Taiwan Charts Science and Technology Policy into the Next Millennium

The recent cabinet reshuffle in Taiwan is likely to be a boon for science: The newly appointed vice premier is Chao-Shiuan Liu, chairman of the National Science Council (NSC), Taiwan's main agency for funding research and setting science policy. While at the NSC, Liu became known as an effective advocate for science. Among other things, he is credited with pushing through a 15% rise in basic research funding. He was also the chief architect of Taiwan's first-ever "White Paper on Science and Technology," released by the NSC last July, which carries strong recommendations for substantially boosting R&D funding, fortifying Taiwan's research infrastructure, building up international collaborations and expanding the island's pool of researchers.

In his new post, Liu, a PhD chemist, now oversees science and education policy, and is therefore in an even better position to make good on those recommendations. Already, the Taiwanese legislature is preparing to enact one of the report's main proposals, a Basic Science and Technology Law that would formalize the government's role in developing science and technology. And in the budget for fiscal year 1998, which begins in July, basic research is once again slated for a healthy funding boost.

The science community got an added bit of good news on 4 February, when it was announced that Liu's successor at the NSC will be Jeng-Tai Hwang, former president of Feng Chia University. Hwang, also a chemist and a close friend of Liu's, is expected to back the policies set down in the white paper, says Huan-Chiu Ku, head of the NSC's natural sciences and math division (and a physicist at National Tsing Hua University in Hsinchu). "So it looks like we will have a good year ahead," Ku says. "We feel very optimistic."

The science community in Taiwan has welcomed the government's recent R&D initiatives, including a 15% increase in basic research funding this fiscal year.

'A far-seeing blueprint'

As stated in its opening paragraphs, the white paper is intended as "a far-seeing blueprint for the nation's scientific and technological development well into the next century." The key to Taiwan's future, the report declares, will be the development of science and technology, "to drive the nation's modernization and raise [its] international competitiveness."

Most important, for the scientific community at least, the white paper recommends a hefty rise in total R&D spending, to 2.5% of GDP by the year 2000 ("roughly the level found in most developed nations," the report notes) and 3.0% by 2010, with 40% of the total coming from the public sector and the remainder from the private sector. In addition, "no less than 15%" of the total would be funneled into basic research. For comparison, in 1995 (the most recent year for which data are available), Taiwan spent NT$17.83 billion (about US$600 million) on basic research. While the white paper avoids setting absolute dollar goals, such a scheme could lift basic research outlays to well over US$1 billion a year by 2010.

Basic research is likely to get a "moderate" boost of 10% this coming year, on top of the 15% increase in FY1997, says the NSC's Ku. But that followed two years of flat government funding, and in years past, government spending has even shrunk. Such large fluctuations have been frustrating for the research community, Ku says. One of the white paper's objectives, therefore, is to ensure "a steady and reasonable rate of growth" in funding. The NSC, Taiwan's chief source of support for individual researchers, is also looking to make the grant process more competitive, moving away from the "blanket approach" of distributing grants across the board, to one that selects "special-topic research projects hosted by outstanding senior researchers and promising newcomers."

The report details Taiwan's current R&D activities, especially in terms of how they measure up to other countries'. "[Taiwan's] total R&D outlay of US$4.6 billion [in 1995] was only about one-half of South Korea's and 60% of Sweden's and the Netherlands'," the white paper states. "Both in absolute and relative terms, [Taiwan's] total R&D spending must be considered as still quite low." Even so, by almost any measure—number of researchers, papers published, patents grant-

TAIWAN'S NEW VICE PREMIER, Chao-Shiuan Liu, engineered the country's first "White Paper on Science and Technology," which recommends substantial increases in R&D funding. A PhD chemist and the former head of the National Science Council, Liu now oversees Taiwan's science and education policy. (Courtesy of the Taipei Economic and Cultural Representative Office in Washington, DC.)

ed—the science enterprise in Taiwan has grown significantly over the past decade. These and other improvements have been fed by, and have also contributed to, the return of many Taiwanese scientists and engineers living abroad, the report notes, and it calls for the researcher population there to grow still more: from the current 45 000 to 75 000 by 2010.

The white paper's recommendations echo many of those made in recent years by nearby Japan and South Korea, which sketched out grand plans for expanding their science and technology activities, only to scale back when confronted with harsh fiscal reality. Taiwan's chances of success may be better. While many of its neighbors have been pummeled by the financial turmoil of recent months, Taiwan has emerged relatively unscathed—perhaps the only Asian tiger to land squarely on its feet.

"Economically speaking, Taiwan is rock solid," says University of Georgia economist Knox Lovell, who has compared the economies of a dozen countries across the Asia–Pacific region. "They're less exposed than the Japanese, for example, to Korea and Thailand and Indonesia," he says. "And they have vast reserves of foreign currency"—over US$82 billion—"so they can defend their own currency. I think Taiwan can weather any storm in the region, except a collapse of the Chinese economy."

A stronger infrastructure

The changes envisioned in the white paper will be "very important for physics research," says Ku. "We'll be able to promote frontier research and also strengthen our research infrastructure," both domestically and as a participant in international projects. As one example, he points to current negotiations to set up three beamlines at Japan's 8 GeV synchrotron, SPring-8, which began operating last October. The hard x-ray studies planned for the Japanese facility would complement the soft x-ray and ultraviolet research now done at Taiwan's own four-year-old Synchrotron Radiation Research Center, a 1.5 GeV machine in Hsinchu.

The physics community has also welcomed the creation of two new basic research centers in Taiwan: the Center for Theoretical Science (CTS), based at National Tsing Hua University, and the Center for Ocean Research (CORE), located at National Taiwan University in Taipei. As the white paper states, the hope is that the new centers will "encourage outstanding international [scientists] to come to Taiwan to lead research, and will entice promising young scholars and students to pursue basic research projects." The NSC is putting up the bulk of the funding, which amounts to a rather modest US$1 million for CTS and US$3 million for CORE, with additional support from the centers' academic hosts in the form of office space, laboratories and newly created faculty slots (eight for CTS, four for CORE).

The centers were set up in what may amount to record time. Planning got under way a little over a year ago, when the NSC invited universities to bid on hosting the centers and began soliciting advice and support from big-name researchers like C. N. Yang, T. D. Lee and S. T. Yau. Recruitment ads for staff scientists, visiting scientists and postdocs went out last spring, the sites were finalized in July, and by 1 August, both centers had opened for business. "Things started in a bit of a rush," admits Ting-Kuo Lee, who chairs the CTS executive committee; many of the staff positions are only now being filled. "On the other hand, the progress has been very smooth. We have already held several workshops and topical programs, and several more are coming up."

Modeled after Santa Barbara's Institute for Theoretical Physics, though decidedly smaller, CTS sponsors topical programs in math and physics that last from three to six months, as well as shorter workshops, all designed to draw in researchers from far and near. Two of the physics topical programs currently under way are looking at strongly correlated electronic systems and biophysics. This month, a program on "Perturbative Quantum Chromodynamics, B Physics and *CP* Violation" is starting up.

"One of the goals is to bring together experimentalists and theorists," explains Ting-Kuo Lee, and programs are being selected with an eye to those areas where Taiwan has a strong experimental base: synchrotron science, high-energy physics, high-temperature superconductors, semiconductor nanostructures, plasma physics. And so, for example, K. D. Lee, an experimenter at the Synchrotron Radiation Research Center, and Kwong T. Chung, a theorist from North Carolina State University, will jointly lead a topical program on "Synchrotron Radiation and Multiply Excited Atomic Systems," set to begin in July. Most participants will be Taiwan-based, says Chung, but a handful of US physicists have already signed up. "We will of course welcome everyone who has an interest in this subject to participate," he adds.

Ocean science

Like its theoretical science counterpart, CORE also offers occasional short courses, but its main function is to be a focal point for Taiwan's ocean research, coordinating domestic and international projects. The center maintains a national databank on the hydrology, currents, bathymetry and sediments of the seas surrounding Taiwan; later this year, it will add chemical and biological data from a soon-to-be-deployed time-series station off the southern coast. In addition, CORE has assumed responsibility for the island's oceanographic fleet; that includes the planning, and eventual construction, of a next-generation 3000-ton research vessel.

Taiwan's location between the East China and South China Seas, and also at the boundary of two tectonic plates, makes it both oceanographically and geologically interesting, says Min-Pen Chen, a professor at National Taiwan University who is serving as CORE's interim director. A number of international teams have studied the area in and around the island, he says. With the creation of CORE, Taiwan is now in a much better position to participate in those projects.

According to George T. F. Wong, an oceanographer at Old Dominion University in Virginia who heads the center's advisory committee, the hope is that CORE will be upgraded to a national lab within the next five years, and then possibly to a government agency, along the lines of the US's National Oceanographic and Atmospheric Administration. In the nearer term, possibly even this year, the NSC may expand the center's purview to include atmospheric research.

Wong guesses that in his specialty, chemical oceanography, there are maybe 15 researchers in Taiwan, and the total number of oceanographers is less than a hundred—not necessarily a disadvantage, he notes. "The size of the community is small, and so your skill is much more needed. In a sense, it gives you opportunities to do things that you can't do [in the US]." In the ten years that he has been collaborating with colleagues in Taiwan, Wong has seen marked improvements in the research environment, as well as in overall living standards.

Ting-Kuo Lee agrees. In 1996, he left his tenured professorship at Virginia Polytechnic Institute to join the Academia Sinica's Institute of Physics in Taipei. "The atmosphere for doing science is moving ahead," he says, "and I believe I can make some contribution. There's the potential to help young people in the field. I feel very welcome here."

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