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Reversing the Brain Drain

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International students come to the United States to study, and often they stay on after earning a Ph.D. This influx has always contributed to the strength of U.S. research, but it creates a problem—"brain drain"–that leaves a technical vacuum overseas, especially in developing countries.

That's a problem for U.S. researchers, because many of the scientific challenges of the 21st century are international in scope. Security, pollution, energy–just about any problem you can name has an important international component. But strong international collaborations require strong international partners. In an attempt to offset brain drain to the United States, some foreign governments are doing surprising things, like sponsoring research in the United States so that visiting scientists in those labs can observe, participate, and take what they learn back home. Some programs sponsored by U.S. organizations have similar aims.

HHMI's grants, for example, provide "an opportunity to do your work where you might not otherwise be able to get the funding you need," says Conley.

West meets East

Taiwan's Industrial Technology Research Institute (ITRI) has been involved in partnerships with the University of California, Berkeley since 2004 and with Carnegie Mellon University since 2003. The Berkeley program includes an unrestricted grant of $500,000 per year over 5 years to support about 15 graduate students and postdocs. The program at Carnegie Mellon pays the university $1.5 million per year through 2008 for research in visual computing technologies, micro-electro-mechanical systems (MEMS), and system-on-a-chip design and methodology. In 2006, Carnegie Mellon and Taiwan's government-sponsored International Collaboration for Advancing Security Technology inked a follow-up deal that will provide an additional $1 million for each of the next 3 years. Twenty Taiwanese researchers will visit Carnegie Mellon to work on a variety of security-related projects designed to improve both U.S. and Asian advanced security technologies.

The Berkeley deal focuses on nanotechnology and energy. Taiwan is interested in energy production because the island has no natural energy sources. What it does have is world-class semiconductor and electronics manufacturing facilities that could be leveraged with nanotechnology to make an impact on energy production. Berkeley faculty members compete for the Taiwan money, which encourages energy research. "Some people had already been working in the energy area. Others have started looking at that more keenly.

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[The funds] get them thinking about collaborations to get support for their students, and it gets them thinking about energy," says Arun Majumdar, a professor of mechanical engineering at Berkeley.

In return for the money, Berkeley agrees to host ITRI researchers, who take part in research and pick up expertise. "It's sort of like a sabbatical," says Majumdar, adding that Taiwan is interested in starting commercial enterprises eventually, with nanotechnology components developed or inspired by the work at Berkeley.

U.S. institutions are also interested in commercializing overseas. That's one reason that the Rochester Institute of Technology (RIT) in Rochester, New York, entered into an agreement with Korea's Institute of Industrial Technology (KITECH), which is focused on remanufacturing, in February of this year. Last year, Korea passed a law legalizing remanufacturing, but only if the reconditioned product passes a government assessment. The Koreans approached RIT to learn about its signature analysis technique, which predicts the operational life of individual components. KITECH is funding several collaborations, with 3-4 researchers from KITECH working at RIT at any given time, says Nabil Nasr, assistant provost and director of the Center for Integrated Manufacturing Studies at RIT.

If you build it, researchers will come

In some cases, it is U.S. researchers who are drawn to foreign soil. The Spanish government has ambitious plans to set up health agencies styled after the U.S. National Institutes of Health, complete with extramural funding programs. Spain is an ideal locale for genetic studies because modern Spain is the result of a merger of individual, historic cultures, "all characterized by [very little] migration from place to place. There are regions that are inbred, so you can do some very interesting genetic studies," says Valentín Fuster, who is director of Mt Sinai Heart at Mt. Sinai School of Medicine in New York, New York.

Each of the agencies will focus on a leading cause of death in Spain, including cardiovascular disease, cancer, and neurodegenerative diseases. The Fundación del Centro Nacional de Investigaciones Cardiovasculares (CNIC) was initially begun in 2002 but ran into financial problems. Earlier this year, Fuster was brought aboard to direct its scientific evaluation committee, where he is overseeing the hiring of investigators at the central institute in Madrid, which will ultimately house about 250 investigators within 2-3 years. Currently, the extramural fund is 25% of the total annual funding, while 75% is earmarked to build the infrastructure at the institute. In 5 years, with the institute established, Fuster expects those numbers to have reversed, with 75% of the funding going to extramural projects. Extramural funds will be available to researchers in Spain, as well as in Europe, Asia, and the United States. Fuster estimates that 5-10% of extramural funds will likely go to U.S. researchers.

One of Fuster's priorities is to discover and encourage the next generation of Spanish researchers. To that end, he is emphasizing a CNIC program that gives grants to high school students in Spain to study and perform research at the nascent institution. The program started with twelve grants this summer, with plans to host about 30 students a year. "This is the number one priority–discovering young people and giving them a great opportunity," Fuster says.

Not all foreign investments are governmental. In 2002, the Japanese company Tokyo Electron (TEL) in Tokyo, Japan, accepted an invitation by IBM to participate in a large collaborative project centered at the College of Nanoscale Science and Engineering at the State University of New York (SUNY) at Albany. TEL builds wafer-processing and semiconductor manufacturing equipment, and agreed to spend $300 million to set up a clean room and research center, featuring various semiconductor manufacturing and processing tools. Applied Materials, in Santa Clara, California, and ASML in Veldhoven, The Netherlands, also supplied equipment, but TEL's contribution was the largest. The huge investment was softened by matching funds from New YorkState, which provided another $300 million to TEL to finance its own research at the new facility.

That investment helped SUNY attract other semiconductor firms, and today, the facility now known as Sematech North boasts 12 companies, including 7 U.S. firms (IBM, Intel, Hewlett Packard, and Texas Instruments among them), three European companies, and two Asian companies.

Unlike other such arrangements, TEL's interest was not to gain technical expertise, although the company has collaborated with academic scientists at SUNY-Albany. TEL's

main goal was to establish a research center outside of Japan in order to work more directly with the chip manufacturers that are its customers, says Makoto Hirayama, senior vice president of Technology Center America in Albany, New York. "We are an equipment company, and we need various kinds of information, like [access to a customer's] process technology. We need a very high level of research and development facilities, and also we have to collaborate with our customers to apply that technology. In Albany, IBM is very close to us. IBM is a very technology-driven company, so we need to work with them." TEL has since begun to work with other companies that are part of the consortium.

For its part, SUNY has gained much from the arrangement, says Alain Kaloyeros, vice president and chief administrative officer of the College of Nanoscale Science and Engineering, who takes an unabashedly pragmatic view of the partnership. The large consortium brings together enough financial backing to build and operate the high-end facilities required by nanotech. "The cost of development is becoming so high that one single entity can't afford it," he says. The hub also brings together a technical blend that he hopes will maximize the cross-disciplinary potential of nanotechnology. "The challenge is the development of the technology, including new paradigms and new materials, and the way you build the chip. The brain power comes in from skill sets that [can't all come from] one company or one university."

The arrangement is particularly advantageous to the department's graduate students. Time on the wafer tools is split evenly between academic users and industry users, and students get a first-hand view of cutting-edge industrial research, which makes them attractive to employers. "They get involved early on, doing science in a realistic environment, as opposed to doing something in a lab and somehow trying to transfer it to real scientific problems in industry. They learn how industry researchers operate and think. They learn how the culture works in teams, how to innovate with specific metrics and deliverables. It benefits industry by having a fresh intellectual skill set that is being molded and trained to innovate. They don't have to train them how to do it after they finish their degree," says Kaloyeros.

That preparation has a clear payoff. "Of the 110 graduate students in the department, half are on fellowships and scholarships working part time on-site at a company, and many have job offers before they finish," says Kaloyeros.

Nonprofits

Other organizations are getting into the act. The Howard Hughes Medical Institute (HHMI) initiated its international program in 1991. The program's $11 million annual budget now supports 111 scholars in 28 countries, providing access to equipment and travel expenses for meetings. The program puts an emphasis on collaboration, says Jill Conley, the director of the international program. At a meeting in Australia in 2002, HHMI brought together 132 scientists, spawning 52 new collaborations.

But the program also seeks to bolster independence. "We try to find the best scientists and give them the resources in their own country. It not only builds infrastructure, but it creates a center of excellence," Conley says. Just as it does in its U.S. programs, HHMI encourages high-risk, high-reward research. The prestigious program also lends a stamp of approval. "HHMI recognition gives them an imprimatur. [It helps them] publish in better places," says Conley. In some places, HHMI's support is even more fundamental. "One group who visited labs in Russia said that you could tell which ones were funded by HHMI. They were the ones with the lights on," Conley says.

Other organizations are pursuing similar goals. The Civilian Research and Development Foundation's Grant Assistance Program has connected over 170 organizations to fund international research. Businesses, educational institutions, and government agencies have funded nearly 1000 projects totaling more than $150 million.

Such projects bolster foreign research expertise. Majumdar believes that Berkeley's collaboration with ITRI is changing the face of research in Taiwan. Taiwanese researchers, he says, "come here and see a different place, and get deeply involved in research that is not in their comfort zones. When they go back they start thinking along different lines. We already have evidence of that happening, of people changing their careers."

But foreign scientists are not the only beneficiaries. Such programs are also indirectly beneficial to young U.S. investigators who get cultural and scientific exposure. In an increasingly globalized economy, research and its products will inevitably find international application. Majumdar points out that Berkeley's exchange with ITRI is mutual, as Berkeley professors visit Taiwan to give seminars. "They get the opportunity to actually visit, which I

think down the line will be a very positive thing, to really know how the world works," says Majumdar.

Nasr agrees. "Our goal is to develop cleaner, sustainable technologies that help our industry survive. Many of our companies sell their products overseas. The exchange really allows you to understand the global dimension of what we do, how the product that you sell in other countries will be processed for recycling or disposal, and the regulations associated with that, and what needs to be done to successfully market products and deal with constraints in other countries. I think there is a need for a new breed of professionals who understand those needs, who can guide companies and organizations. There is a huge opportunity for people who have this background to be very valuable to organizations in the future."

All of these programs, whether initiated by a foreign government, a corporation, or a U.S.-based nonprofit organization, serve to strengthen the international ties that are increasingly important to both applied and fundamental research. Just as important, they give scientists better choices. HHMI's grants, for example, provide "an opportunity to do your work where you might not otherwise be able to get the funding you need," says Conley. "You don't need to come to the U.S. You can start exchanges for training and collaborations, but still be where your heart is."

Jim Kling writes from Bellingham, Washington.	Comments, suggestions? Please send your feedback to our editor.