one can judge by the $300 million in punitive tariffs that are scheduled to go into effect tomorrow. A dubious response to the breakdown of what was itself a dubious attempt to "monitor" the international semiconductor market, America's new-found determination to Teach Japan a Lesson has encouraged similar menacing talk from other nations.

Whether the goal is a guaranteed American share of the Japanese semiconductor market or a specific British stake in a Japanese telecommunications venture, in an integrated world economy such bilateral efforts tend to expand the cartel rather than open the market. This in turn has disastrous ripple effects even for those not directly involved, as the howls now emanating from Hong Kong, Singapore, Australia and Europe attest. Despite earnest talk from all sides about avoiding the economic hara-kiri of an all-out trade war, no one scruples about the multilateral damage wrought by even a few sharp thrusts in that direction.

"It's a street fight out there," says Kenichi Ohmae, a managing director with McKinsey & Co., a consulting firm. "You no longer know who is hitting whom."

Bureaucratic Shogunate

Although economically inexplicable, the increasing resort to protectionism is an emotionally understandable response to mounting frustration at a Japan that moves in on everyone else's open doors but keeps its own relatively closed. Despite having less-onerous tariffs than even the Common Market or the U.S., Japan's infamous "non-tariff barriers"—chiefly its vertical distribution system, array of niggling regulations and pernicious "administrative guidance" from the bureaucratic shogunate—restrict access to almost all foreign goods save those locally produced. On top of this is a pricing and tax structure that makes most Japanese manufactured goods more expensive here than abroad.

American chip makers are neither the only nor even the most significant victims. Complaints come from a wide variety of foreign businessmen and diplomats in Tokyo. Producers of Thai boneless chicken, European liquor, Canadian lumber, Philippine papaya, South Korean light electrical goods, Taiwanese pork and Australian beef are just some who can't get through the door.

Japan might protest against America's "voluntary" quotas, but it eagerly imposes them on others, most recently on Korean and Taiwanese textiles. This does not begin to get at the exclusion of foreigners from the financial service sector or the Tokyo Stock Exchange. Says Rikkyo University's Chiaki Nishiyama: "The real problem here is the domestic controls aimed at controlling market entry, regarded as natural in Japan."

Even newly industrialized countries such as Korea and Taiwan complain more about Japan's restrictions on foods than about those on electrical and machine parts.

Take alcohol. Unlike other countries, Japan does not tax by alcoholic content but according to a grading system that places foreign products like Scotch in the high-tax top grade. The upshot of this structure is that even the cheapest bottle of Scotch must sell for at least 2,600 yen ($18.60)—up to three times as much as the cheapest Japanese whiskey, which, of course, escapes the onerous tax burden by being in the lowest grade. Set against this background, the vaunted Japanese preference for Japanese goods appears the outcome less of blind nationalism than of rational economic choice.

Under EC pressure, including a personal complaint from British Prime Minister Margaret Thatcher to Prime Minister Yasuhiro Nakasone at last year's summit here, the Japanese in December announced a reform in their alcohol grading structure. Although foreign wine and beer were freed up, the discrimination against foreign whiskey relative to the local competitors was left intact, mostly by just calling the lowest grade "spirits" instead of whiskey.

"They never tried to solve the problem," says Warren W. Williams of Burson-Marsteller, a public-relations firm. "They tried to defuse the problem by driving a wedge between the whiskey and wine producers. That's more a tactic of a trade war than participation in a world trading system."

Even more damaging are Japan's barriers against goods from developing countries, especially its Asian neighbors, whom access to Japan's vast market is crucial to future prosperity and stability. Developing countries have it doubly tough because more often than not they offer agricultural goods, which go up against Japan's most protected market, one that is tough even for the developed world to crack.

The premier of the province of Saskatchewan complained last week, for example, that the Japanese government buys Canadian wheat at $122.60 per ton and Japanese wheat at $1,226.00 per ton, selling both at $574.60 per ton. The relative numbers are staggering: Hiroshi Kato of Keio University writes that 1985 farm support programs and subsidies to special interest groups amounted to $56 billion, equivalent to Japan's entire trade surplus that year.

Then there's Philippine papaya, today banned from Japan. To kill flies, Philippine papaya growers treat the fruit with the chemical EDB, as do Hawaiian papaya growers, who currently are able to sell their papaya in Japan. But in June new Ministry of Health and Welfare regulations will prohibit all EDB-treated papaya, and Filipinos worry that their mangoes—for which Japan is their largest buyer—will be the next fruit targeted. The damage such regulations can do to struggling economies such as the Philippines is immense.

Even newly industrialized countries such as South Korea and Taiwan complain more about the restrictions on foods than about the restrictions on electrical and machine parts for which they are better known. "Japan should be more sympathetic to its Asian trading partners rather than getting angry at the unreasonable demands of the U.S.," says Kiyohiko Fukushima, a senior economist at Nomura Research Institute.

Although past U.S. administrations have threatened sanctions, they at least did not exhibit the current zest for determining the "fair" share of a given market or the "true" value of the dollar. In 1933, moreover, U.S. officials scored a notable success in getting the Japanese to change 17 laws in the famous baseball-bat case. The change permitted designated "registered" U.S.-based factories to manufacture "self-certified" bats. It was the first time anyone but the Japanese government was permitted to put approval stickers on

True, the scales remain grossly lopsided. The U.S., for example, permits several thousand factories in Japan to certify their goods for the U.S. market, while Japan licenses only a few dozen worldwide. The American victory on baseball bats was a real market-opening measure, and Korea, Taiwan and France have used the U.S. opening to get their own factories licensed. Working to change laws and regulations may not lend itself to the current wave of congressional jingoism, but it's more effective.

In trading in this approach for tit-for-tat protectionism, moreover, the U.S. has launched a kamikaze attack on its own industries by raising the price of semiconductor chips and some electronic goods while compounding the distortions in the international markets. Mrs. Thatcher probably would not have dreamed of threatening to boot some of the world's biggest lenders out of London's fledgling world financial market had President Reagan refrained from imposing sanctions. The American indulgence in protectionism against Japan traditionally has been followed by similar European moves, from steel to cars to videotape equipment.

Indiscriminate Discrimination

In a world economy that's gone far beyond bilateral relationships, the real problem is that it's impossible to confine punishment to the guilty. Europe, for example, lodged a complaint with the General Agreement on Tariffs and Trade that the attempt to guarantee America 20% of the Japanese chip market discriminated against European semiconductors, and Hong Kong's director of trade quite rightly slammed the same accord for trying to prevent Hong Kong firms from acquiring chips for less than the fixed price of 32. Similarly, when the dust clears from the latest American sally, all we are likely to find is a rise in prices for Americans, no change in the much-misunderstood trade balances, an increased say for Japanese regulators—and bad feelings all around.

It has yet to dawn on the bureaucrats in the Land of the Rising Sun how inefficient their actions make their own economy. Nor do they appear to appreciate that trade wars are seldom declared outright. They are, rather, the cumulative effect of protectionist blunders. More than a century ago, Commodore Perry convinced the Japanese it was time to come join the rest of the world. His heirs have yet to persuade them to let the rest of the world in.

Mr. McGurn is [illegible] editorial page of the Wall Street Journal.

of yttrium, for example, and labs must wait three weeks for orders to be filled.

'The Real Thing'

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

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

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

The breakthrough generated tremendous excitement among Bell Labs scientists, says Robert A. Laudise, director of the laboratories' inorganic chemistry branch. "Usually, research managers are coaching people to do this or that," Mr. Laudise notes. "But in this case we had people coming around from all different disciplines wanting to know if there was anything in this for their area," he says.

Too Soon for Applications

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

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

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

Jury Is Still Out

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

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

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

"Wherever I go around town somebody buttonholes me and asks how we're coming along or when can we use this," Mr. Donaruma says. Some inquiries have come from the space and defense related agencies in the area, including the Marshall Space Flight Center and the U.S. Army Missile Command, he says.

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

Crash Programs

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

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

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

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

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

JERRY E. BISHOP IN NEW YORK
CONTRIBUTED TO THIS ARTICLE

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 sixth 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.

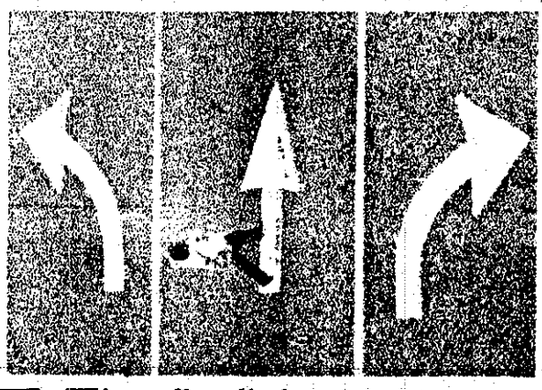
Now, Aho said, "we will see how much vibrancy this economy has."

NEXT: Politics of "competitiveness"

RUDE AWAKENINGS

BY JAMES M. THRESHER—THE WASHINGTON POST

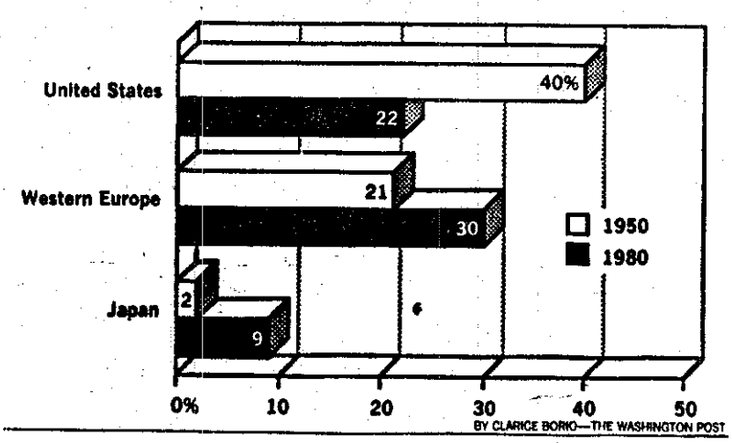
Korean workers prepare Hyundais for export to the United States and Canada. In the United States, the car set a first-year sales record for imports.



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

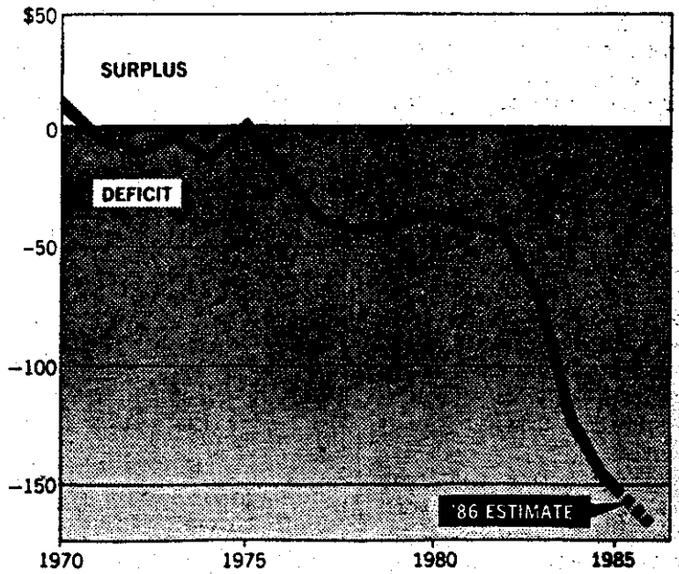
IN PERCENT



BY CLARICE BORIO—THE WASHINGTON POST

U.S. MERCHANDISE TRADE BALANCE

IN BILLIONS OF DOLLARS



SOURCE: U.S. Department of Commerce

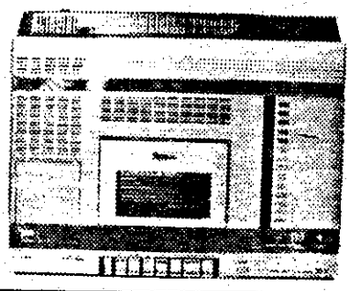
BY JO ELLEN MURPHY—THE WASHINGTON POST

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

COMPETE, From A1

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

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

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

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

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.

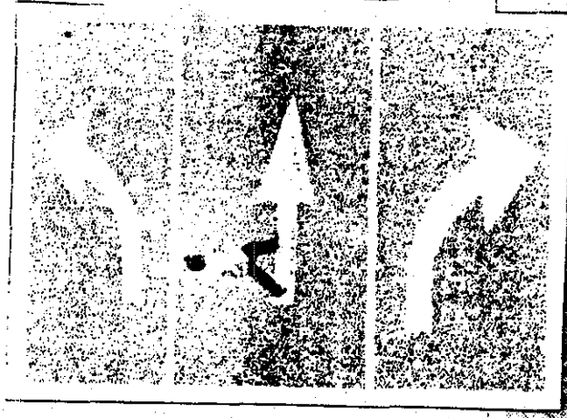
While such corporate-university collaborations are developing, there is controversy as to whether industry's need for proprietary secrecy conflicts with the traditional openness of university research.

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.

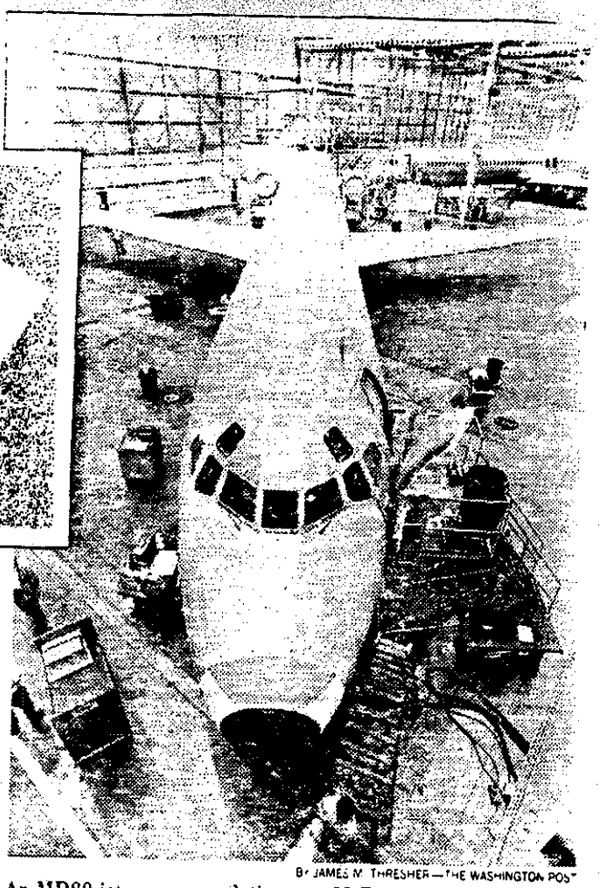
"In 10 years, if what I'm saying is correct," Cape says, "I bet we'll have hearings in Congress and a lot of American industrialists will bitch and moan about how the Japanese have done unfair things in trade. But that is not the case with biotechnology. The Japanese are doing the right thing."

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.

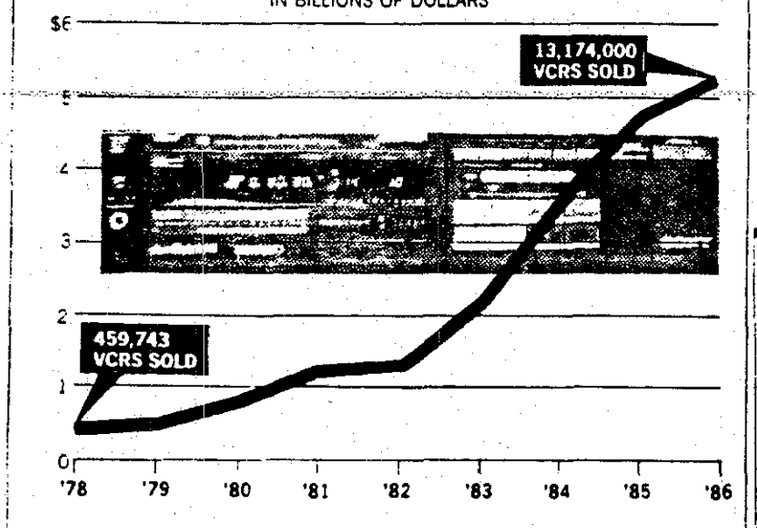


By JAMES M. THRESHER—THE WASHINGTON POST

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

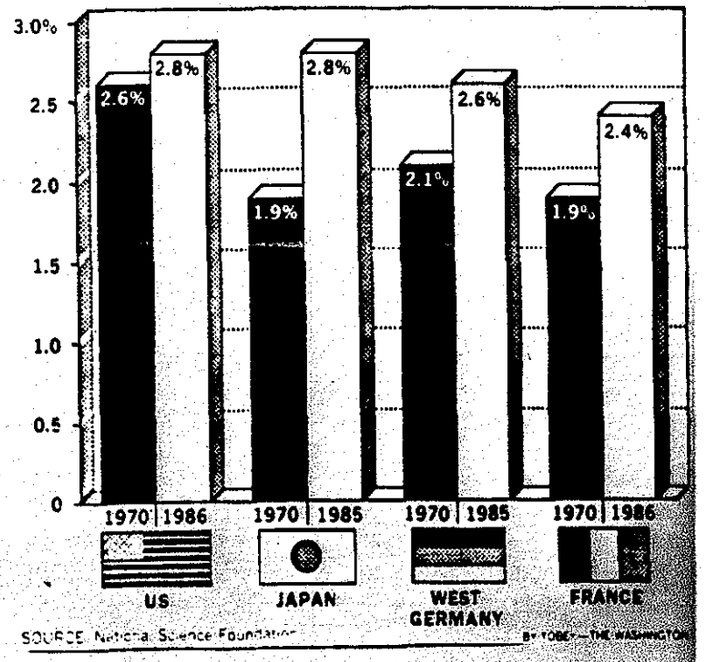


SOURCE Electronic Industries Association

BY JO ELLEN MURPHY—THE WASHINGTON POST

PERCENTAGE OF GNP SPENT ON RESEARCH AND DEVELOPMENT

INCLUDES RESEARCH AND DEVELOPMENT FUNDS FOR MILITARY RESEARCH



SOURCE National Science Foundation

BY TOBEY—THE WASHINGTON

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 sixth 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.

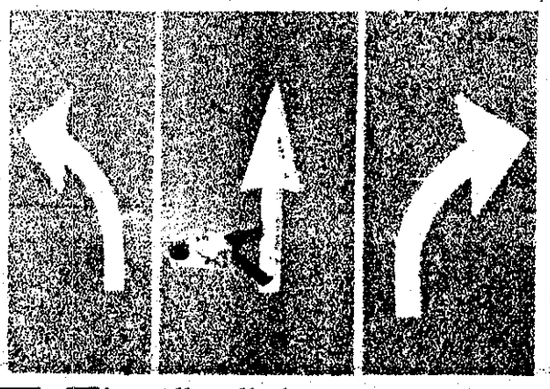
Now, Aho said, "we will see how much vibrancy this economy has."

NEXT: Politics of "competitiveness"

RUDE AWAKENINGS

BY JAMES M. THRESHER—THE WASHINGTON POST

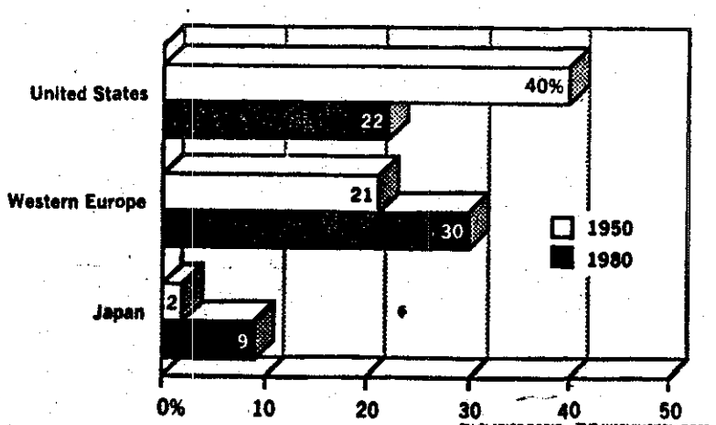
Korean workers prepare Hyundais for export to the United States and Canada. In the United States, the car set a first-year sales record for imports.



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

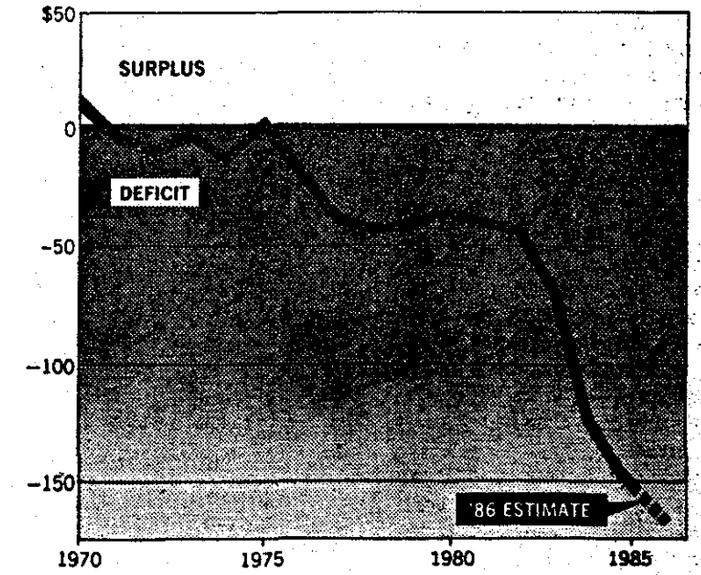
IN PERCENT



BY CLARICE BORIO—THE WASHINGTON POST

U.S. MERCHANDISE TRADE BALANCE

IN BILLIONS OF DOLLARS



SOURCE: U.S. Department of Commerce

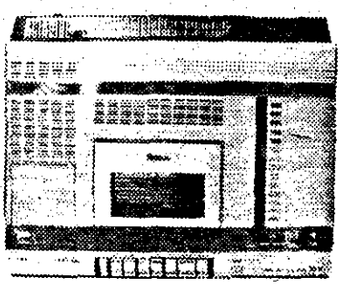
BY JO ELLEN MURPHY—THE WASHINGTON POST

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

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

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

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

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 leaptrog 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.

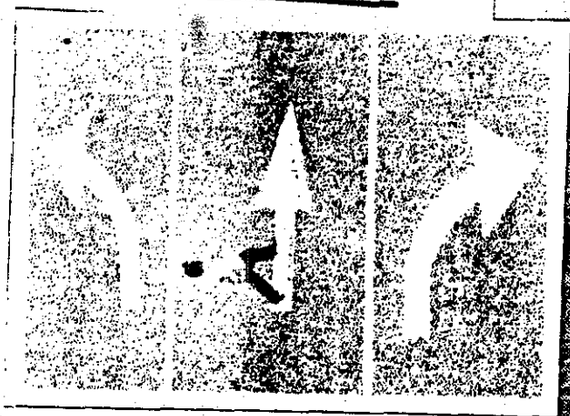
While such corporate-university collaborations are developing, there is controversy as to whether industry's need for proprietary secrecy conflicts with the traditional openness of university research.

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.

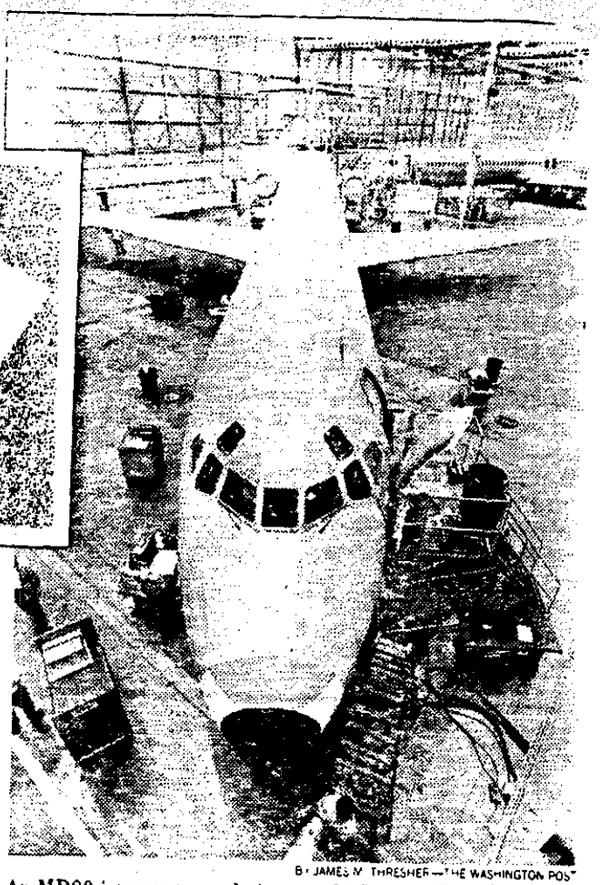
"In 10 years, if what I'm saying is correct," Cape says, "I bet we'll have hearings in Congress and a lot of American industrialists will bitch and moan about how the Japanese have done unfair things in trade. But that is not the case with biotechnology. The Japanese are doing the right thing."

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.

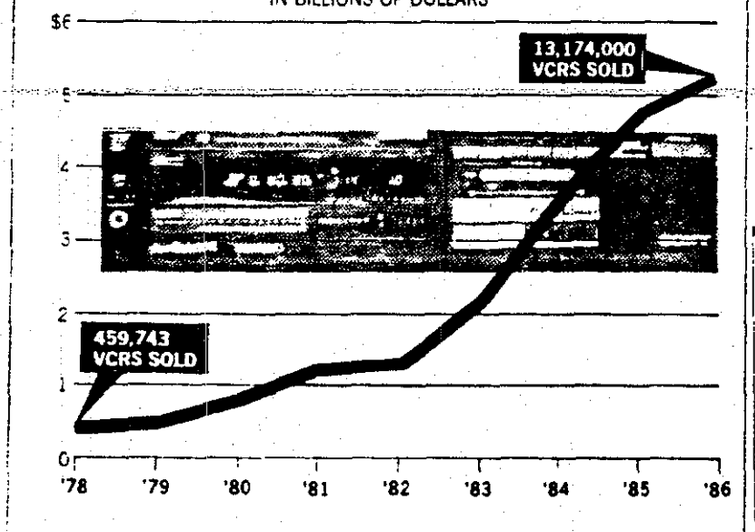


BY JAMES M. THRESHER—THE WASHINGTON POST

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

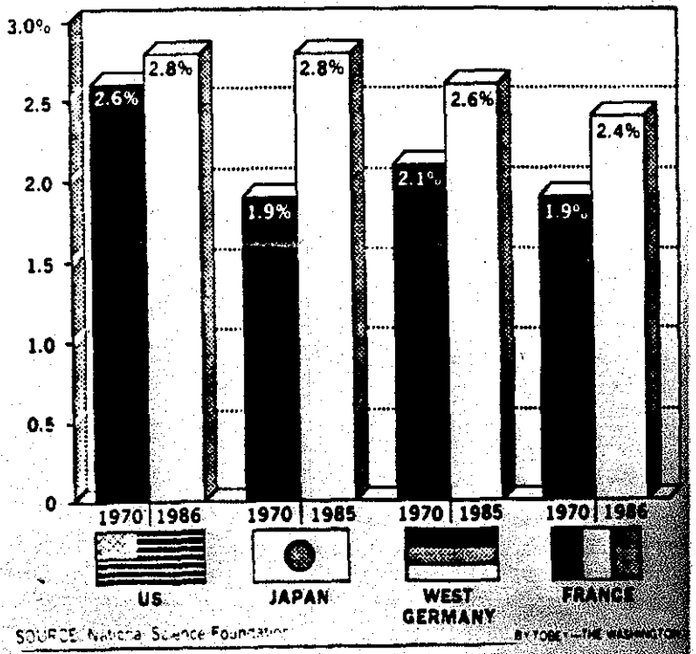


SOURCE Electronic Industries Association

BY JO ELLEN MURRAY—THE WASHINGTON POST

PERCENTAGE OF GNP SPENT ON RESEARCH AND DEVELOPMENT

INCLUDES RESEARCH AND DEVELOPMENT FUNDS FOR MILITARY RESEARCH



SOURCE National Science Foundation

BY TOM E—THE WASHINGTON

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 sixth 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.

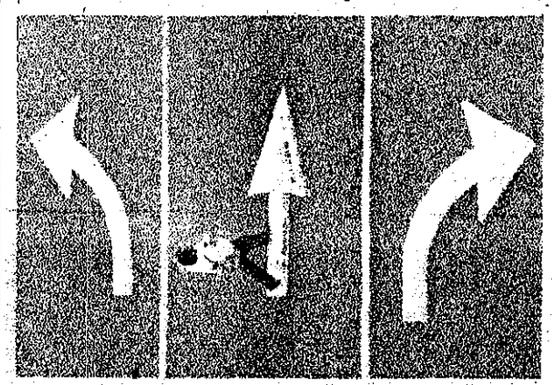
Now, Aho said, "we will see how much vibrancy this economy has."

NEXT: Politics of "competitiveness"

RUDE AWAKENINGS

BY JAMES M. THRESHER—THE WASHINGTON POST

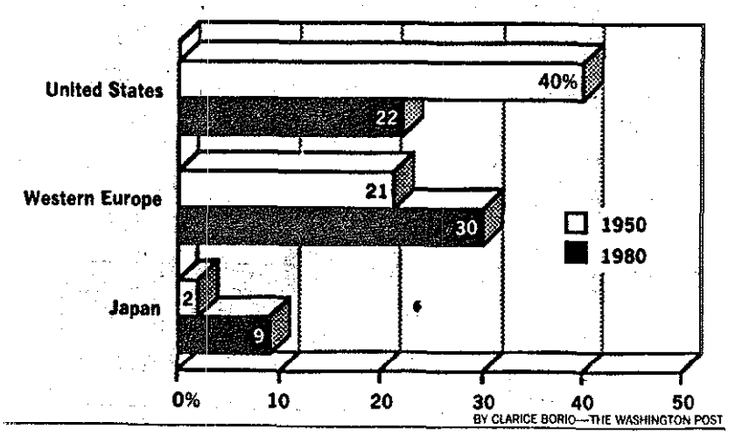
Korean workers prepare Hyundais for export to the United States and Canada. In the United States, the car set a first-year sales record for imports.



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

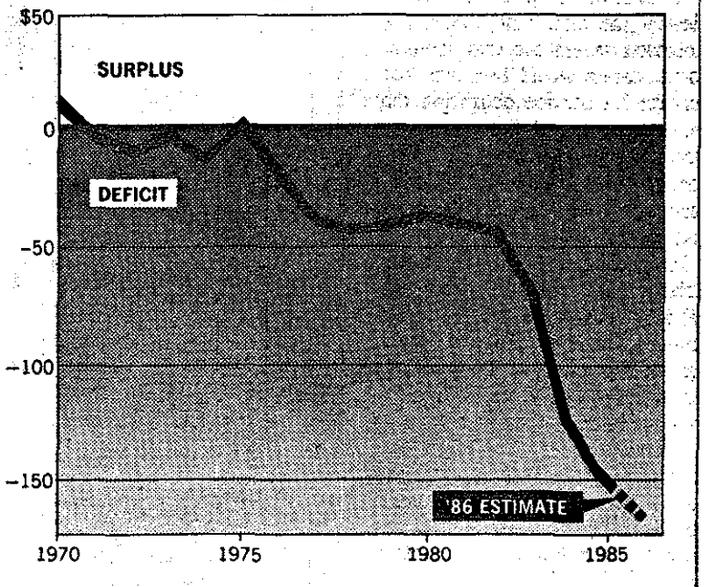
IN PERCENT



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

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

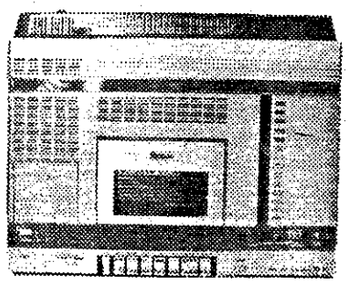
The videocassette recorder is an American invention, conceived in the 1960s by Ampex and RCA. The first VCR for home use to reach the U.S. market, in 1971, was the American-made Cartri-Vision.

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.



RUDE AWAKENINGS
THE CHALLENGE OF THE GLOBAL ECONOMY

"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

COMPLETE From A1

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

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

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

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

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.

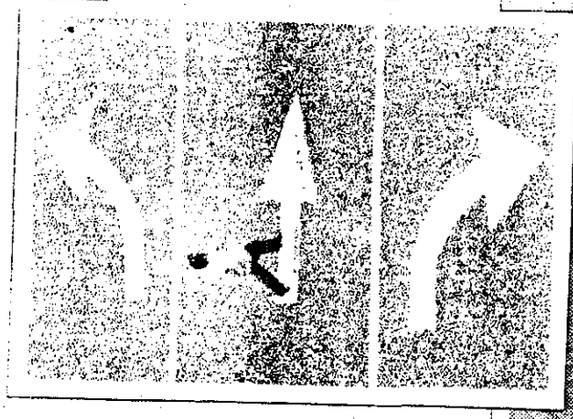
While such corporate-university collaborations are developing, there is controversy as to whether industry's need for proprietary secrecy conflicts with the traditional openness of university research.

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.

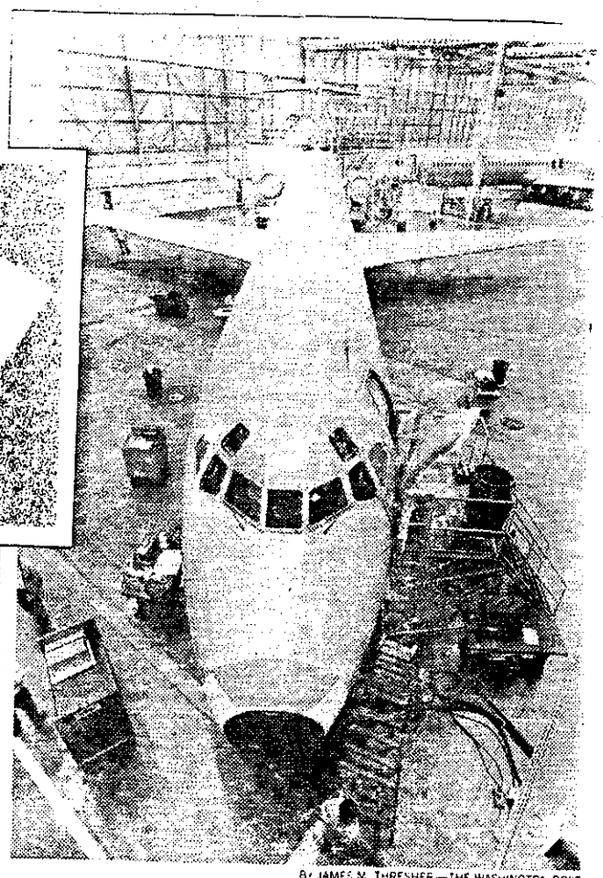
"In 10 years, if what I'm saying is correct," Cape says, "I bet we'll have hearings in Congress and a lot of American industrialists will bitch and moan about how the Japanese have done unfair things in trade. But that is not the case with biotechnology. The Japanese are doing the right thing."

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.

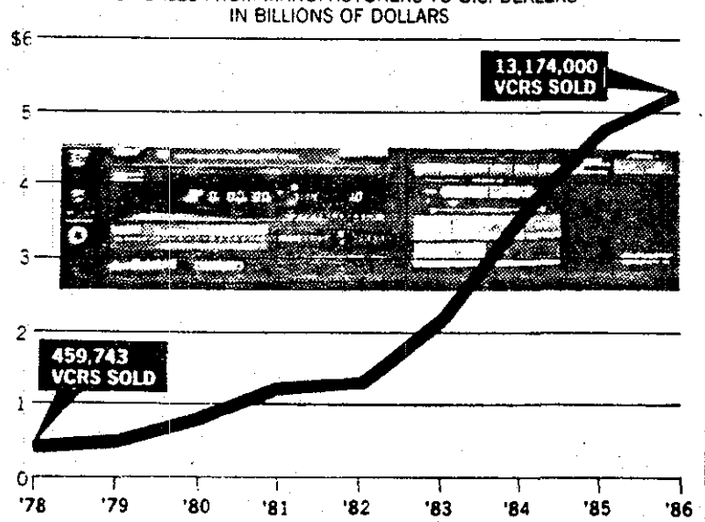


BY JAMES M. THRESHER—THE WASHINGTON POST

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

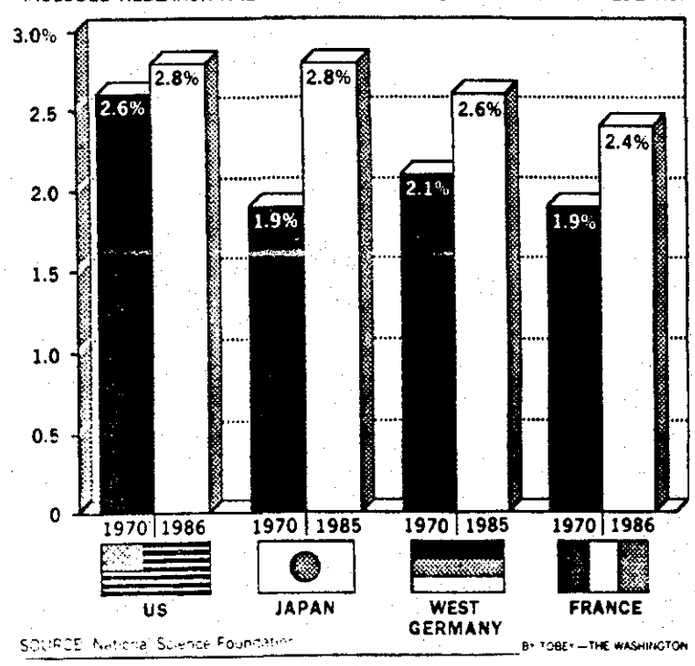


SOURCE Electronic Industries Association

BY JO ELLEN MURPHY—THE WASHINGTON POST

PERCENTAGE OF GNP SPENT ON RESEARCH AND DEVELOPMENT

INCLUDES RESEARCH AND DEVELOPMENT FUNDS FOR MILITARY RESEARCH



SOURCE National Science Foundation

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