

industry any longer," says ERSO's director, David C. Hsing, "it's the end of the IC era in ERSO." In fact, Hsing's predecessor, C.C. Chang, the principal architect of the Submicron Project, left the project after 14 years with ERSO because he had lost faith in the organization's function.

"When we began," he says, "I felt we were doing something big and useful for our country and ourselves. But I could no longer convince myself that we were doing good." Now that he is vice president of chipmaker Winbond Electronics Corp., Chang hopes that government will broaden its support for IC projects outside ITRI.

Even ITRI chairman Morris Chang agrees: "I'm in favor of continuing research," he says, "but not under the sole sponsorship of government." For all their success, the combined sales of Taiwan's eight chipmakers are less than those of a single South Korean company, Samsung, and far less than those of U.S. firms like Intel, Motorola, and Texas Instruments. Chang envisions the next generation of IC process technology being developed through an R&D consortium similar to the U.S.'s Sematech, managed by industry instead of ITRI. But Chang cautions that industry might not be able to pay its half of the \$50 million a year that he estimates will be needed.

High-tech salesmanship. A more fundamental problem is that Taiwanese industry does not yet see the need to do cutting-edge R&D. The NSC's Synchrotron Radiation Research Center (SRRC) at Hsinchu has set aside several beams for the use of the IC industry, but so far, no company has signed up to take advantage of the \$110 million facility. "Industry is slow to catch up on the applications," says SRRC director Edward Yen. "But," he adds, "2 years ago they wouldn't have believed it was possible [to build the machine]." Instead, it has fallen to ITRI, perhaps as part of its effort to find a new niche, to collaborate with the SRRC on experiments in x-ray lithography and micro-machining. When the SRRC holds its grand opening this fall, scientists there will make a presentation to try to persuade local firms to get involved.

Materials scientist M.K. Wu also finds himself playing salesman as director of the Materials Science Center at National Tsing Hua University. Wu, known for his role in developing high-temperature superconductors, was enticed back from Columbia University after the government decided to invest in his area of research. Wu tried to interest local firms in various applications grow-

ing out of his lab. "They were skeptical," he says, so "I visited their factories, hoping to identify something we could work on together." So far, he's convinced a local electrical equipment maker to collaborate on a high-power circuit breaker using ceramic superconductor materials.

Returnees like Lance Wu and M.K. Wu have made enormous contributions to the island's industry and to science and technology in general. But returning to their native land often entails considerable sacrifice, especially for their families. The planners of Hsinchu had the foresight to build a bilingual school, but returnees elsewhere must contend with sending their non-Chinese-speaking children to public schools and subjecting them to "exam hell." Decades of neglect of roads, utilities, housing, and natural resources make for a "terrible living environment," complains

Lance Wu. "There's more opportunity here, but you have to suffer."

In 1991, the government launched its \$190 billion, 6-year National Development Plan to improve Taiwan's infrastructure, but many say it should have done this

long ago. "A lot of people are going back to the United States" because they can't take the poor living conditions, says Lance Wu. The loss of talent, worries C.C. Wang of the Academia Sinica's Institute of Molecular Biology, "could haunt Taiwan for a long time to come."

The massive cost of the National Development Plan is hitting research directly in the purse, however. The Academia Sinica's budget, for example, has ceased growing at its previous healthy rate. ITRI's budget, which had been growing at 20% to 25% a year, has also been frozen at 1992 levels.

While ITRI's critics say there is no longer a need for the lab to grow, Lance Wu thinks the freeze is disastrous. "It's too early for Taiwan to face this problem," he says. "Our R&D capability is still so low." In his view, R&D has become "a target" because "physical infrastructure is pork barrel," whereas there is no politically powerful constituency for science and technology.

The consensus among Taiwanese technocrats is that a new industrial policy for R&D is required. But there is no agreement on what the policy should look like. What is clear, however, is that the choices are more complicated than they were in 1976.

—Bob Johnstone

Bob Johnstone is a science and technology writer based in Tokyo. Additional reporting by June Kinoshita.

HONG KONG

Jockeying for Position in The World After 1997

HONG KONG—Hong Kong's new University of Science and Technology (HKUST) perches on a bluff near the border between Hong Kong and China. Its location is appropriate: The territory's government wants the new university to be a focal point for scientific collaboration with Chinese institutions when Hong Kong comes under Chinese rule in 1997. But that's not all. Until HKUST opened in 1991, Hong Kong wasn't even a bump on the technology landscape in this part of the world. But now the government hopes HKUST will drive regional development and keep the area's talent at home.

Vice-chancellor Chia-Wei Woo modestly acknowledges such lofty goals. But swiveling away from his office window overlooking the blue sweep of Port Shelter Bay, he insists that, despite the nickname favored by the media, "We are not the MIT [Massachusetts Institute of Technology] of Asia."

Not yet, anyway. Woo, a physicist and former president of San Francisco State University, is feeling the growing pains of bringing a major institution to life in a very short time. (The British governor of Hong Kong, Chris Patten, is officially chancellor of the university, but Woo runs its day-to-day operations.) Two years after HKUST opened, it is running at about 30% capacity. By 2000 it expects to have 888 faculty members, 7000 undergraduates, and 2496 postgraduate students, a growth rate that means recruiting 10 faculty members a month. "That's a killing pace," Woo says with a wry smile. "But what will make us a world-class institution is how we perform."

Planning for the university began in 1986 after the government decided to stop both exporting students—who lead the world on standardized science and math tests—and importing technology. Just as Hong Kong has established itself as a regional financial center, local leaders expect HKUST to help make it a regional research center as well. "Technology should be a part of Hong Kong life, just like commerce is," says Research Center director Jay-Chung Chen, formerly of the National Aeronautics and Space Administration's (NASA) Jet Propulsion Lab.

Bolstering its regional scientific aspirations, the university will become a downlink site and research center for data from a

NASA instrument to assess the ocean's color, part of a study of the global carbon cycle, to be launched next year on a commercial satellite. That's the largest of some two-dozen environmental projects involving HKUST and institutes in southern China, which will share the NASA data, all aimed at reducing the damage from South China's breakneck industrialization, says Thomas Stelson, pro-vice chancellor for research and development, who joined HKUST from the Georgia Institute of Technology.

Stelson and his colleagues hope that these will be the first of many research collaborations. China performs good basic research, Stelson says, but its universities, government, and industry do not work well together. In contrast, HKUST scientists are already working on wind-shear problems for Hong Kong's new airport and developing new communications technologies for Hong Kong Telecom. In addition, Hiroyuki Hiraoka, a physical chemist previously at IBM's Almaden Research Center, has just filed a patent for producing laser-generated diamond film from polymer sources. "If the new technology is adopted by local manufacturers," says Gareth Thomas, director of the Technology Transfer Center, "it could help to revitalize the declining tool industry in Hong Kong." The Chinese, says Stelson, "are more than a little interested in these developments."

So are people in Hong Kong, who have watched the university move in a few years from blueprints to buildings. As is typical of fast-paced Hong Kong, plans for the university had no sooner been announced before it was off to the races—literally. Two-thirds of the building costs will be paid from horse-racing proceeds under the guise of a grant from the Royal Hong Kong Jockey Club. The entire project was completed 3 years ahead of schedule—although the price, \$460 million, was almost twice the original estimate.

Its operating budget exceeds \$100 million, which translates into a healthy \$29,000 per student. Almost all of the future funding will come from the government (not the Jockey Club), except for 4% from tuition and 4% from external sources such as industry and government projects. Labs are designed by the professors who will be using them, and the equipment is state of the art. "It's exciting to build from the ground up," says Stelson.

That opportunity is part of the reason David J. Barber, director of the Materials Characterization and Preparation Center, is

here. Barber said he had drifted out of the lab and into administration at England's University of Essex but was looking for a chance to get back into teaching and research. After enthusiastically demonstrating a new computer-aided surface analysis system that probes materials at the molecular level, he says with a slight smile: "It's a lot like Christmas all the time." Min-min Chang, who designed a "library of the future" for Caltech linking every student to extensive electronic databases, shares that sentiment. Chang's idea impressed Caltech, says Stelson, "but they didn't build it. We did." Now Chang is at HKUST running her creation.



Bridge to China. The Hong Kong government is hoping that the new University of Science and Technology will form scientific links to the mainland.

The university has openly recruited top researchers and scholars from institutions around the world, including a few who left Asia many years ago. "After the brain drain, we've started a reverse brain trickle," Woo says. "We've stolen quite a few established professors from major universities."

California schools were a favorite fishing ground—Woo and his cohorts raided 16 professors from the University of California, Los Angeles, and 18 from Berkeley. And they didn't stop at universities, plucking one of their top people from IBM's Watson Research Lab. "We went after Leroy Chang for 4 years," says Woo, of the award-winning semiconductor physicist.

There are, as expected, the usual growing

pains of a fledgling institution. Professors and students grumble about having to move their labs to keep pace with construction. Some feel isolated by HKUST's location in Hong Kong's hinterlands and crave more contact with colleagues overseas. A few say they had hoped for higher quality students.

But the freedom to do research, a handsome salary (from \$87,900 for professors), and a paid sabbatical has proved to be a winning combination. Most professors take a leave of absence from their home institutions, a few arrive with graduate students in tow, and almost all have decided to stay.

Professors at HKUST may receive tenure after 3 years, but only after a three-tier review by committees from the department, college, and university. Salary increases are dependent upon an academic review every 3 years.

HKUST seems to offer a special attraction to ethnic Chinese from the United States, China, Taiwan, or Hong Kong, who make up almost 80% of the staff. "There are some who have come to Hong Kong with grander things in mind—such as how they can contribute to the old country," says Woo. Adds Leroy Chang, originally from Taiwan, "I've been talking about coming back to this area for 10 years."

By the time Hong Kong reverts to Chinese sovereignty in 1997, HKUST hopes to be well positioned to work more closely with mainland research enterprises and industry. But the political transition is also fraught with uncertainties. Vice Chancellor Woo, who has been appointed by Beijing as an adviser on the transition to Chinese rule, waves away concerns, however. "There will be no changes after 1997," Woo says. "The Basic Law has stated very clearly that education will not be

touched," he says, referring to the mini-constitution that defines China's rule of the territory after 1997.

Woo admits that the bloody crackdown on pro-democracy demonstrators in 1989 repelled some potential recruits. But he says that the question, What about 1997? "isn't asked very much anymore."

However, Woo hesitates slightly when he's asked whether China's backing for HKUST is guaranteed. "You can't be confident about such things," he says. "But considering the need for universities in southern China, how can China not back us?"

—Maggie Farley

Maggie Farley is a journalist based in Hong Kong.