Counting on Science to Compete

China and the "Asian Tigers" are trying to boost R&D and lure back expatriate researchers to help them compete in the high-tech markets of the 21st century, but they all face a variety of difficulties

For years, the nations known as the Asian Tigers—South Korea, Taiwan, Hong Kong, and Singapore—have bemoaned the massive exodus of their scientific talent to the West, especially to the United States. The best students traveled abroad to earn advanced degrees, and of these, one-half to two-thirds stayed to pursue their careers. But the past decade has seen a dramatic reversal of this trend. While the number of young people going abroad for advanced degrees continues to swell, a majority are now returning home (see chart, facing page), drawn by new opportunities and improved living conditions. Even scientists who have lived in the West for decades are going back to run institutes and to help bring Asian science into the international mainstream. The once lamented brain drain is proving to be a brain reserve of immeasurable worth.

FORREST ANDERSON/GAMMA LIAISON

Popular dish. Chinese labs are producing high-tech products like satellite dishes to feed a booming market.

Sprinkled across Asia are the magnets for their return: glimmering palaces of research offering world-class equipment and generous budgets. Facilities like Taiwan's 1.3 GeV Synchrotron Radiation Research Center (SRRC), which will be one of the world's most powerful radiation sources when it opens this fall, and Singapore's Institute of Molecular and Cell Biology (IMCB), which in 6 years has earned a glowing reputation, are putting the Asian Tigers on the world's scientific map. In Hong Kong and South Korea, lavishly funded new research universities are attracting hundreds of midcareer professors from the United States. Even China—which remains the exception, with the majority of its foreign students planning to remain abroad—is pumping resources into elite labs and loosening travel restrictions, hoping to lure back some of the tens of thousands of scientists who have chosen to stay overseas.

Asia's investment in science and technology has skyrocketed over the past decade, outpacing even the high economic growth in the region. Since 1980, R&D spending has grown at annual rates ranging from 15.8% in Taiwan to 23% in South Korea, according to figures compiled by the U.S. National Science Foundation. Today, the Asian Tigers spend close to $80,000 a year on each research scientist and engineer, about two-thirds of the amount in Japan and over half the amount in the United States.

These countries see science and engineering as critical to their economic futures. Soaring labor costs have already driven many manufacturing jobs into lower-wage countries in Southeast Asia. To maintain growth, the Tigers recognize they must shift to higher value-added products, which depend on homegrown research and innovation. Thus money is being pumped into research centers, consortia, and projects that will provide foundations for future industries, such as biotechnology, microelectronics, telecommunications, multimedia, and advanced materials.

Although Asia's centers of excellence remain the exception, they mark a coming of age for the region. After decades of trying to catch up, these countries are setting their sights beyond parity. Taiwan's SRRC, for example, was originally intended to operate at 800 MeV, far surpassing the highest-energy machine then on the island, a 3 MeV Van de Graaf generator. But in the end, says lab director Edward Yen, "we decided it should be at the frontier level." The SRRC will probe semiconductors and new materials, as well as protein structures for the Academia Sinica's Institute of Molecular Biology (IMB), a new center devoted to basic research with potential biotech applications.

As the Tigers jockey for position in the economic future of Asia, China looms huge in their consciousness. Fast becoming the world's largest market, it also provides a vast pool of low-wage labor to fill the growing number of manufacturing jobs. After years of deprivation, Chinese scientists are advancing rapidly in such areas as clinical medicine, solid state physics, chemistry, and computer science. China has also begun to parlay its wealth of talent into foreign exchange, as its researchers, especially in computer science, have taken on contract research for companies from around the world.

Tough road ahead

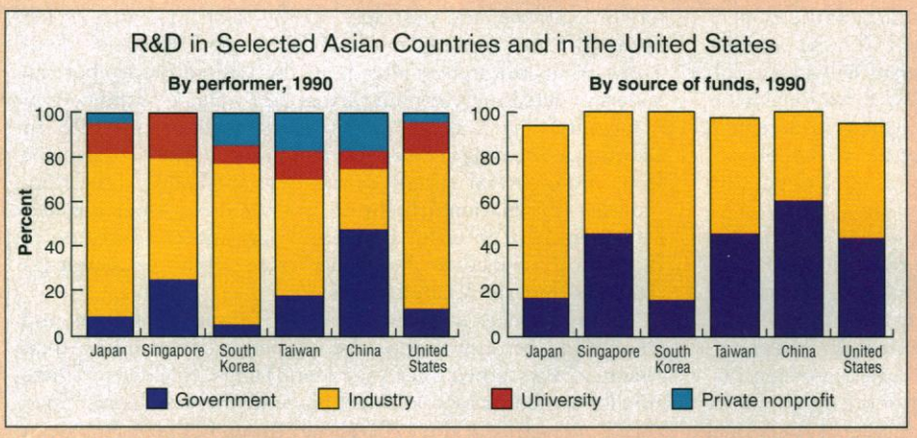
For all these promising developments, however, the road ahead is strewn with obstacles. They range from a lack of critical mass and rigorous peer review to the constant pressure for short-term gains from research.

Industry, which accounts for the lion's share of growth in R&D spending, supports little basic research. There are a few exceptions, such as South Korea's Hanil, a textile firm that has founded a research institute for basic biology and chemistry. Singapore's IMCB is attracting millions of dollars from a variety of multinational drug companies. But major Asian conglomerates such as Korea's Samsung and Daewoo are focused on near-term product development.

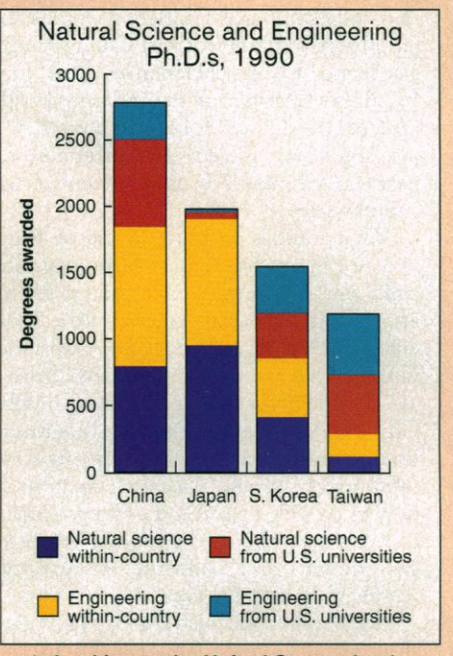
In Taiwan, companies are too small to sustain any serious research. There are a whopping 5000 personal computer makers on the island, but even the largest, Acer, employs only about 1000 people. "Subordinates leave all the time to start their own companies," says Lance Wu, deputy director of the Computer and Communications Research Laboratories at Taiwan's Industrial Technology Research Institute (ITRI). Wu blames poor management and a lack of team spirit and warns that the consequences could be dire. "If we cannot create enough large companies in the next few years, the majority of our manufacturing will go to China."

Government-run labs like ITRI and South Korea's Electronics and Telecommunications Research Institute (ETRI) are meant to supply R&D for technologies deemed too risky for companies, such as advanced semiconductors. But even at these labs, modeled on AT&T Bell Labs (and staffed by many former Bell employees), the emphasis is on quick paybacks. Much of ETRI's $150 million annual budget is devoted to developing a prototype mobile telephone, with only 3% going to more basic areas such as nanotechnology, neural networks, and femtosecond

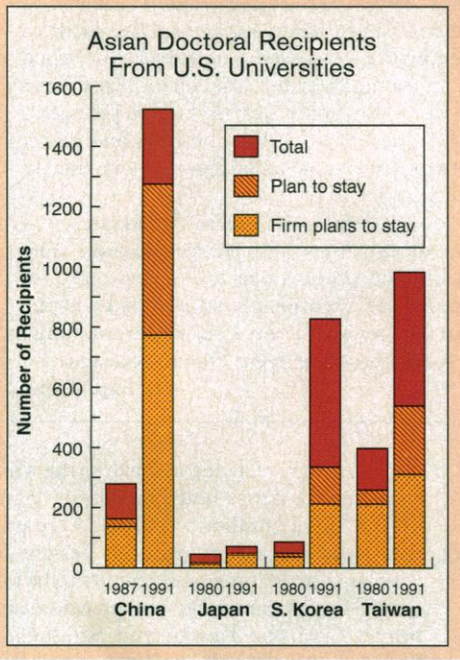
Datapoints: Money and Manpower

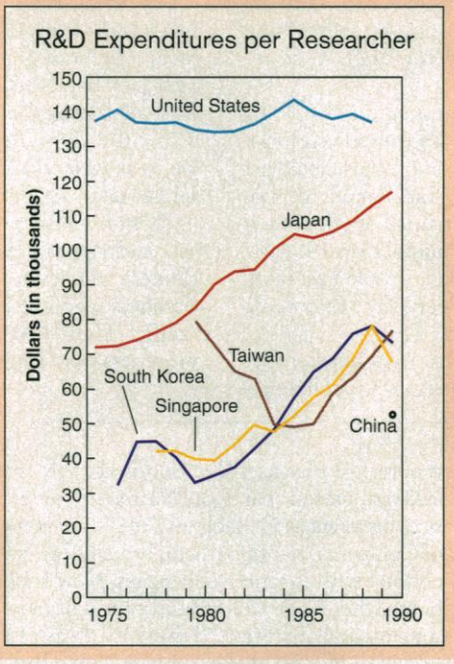


Who pays, who plays. Asian countries show wide variation in patterns of support for, and performance of, R&D among public and private sectors.



Looking to the United States. A substantial fraction of the science and engineering Ph.D.s earned by citizens of China, South Korea, and Taiwan are awarded by U.S. universities.





Catching up. The amount spent on R&D per researcher in South Korea, Taiwan, and Singapore is about half that in the United States, but the gap is narrowing.

Slowing the brain drain. Although more Asian students are getting their Ph.D.s from U.S. universities, a declining fraction of South Koreans and Taiwanese plan to stay on in the United States. Only about one in five Chinese Ph.D. students plans to return to China, however.

SOURCE: *HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY: THE ASIAN REGION*, U.S. NATIONAL SCIENCE FOUNDATION, 1993.

lasers. ITRI's research on big-screen liquid crystal displays is considered too "blue sky" and has been cut back sharply

Because economic pressure makes it so difficult for industry or government labs to undertake long-range economically oriented research, increasingly these Asian nations look toward universities to perform cutting-edge research. But this will require major adjustments in academic policy and funding and peer-review systems. The primary mission of most universities is to educate undergraduates, not conduct research, so professors are not well equipped to train Ph.D.s. Although the number of domestic Ph.D.s has climbed steadily over the past decade, many students—from 46% in China and South Korea, to 81% in Taiwan—still go to the United States for their doctorates. Postdoctoral positions are virtually unknown at all but a handful of elite institutions.

One change that many scientists would like to see is larger awards made after more stringent peer review. Right now, researcher-initiated grants tend to be small and are given out liberally—approval rates range from around 30% in South Korea and China to 80% in Taiwan. That approach may have made sense 10 years ago, scientists say, but world-class research requires higher standards.

But the size of the scientific community confounds such reform. "Peer review is difficult because Taiwan is very small," says Cheng-Wen Wu, a former State University of New York, Stony Brook, cancer researcher who now directs the Institute of Biomedical Science (IBMS) in Taiwan. "First you need to find an expert, and when you do, he's either a collaborator or a competitor." Scientists in Korea and even in giant China echo his feelings. According to Zhang Cunhao, director of the Natural Science Foundation of China, "We have more than 20,000 reviewers, but in a narrow field we cannot find the right person to review."

One solution is outside reviewers. Wu has enlisted 45 U.S. scientists to help in a new program of "outstanding investigator grants" funded by Taiwan's recently established National Health Research Institutes (NHRI), which Wu also directs. "Fifteen to 20% are funded," says Wu. "We think this is a most important development." Indeed, one of the hallmarks of the outstanding new Asian in-

The China-America Connection

To understand why Chinese are prone to cancer of the esophagus, Rutgers pharmacologist Chung Yang and Chinese pathologist Wang Li-Dong of Henan Medical University will do research in China's Hunan Province sponsored by the U.S. National Institutes of Health. But the collaborators view this effort as more than just a research project: It's an opportunity to strengthen ties between Chinese-American scientists and their Pacific Rim counterparts.

Yang intends to bring Wang to Rutgers later this year to update him on biomedical techniques and to produce what he calls "a more 'international' Chinese scientist." Yang foresees the effort as a model arrangement for the Society of Chinese Bioscientists in America (SCBA), an organization he leads that's committed to advancing the careers of Chinese-American scientists.

The society is one of a growing number of organizations for Chinese-American scientists and engineers that serve as informal links to researchers in Asia. These networks, which include organizations of Chinese-American chemists and physicists, help not only to provide opportunities for scientists from Asian countries to work and train in the United States but also to assist Asian governments and companies in recruiting top-flight U.S. researchers for jobs in Asia.

SCBA was conceived in a San Francisco restaurant in 1983 by three senior Chinese-American scientists—Yale pharmacologist Yung-Chi Cheng, University of Minnesota pharmacologist Horace Loh, and University of California, San Francisco, molecular parasitologist C.C. Wang. It has remained apolitical—it took no position on the Tiananmen Square massacre in 1989, for example—and has grown from 200 members in 1985 to more than 1500 in 1993. Yang insists the SCBA "can play a major role in improving biological science in the Pacific Rim."

The society's key role is as an employment matchmaker. Senior SCBA members trawl the society's meetings for collaborators or postdocs, and post-docs do the same in search of job openings. Until recently, much of this networking occurred between Asian researchers already in the United States, but the society is increasingly reaching across the Pacific. One indication: It met in Hong Kong in 1990 and in Singapore in 1992. In addition, its meeting in Baltimore last June was attended by talent scouts from several Asian organizations, including three from Taiwan—the National Institute of Preventive Medicine, the Development Center for Biotechnology, and the Institute of Biomedical Sciences at Academia Sinica—trying to recruit researchers from the United States.

"Many trainees are going home to Taiwan, Singapore, and Hong Kong because they're offering better opportunities than America," says former SCBA president Yung-Chi Cheng. "There are a lot of positions abroad," adds Harvard physical chemist Shao Huang, president of the 1000-person strong Chinese-American Chemical Society, whose members are prime candidates for many of those slots.

As the SCBA looks toward Asia, it also is helping members develop their professional skills. Foremost among the society's goals is to "start changing the stereotype that orientals are good with their hands but can't communicate," says cell biologist Savio Woo of Baylor College of Medicine, a past SCBA president. While the chatter of Chinese dialects fills the halls and poster rooms at society meetings, the official language—the one used to deliver talks—is English.

By honing the professional skills of Chinese-American scientists and tapping into the existing wealth in Asia to train more Chinese scientists, Yang and others hope to develop more researchers who can contribute scientifically on both sides of the Pacific. Their first step is to instill the kind of international awareness that Yang sees blossoming in his Hunan colleague.

–Richard Stone

stitutes is an insistence on international reviews. They also use English in everyday scientific discourse. But it is not clear if other, less prestigious institutions will follow their example. "Local scientists really prefer their isolated, easy life than to open up and compete internationally," complains a prominent Taiwanese returnee.

Regional collaboration

Cooperation is another way to overcome isolation and strengthen Asian science. But most Asian researchers would still rather collaborate with the West than with fellow Tigers or even with Japan. "I don't think Asian countries can provide as much up-to-date information," says one Korean immunologist.

Once again, the impetus for change is coming from returnees. Last summer, scientists from Taiwan's IBMS and Singapore's IMCB—mostly returnees—went on a 3-day retreat at a hot springs resort in the mountains south of Taipei. "We're calling it Hot Spring Harbor," jokes IMCB's director Y.H. Tan, who hopes the retreat becomes an annual tradition under the auspices of the new Asia Pacific Society of Bioscientists. For theoretical physicist Rey Soo-Jong, now an assistant professor at Seoul National University, his years at Caltech and the University of California, Santa Barbara, brought him in contact with Japanese colleagues. Now back home, they hope their friendships will blossom into collaboration. "I think it's a waste of resources not to make contact," says Rey. "Some Japanese may say, what can they learn by exchanges with Korea? But if you're a good physicist, you realize any time you exchange ideas with someone, you get twice as many new ideas. You can always learn another dimension of problem solving."

Economic forces are also beginning to forge regional collaborations. No single Asian nation has enough money, talent, and know-how to develop science and technology across the board, but some are beginning to form strategic alliances that enable them to complement one another.

The electrical engineering lab at Fudan University in Shanghai, one of China's top science and engineering universities, may be a harbinger of the future. Housed in a modern six-story building donated by a Hong Kong movie mogul, the lab is furnished in universal high-tech decor, down to the white laminated desktops and flannel-gray partitions. Using $2 million worth of CAD equipment, the researchers turn out designs for very large-scale integrated circuits to be fabricated by companies like United Microelectronics Corp. in Taiwan and Samsung in Korea. Across the hall, the computer science department runs a joint project with the European Community to test computer hardware and network software against international standards. In both cases, the foreign partners provide costly equipment, and the Chinese furnish brainpower at salaries of less than $100 a month.

Not far away, at Shanghai's Institute of Organic Chemistry, Wang Lai-Xi is synthesizing potential anticancer molecules for Singapore's IMCB. IMCB's Tan dreams of teaming up with multinational drug companies to test and market new drugs among China's 1.2 billion people. For Tan, the future lies in Asia. Says he: "I used to think, Singapore is too far from United States and Europe. Now I think the United States and Europe are too far from China."

–June Kinoshita