"Also we can't use it to transfer data files." Another impediment is the narrow bandwidth of the existing network backbones and international links. At IHEP, users can do almost everything except read Usenet news—not because of censorship, says Hao, but because "that would put too much load on the 64-Kbps link."

Some policy-makers blame the problem on the inefficient use of resources. "We have too many networks," complains a senior official. "One would be enough. The problem is to raise the capacity. If the speed is slow, what is the good of having all these networks?"

But the case of the National Computing and Networking Facility of China suggests that competition can also lead to progress. The CAS narrowly outbid Qinghua University for the project, an $8.4 million, World Bank–supported effort to finance China's portion of the global Internet. Poor management, according to a former employee, has stalled the purchase of a supercomputer needed to do the job, and its national backbone now exists only as a triangle in northwestern Beijing that links CASnet and Beijing and Qinghua universities. But with competitors such as CERNET and ChinaNet racing to complete their nationwide backbones, CASnet is now rushing to extend links to other cities as well. "Before, CASnet had no intention to connect anybody," says the former employee. "Competition has surely changed them."

The Internet craze is also causing people to make end runs around rules restricting global connections to a few national agencies and "landing points" to Beijing and Shanghai (with Guangzhou under consideration). Several regional networks have already sprouted, using leased telephone lines.

With Internet access becoming a part of everyday life for scientists, any attempts to limit access seem doomed to fail. "The official story is that the government wants control," says Chin-Tu Chen, a medical physicist at the University of Chicago who swaps data with colleagues in Beijing. "But technology-wise, that's no longer easy. Everyone I know can use the Internet freely."

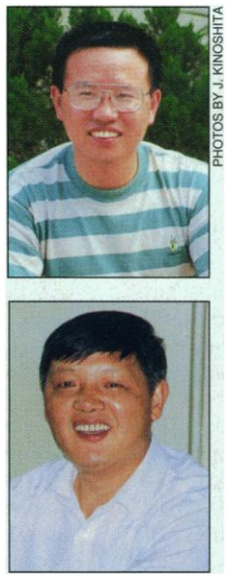
–June Kinoshita

YOUNG SCIENTISTS

Incentives Help Researchers Resist Lure of Commerce

BEIJING—Perhaps it's no accident that the emerald-colored mirrored glass that sheaths the soaring office tower in the south China economic boom town of Shenzhen shines like a precious jewel. It's the most prominent feature in the region, which embodies the get-rich-quick philosophy that has drawn thousands of scientists unwilling to pursue a long, arduous, and financially unrewarding path to glory. "I wanted him to go to America to study, but he says that doing research is too hard," recalls Qian Yitai, a chemistry professor at the University of Science and Technology of China (USTC) in Hefei, about one promising student. "Now he manages a McDonald's restaurant in Shenzhen, and he's made enough money to go to America three times as a tourist."

But for every tale of talent lost to mammon, there's a countervailing story of a promising researcher returning home. This past July, for example, nearly 1000 young Chinese scientists—many from elite institutions in the West—gathered at Qinghua University in Beijing. For 4 days they networked, discussed their research, and explored the exciting opportunities offered by the fast-evolving world of science in China.



PHOTOS BY J. KINOSHITA

Rising stars. Chemist Zhao Xinsheng, *(top)* and paleontologist Sun Weiguo are on the fast track.

These changes are pressing on a generation of Chinese scientists in their 30s and early 40s. In every discipline, economic forces are separating wheat from chaff, directing talents to where the money is. Top students flock to computer science, which feeds China's sizzling software industry, while funding for basic research is restricted to the most gifted and enterprising scientists. It's a sharp break with the past, when the state parceled out tiny amounts to everyone. But it feels right to Zhang Cunhao, president of the National Natural Science Foundation of China (NSFC). "The market economy is really working," he declares with a broad smile.

One of the most important forces for change is a demographic shift in Chinese science. There's a yawning void in the ranks of middle-aged scientists left by the Cultural Revolution, which disrupted most learning from 1966 to 1976. And the looming retirement of thousands of senior scientists as they reach the age of 60 is expected to clear the way for younger scientists. For example, an informal survey of institutes belonging to the Chinese Academy of Sciences (CAS), in fields ranging from paleontology to plasma physics, found that 50% to 90% of senior professors will retire by the year 2000. Although only half as many young people will be hired to replace retirees (in order to shrink the overall size of institutes), they will enjoy a larger share of research funds.

The nagging question is whether younger scientists, many of whom now work in the West, will throng to the newly available jobs. The answer varies. China's top institutions, for example, still seem to have their pick of talent. "Last year, we had 74 graduates who went abroad and 48 who came back," says Yang Fujia, a physicist and president of Fudan University in Shanghai, one of China's leading universities. "My first Ph.D. student says Fudan gives him better opportunities than any other place." At the Beijing Electron-Positron Collider, one third of the 40 postdocs are returnees who found the climate for particle physics better in China than overseas.

Location is another important factor. Just being in an out-of-the-way place can be enough to tip the scales against a top-flight institution. "In the past 2 years we have lost eight professors in a 25-person department," says mathematician Feng Keqin, vice president for research at the USTC, about 400 kilometers west of Shanghai. "They want to go to the big cities."

And jobs go begging in fields such as the life sciences, where China still lags. "Work conditions and living conditions are not attractive," says Mang Keqiang of the CAS Institute of Microbiology in Beijing. "Only 2% of my students have come back [from abroad]. It will take us 10 to 20 years to get a critical mass." Virtually every other director of a life sciences institute interviewed by *Science* echoed Mang's lament.

Prospects look particularly bleak for those just starting their careers. Li Guoxiang, a doctoral candidate at the CAS Institute of Geology and Paleontology in Nanjing, tells a typical story. "I entered university in 1984, at a time when there was little difference in salary from job to job," he says. "But when I graduated, I found I had made a big mistake!" Wages in China's growing commercial sector were rising fast, while academic salaries remained frozen. While Li ekes out a living on $30 to $40 a month, a 21-year-old taxi driver flagged down by the front gate of the institute says her monthly take is $750.

A talent bounty. Government officials are concerned about the plight of budding scientists, but their ability to correct the situation is extremely limited. Two years ago,

the NSFC eased its regulations so that 20% of a researcher's grant money can now pay salary bonuses and stipends. "Our graduate students get 180 yuan [$23] a month, and we give them an additional 50 yuan out of our grant," says Zhao Xinsheng, dean of Beijing University's College of Chemistry. "So we are able to pay them barely enough to live on."

To make science more attractive to young people, policy-makers are taking a lesson from market economics and offering incentives. The NSFC helped lead the way with its Distinguished Scholar Award, established in 1992 and now funded by the State Council. Each winner receives a $75,000, 3-year grant. "It's modeled on the [former] presidential young investigator award in the U.S.," explains the NSFC's Zhang. Eighty-five of the awards were handed out this year.

Sun Weiguo, 44, of the CAS Institute of Geology and Paleontology in Nanjing, got the award in 1993 and 1994 for his outstanding research on Precambrian fossils and the early evolution of animal life. "I think this policy [of giving awards] will encourage young scientists to work hard," says Sun, a burly, intense man who totes his laptop computer everywhere.

Last year, the CAS launched an even more lucrative grants program. Entitled "100 Outstanding Project Leaders," the program awards $125,000 for research costs plus a similar amount for equipment to CAS scientists age 40 and under. Candidates "have to have good management skills as well as scientific skills," says Zheng Zhipeng, director of the CAS's Institute of High-Energy Physics. There were 14 recipients this year, including three who have returned from overseas assignments.

Wang Enge, a 38-year-old recipient who had been working in semiconductor theory at the University of Houston, joined the Institute of Physics after winning the award. "It's not easy to get a suitable grant anywhere in the world," he notes. "I am glad to have such a good opportunity."

But few scientists believe that such prizes will reverse the brain drain from science. "Specialized policies cannot do much to bring young people back," declares Feng Duan, one of China's most respected physicists and a professor at Nanjing University. "We need an improvement in the economic situation. Some of our students have gone to Shenzhen. Even though the job is not connected with research, the pay is much better."

Swift upward mobility. Besides being a reward to young scientists, prizes like the CAS outstanding leaders grant also serve to propel them into leadership roles. "People are taking seriously the idea of ceding authority to younger scientists," says Stewart McIntyre, a physicist at the University of Western Ontario, who has reviewed many Chinese labs for the World Bank. Beijing University's Zhao, for example, was named dean this year at the age of 37. Zhao earned his Ph.D. in molecular reaction dynamics at the University of California, Berkeley, under Nobelist Yuan Lee, and since his return to China in 1991 he's won several large grants, including the Distinguished Scholar Award.

Zhao is still adjusting to his new responsibilities. His days are now spent worrying about providing housing for 250 staff members, finding investors for the college's various faltering companies, and setting up new departments. "I'm still becoming familiar with my job," he says. "But I hope I can get back to research soon."

One of Zhao's biggest supporters, university vice president Chen Zhangliang, also enjoyed a meteoric ascent after he arrived at Beijing University in 1987 with a Ph.D. in plant biology from Washington University in St. Louis. Five years later, at the age of 32, he was made dean of the College of Life Science, and this year he became a vice president.

Such stories of quick advancement, however, do not mean that life is smooth sailing for everyone who comes home. "For young scientists returning from overseas, it's a shock," says Xu Zhihong, vice president of CAS and director of the State Key Laboratory of Plant Molecular Genetics in Shanghai. Xu was sufficiently concerned that he helped launch an experimental new lab called the Shanghai Research Center for Life Sciences and generally known as the Academy Center. "We hope the Academy Center will be a base for young scientists to ease back into the Chinese system," explains Xu.

The center is housed in the new building of the CAS Institute of Brain Research and comes with $1.5 million in advanced equipment and space for up to 10 principal investigators. Each will get $100,000 for additional equipment and $25,000 annually for research costs, roughly 10 times what the average NSFC grantee gets. Only people under age 45 can apply. And in an unusual step for a Chinese institution, where lifetime jobs are the norm, the center limits appointments to 4 years, renewable only once.

He Lin, a molecular geneticist at the U.K. Medical Research Council's Human Genetics Unit in Edinburgh, plans to move to the center early next year. "There's a lot of opportunity," he says. "The top people said they don't have a good idea of what to do, and they want me to contribute my ideas. It's an experiment."

Another experiment is a fellowship program, coordinated by Cornell University, that allows Chinese-born scientists now working in the United States the chance to spend 3 months a year, for 3 years, in a Chinese academic lab. The program, funded jointly by the Rockefeller Foundation and the Chinese government, enables fellows to establish ties with mainland scientists and test the waters for funding and employment opportunities while retaining their U.S. posts. So far, 35 scientists have participated in the program since its inception in 1992, including 18 this year, and two scientists from the first class of eight fellows have already taken jobs in China.

In the end, however, most scientists say the chance to make a difference, rather than incentives, is what motivates them to return home. Hao Xin, a vivacious 35-year-old with a physics Ph.D. from the Massachusetts Institute of Technology, returned in 1992 and saw an opportunity to make a mark in computer networks. She now works at the Computing Center of the Institute of High-Energy Physics in Beijing and is a consultant to other organizations. Cui Xiangqun, age 43, of the CAS Astronomical Instruments Research Center in Nanjing, gave up a comfortable life in Europe to help design a new optical telescope for a sky survey of unprecedented scope (see p. 1139). The change in living standard doesn't bother her. "I just need enough money for food," she says cheerfully.

Indeed, Cui's idealism and dedication are shared by many young scientists. "It's our task not to complain but to change our situation," declares Sun. "It may be bitter and painful for a while, but I think we should have a good future."

–June Kinoshita

CARROTS FOR YOUNG SCIENTISTS

Award	Sponsor	Amount*	Age	Number issued
Young Scientist Grant	NSFC	Y81,300	35	600/year
Distinguished Scholar	State Council	Y600,000	45	50–80/year
100 Outstanding Project Leaders	CAS	Y2 million	40	100 over 5 yrs.
Transcentury Award	Educ. Comm.	Y2 million	40	Not available

* Y8.3 = $1 SOURCE: CHINESE GOVERNMENT

PHOTOS BY J. KINOSHITA

Academic leaders. Deng Fuan *(left)* and Yang Fujia are on the lookout for young talent.