

my's Shanghai Institute of Technical Physics, is well aware of the difficulties of bringing ideas from the lab to the market. Like Chen, he sees a great need for Chinese scientists trained in Western management skills to return to help China to develop start-ups.

Tsinghua University has recently recruited Jing Cheng from Nanogen, a biochip venture in the United States, to head its new Biochip R&D Centre. Cheng's group will receive over US\$1 million research and development funds from the university, and Cheng is also setting up a biochip start-up company using offshore capital (see box opposite). This approach of seeking venture capital offshore has been adopted by entrepreneurial scientists elsewhere in the region, and it may become a widespread phenomenon as governments struggle to change the regulatory, financial and cultural environment that inhibits venture business.

For example, Sunyoung Kim at the Institute for Molecular Biology and Genetics of Seoul National University, who in late 1996 established ViroMed, South Korea's first venture business in gene therapy and diagnostics, has sought investment and strategic alliances in the United States and Europe because of the lack of long-term venture capital in Korea. And bioinformatics researchers at Singapore National University have set up a company called KRIS Technology in

Menlo, California, to market bioinformatic software products.

It will take time for government initiatives to stimulate venture businesses in the region, particularly in the larger economies of Japan, China and Korea. So, in the imme-

diated future, it is the actions of individuals, such as Cheng and Kim, and their links with venture funds, venture businesses, entrepreneurs and scientists in the West, that are likely to bear the most fruit. □

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Taiwan targets biotechnology

Although Taiwan has shown great success in establishing venture businesses in information technology, a push into biotechnology at Hsinchu science park that began in the early 1990s has been slower to develop. However, some new initiatives by the Taiwan government are expected to boost the growth of start-ups in the years ahead.

To date there are only 15 biotech companies in Taiwan's two science parks — Hsinchu near Taipei and Tainan in southern Taiwan — employing a total of fewer than 500 people. About five companies are formed each year, but this figure is expected to double soon, according to Jeff Wang, science adviser at the Ministry of Economic Affairs.

Venture capitalists in Taiwan have been reluctant to invest in biotechnology because of their desire for the quick returns seen in the information technology sector. So, as in Singapore, the Taiwan government has created a large fund of US\$600 million to

promote biotech start-ups over the next five years, and is taking measures to create the necessary infrastructure, including clinical trials, training, and venture funds.

The government is also making substantial investments in research, which are expected to help cultivate start-ups. Some NT\$1,663 million (US\$51 million) are being invested in agrobiotechnology research between 1998 and 2004, while medical genetics will receive NT\$875 million over the same period. Pharmaceuticals and biotechnology research will be given NT\$2,920 million in 1999–2004.

Wang says there are many Taiwanese bioscientists in the West willing to return to Taiwan if and when the environment is right. These programmes, due to employ 430 principal investigators, 630 postdoctoral research fellows and hundreds of PhD students and part-time staff, may mean that now is the time. **D.S.**

End of the brain drain could be in sight

Potter Wickware

Does scientific and engineering talent flow as freely as capital between the world's regions of economic activity and opportunity? Many countries, whether developing ones like Taiwan and Malaysia, or industrialized countries like Germany and Canada, base their economic development policies on the idea that it does, or at least that it could. Hence they channel state resources to start-up companies and offer inducements to scientists and engineers to staff them, particularly their own expatriates who are working in technology ventures in the United States and other developed countries.

These countries look to the high-tech centres of the United States, such as Silicon Valley in northern California and the Route 128 corridor near Boston, as models for the development of their own high-value, knowledge-based industries. The aim is to reduce their dependence on manufacturing, commodity exports, and other more traditional activities.

Indeed, when William Hewlett and David Packard scraped together \$538 in 1938 to start their electronics venture in a garage in Palo Alto, the Santa Clara Valley (as Silicon

Valley was called then) employed mostly farm workers and was famous for its plums and cherries. Last year Hewlett-Packard had nearly 125,000 employees worldwide and reported revenues of \$47 billion.

But is the Silicon Valley model readily transferable to other countries, particularly ones that have thinner traditions of entrepreneurship, or those governed by centralized regimes which have emphasized state planning over individual initiative? Foreign-born scientists and engineers who work in Silicon Valley seem to share the view that an earlier pattern from the nineteenth and early twentieth century still prevails to some extent. That is, move to the United States, become assimilated, and don't look back.

Globe-trotting entrepreneurs

Dinesh Patel exemplifies today's globe-trotting entrepreneurial scientist, who has identified and taken advantage of resources and opportunities as he found them. Born in Zambia, he studied in India, then came to the United States in the 1970s, receiving a PhD in pharmacology at the University of Michigan. In 1985 he co-founded TheraTech, in Salt Lake City, a drug-delivery company which earlier this year



Patel: Silicon Valley lures people back.

was sold to Watson Pharmaceuticals in California for \$350 million. Reflecting on the efforts of countries such as Singapore and Japan to produce technology industries like the one he started, by means of state-supported science parks such as Taiwan's Hsinchu centre (see box above), Patel says he is in general not optimistic about their chances. "If they can, the people who go to them tend to come back to the United States. One of the reasons is that, wherever you are, you need the right connections to make things happen, and someone who begins a career in the United States, in Silicon Valley, say, learns a culture and a management style that may not work in the new locale."

Shuo Vincent Liu echoes the idea that for many the trip to Silicon Valley is a one-way voyage. Liu is a software developer at the bioinformatics company Incyte Pharmaceuticals in Palo Alto, California, who graduated from Beijing University, then studied molec-

ular biology at the University of California at Los Angeles, and biomedical research at the University of Southern California, before going to work in the National Center for



Liu: a return to China would not be easy.

Genome Resources, and private industry. Would he return to China to work in a technology venture? "I'd want to look at it very closely, because it takes lots of resources to mount a start-up company. I'd want to look at which ministry is backing the venture, its budget, how they state their goals, who the people are. Bioinformatics borders on pure research and, since China doesn't have a pharmaceutical industry to speak of, it would be hard for China to support a start-up in my field. Of course the situation is somewhat different in computers and electronics."

Quality-of-life issues are also important factors in the desire of foreign-born workers to stay put. Suni Errabali, chief of Frontier Technology, which does information technology consulting for bioscience companies in Silicon Valley, says: "I might consider moving back to India, my country of origin, but nowhere else. But even this would be a challenge for my children in terms of schooling, and employment and social interaction for my spouse. Most places in the world are not as tolerant to diversity as the San Francisco Bay area."



Huang: escaped from postdoc insecurity.

Scientists who choose to work in start-ups face both benefits and risks. Among the former, says L. Royal Huang, is the opportunity to get away from academic research. Huang got his PhD in biophysics from the Roswell Institute in Buffalo, New York, did postdocs at the University of California, San Francisco, and now works as a scientific programmer at Molecular Applications Group, a bioinformatics software company in Palo Alto. "While I would love to do good science in an academic environment, the postdoc process seems to take forever, and the soft-money financial structure that supports most labs also makes things difficult," he says.

Not that start-ups necessarily offer any more security than a university post. Such companies are too often saddled with inexperienced, vacillating managements and high turnover rates among staff. And, although there is no shortage of research

ideas in bioinformatics and biotechnology, young companies often cannot support them adequately with the journal subscriptions, libraries and computing power that a Squibb or Bell Labs can provide without a second's thought.

But Patrick Nicolas, a software developer at Agorics, an Internet security firm in Sunnyvale, California, says: "I have a very strong preference for working in start-ups." Nicolas came to Silicon Valley from France by way of the Middle East and southern California, and has worked in start-ups since 1987. He observes that "in a start-up one gets the opportunity to wear several hats, in my case software engineering and project management. In large organizations it's not easy for a developer to get direct interaction with the customer and get feedback, and sometimes recognition, for a job well done." He too says he plans to stay in the San Francisco Bay area rather than return to France.

Drawn to Silicon Valley

If anything, Silicon Valley is today more a magnet for foreign-born scientists and engineers than ever before. Anna Lee Saxenian, a professor at the University of California, Berkeley, who studies the sociology of Silicon Valley, reports that 27% of the 4,000 companies started there between 1991 and 1996 are headed by Chinese or Indian executives, compared to 13% in the 1980-85 period. Despite the Asia-related economic slowdown, the job market in Silicon Valley continues to be hot, and employers must compete vigorously to attract qualified talent.

Making it even more difficult for employers in Silicon Valley is the culture of 'musical companies', in which new employees move on to another company just as they become seasoned in the first one. And some of the best qualified employees plan to work for someone else only until they can assemble the resources to start their own companies. Employment prospects in the electronics industry are not as good at the moment as in Internet and drugs firms, but Molly Marr, a spokesperson for the Semiconductor Industry Association, in Menlo Park, California, says: "Silicon Valley is still a boom town and will continue to be a world centre for high-tech start-ups."

The continuing shortage in the United States of skilled technology workers, particularly programmers, which is said to be related to the US educational system, can be satisfied partly by shipping work overseas. Off-shore programming centres have sprung up around the world and, in contrast to Silicon Valley's lofty salaries, their programmers may earn as little as \$1,000 a month. Bangalore, in India, is perhaps the best known, but they also exist in St Petersburg, Beijing, Moscow, Thailand and Jakarta. Bill Lilly, who runs Neva Delta Consulting, in Jackson,

Mississippi, which mediates between code-hungry US technology companies and programmers in Russia, says: "It's a growing business. Small start-ups are looking for client-server architecture, database design, scripting for e-commerce. They're looking for expertise, but cost is also a big factor, so they want to ship work overseas if possible."

In most cases, though, core people must work at the company's site, and in the absence of home-grown talent skilled foreigners must make up the deficit. Last year both companies and foreign job-seekers obtained a boon in the form of an expanded H1B visa programme, which will allow an additional 142,500 skilled foreigners to enter the United States over the next three years. Many will probably apply for permanent residency, but their chances may be dim, depending on their country of origin, among other factors.

Liu says: "One thing foreigners ought to watch out for when they apply for permanent residency is the stability of the company that is sponsoring them. If the company fails, so does their application for residency. And it's not trivial to start the process over again. There's a time limit of six years for visa privileges while the process is under way, and the process itself may take three years or more."

Nicolas adds that, in his opinion, the old visa system instituted by former president Ronald Reagan worked well for years, but has now broken down. When H1B visa holders apply for permanent residency they must submit to the old green card system, where applications may far exceed quotas, especially for countries such as China and India.



Nicolas: predicts the end of the brain drain.

Depending on a great deal of future lobbying and voting in Congress, he forecasts that, starting perhaps five years from now, H1B applicants unsuccessful in their applications for permanent residency will be asked to leave.

"They'll be frustrated, but will go back and use what they have learned here to start businesses in their home countries. Their governments will be glad to receive them, and the US can't absorb all of them in any case. It'll be the end of the brain drain."

In this incongruous way, the US start-up culture, which initially drew away their best and brightest, may yet satisfy the aspirations of planners in Singapore, China and other countries to build their own Silicon Valleys. □

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