



Global Research Universities

IT'S NOT A FLUKE THAT THE UNITED States is home to most of the leading research universities in the world. But it's also not a given.

Many countries have paid close attention to what it took for the United States to climb to the top of the global academic research ladder in the past half-century. Some have now translated those lessons into national strategies that they hope will lift them up the ladder. What will it take for them to reach the top rungs?

Over the next several months, *Science* will examine the key ingredients needed to create and maintain what we have labeled global research universities. Indeed, ranking these universities has become a cottage industry. Although there is little consensus on what metrics to use, most scientists carry around in their heads their own list of top schools, compiled on the basis of anecdotal evidence, reputation, and personal preferences.

The first story in the series explores the role of mobility by focusing on the increasing flow of talent into East Asia, in particular Hong Kong and Singapore. Subsequent stories will look at other important factors that shape an institution's ability to become a global research powerhouse.

More than bragging rights are at stake in this race to the top. A world-class university system is a powerful engine for economic development, and research is the fuel powering that engine.



Flocking to Asia For a Shot at Greatness

Academics from around the world are taking jobs in Hong Kong, Singapore, and elsewhere in East Asia, lured by generous budgets and a welcome sign for foreigners

HONG KONG AND SINGAPORE—Ambitious academics have always been a mobile lot. But Stephanie Wehner has taken mobility to a new level. And her career choices reflect a fundamental shift in where some of the best science is being done around the world.

The 35-year-old quantum information scientist completed her undergraduate degree in her native Germany, earned a master's degree from the University of Amsterdam and a Ph.D. from the Centrum Wiskunde & Informatica in Amsterdam, and did a postdoc at the California Institute of Technology (Caltech) in Pasadena. Then she asked herself: "Where would it be scientifically interesting for me to go?" The answer took her further west, across the international dateline, in fact, to the Centre for Quantum Technologies at the National University of Singapore (NUS).

The center, established in December 2007, is already recognized as one of the world's top institutes for quantum studies. "It is unique" in combining computer science and physics, theory, and experiments, says Wehner, who joined its ranks in July 2010. The institute's generous funding from the government—\$126 million over 10 years—means there is money for postdocs and state-of-the-art equipment for experimentalists. It also allows Wehner to concentrate on her research without having to apply for grants. A reduced teaching load of only one course a semester is another bonus. With those advantages, it's no accident that the center's 150 researchers hail from 33 countries.

Such diversity has long been the norm at the top U.S. research universities. For several decades after World War II, top academic talent gravitated to the United States. Researchers were attracted by generous and rising funding and a continually improving infrastructure, the result of broad societal support for higher education and a political consensus that investment in research reaped economic and social dividends.

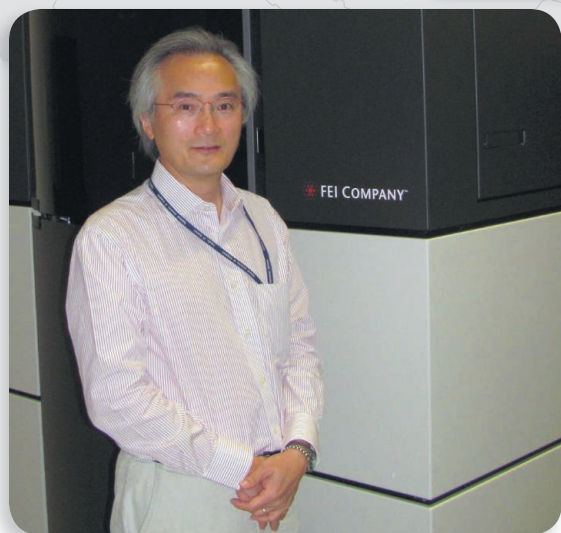
Foreign-born scientists still come to the United States, but that faith in the benefits of vibrant universities is arguably stronger now in Asia. "Many Asian governments see educa-

Online

sciencemag.org

S Podcast interview with author Dennis Normile (http://scim.ag/pod_6099).

On the move. (Clockwise from right) Geologist Kerry Sieh, electrical engineer Khaled Ben Letaief, marine biologist Leszek Karczmarski, and biologist Paul Matsudaira followed job opportunities to Hong Kong and Singapore. (Opposite page) Stephanie Wehner, a quantum information scientist, was excited by the work going on at the National University of Singapore's Center for Quantum Technologies.



Hong Kong

Singapore

tion as a very critical way of societal and economic advancement, so they are investing very heavily in their universities," says NUS President Tan Chorh Chuan. To achieve academic excellence, "attracting, nurturing, and retaining top talent is the most vital strategy," he adds. With the region's rising investment in education, he says, "conditions are right for Asian universities to attract top faculty from the rest of the world."

Although its impact on academic mobility is hard to quantify, the great recession that has staggered Western economies appears to have given Asia an edge. "People on my science advisory board say this is a good time to hire Americans because there are no jobs and funding is looking dreadful," says geologist Kerry Sieh. In 2009, the former tenured professor at Caltech became founding director of the Earth Observatory of Singapore, another one of the city's five centers of excellence, based at Nanyang Technological University. Most of the center's 54 researchers were lured from positions overseas. The Hong Kong University of Science and Technology (HKUST) has made worldwide recruiting a firm policy. "We are filling all positions—faculty, deans, vice-presidents, and presidents—through open international searches," says Khaled Ben Letaief, the school's dean of engineering.

Hong Kong and Singapore schools aren't alone in recruiting globally. The National Research Foundation of Korea has committed \$728 million for a 5-year World Class University Project that has attracted 321 foreign academics, most on full-time appointments.

Three years ago, Japan's Ministry of Education began a program to internationalize both the faculty and the students at its universities, although budget constraints have crimped the effort. And Taiwan's Ministry of Education has an Aim for the Top University Project that supports overseas recruitment.

China has employed a variety of schemes in the past decade to lure back scientists who went overseas for advanced degrees or jobs. These include the Ministry of Education's Changjiang Scholars Program and the Chinese Academy of Sciences' 100 Talents Program. Last fall, it broadened that search by launching a program aimed at hiring 1000 nonethnic Chinese scientists, engineers, and entrepreneurs over 10 years.

Universities are tapping into these schemes, but in most countries they are starting from a low level of internationalization. The Korea Advanced Institute of Science and Technology in Daejeon has used the government support to more than double—to 49—the number of nonethnic Koreans holding tenure-track positions since 2007. The University of Tokyo is aiming to boost the percentage of non-Japanese



permanent and fixed-term staff members from 7% to at least 10% by 2020. (Only 2.4% of its current full-time faculty is nonnative.) And National Taiwan University is aiming to recruit 20 foreign full-time faculty members each year for the foreseeable future to bolster their presence, now at 7%.

Leading the way

But universities in Hong Kong and Singapore have a long head start. NUS boasts that more than 50% of its full-time academics are foreign-born and represent more than 70 countries. At the University of Hong Kong (HKU), 40% of the professoriate comes from beyond the city and mainland China. More than 80% of the full-time faculty at HKUST earned Ph.D.s at top American and European universities, and more than 20% are of non-Chinese ethnicity.

Those schools are setting the pace in internationalization thanks in part to their colonial legacies. One big advantage is the use of English. To teach students in the local language, most universities in Asia “have to rely on people of their own nationality,” says Sun Kwok, an astronomer who returned to his hometown to become dean of science at HKU after more than 20 years in Canada and Taiwan.

The pervasiveness of English also allows nonlocal scholars to move up the academic ladder. “If you are not a local and happen to be in Korea, Japan, or even China, I don’t think you [can] become department head or dean,” says HKUST’s Ben Letaief, who was trained in the United States and worked in Australia before coming to HKUST in 1993. In contrast, only four of seven department and center heads at HKUST’s school of engineering are Chinese.



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UNIVERSITY OF HONG KONG

in 2009. The same could be said about Singapore.

Tan says Asian universities are using their latecomer status to incorporate global best practices into curricula and programs. Toward that end, NUS forged an alliance with Duke University in Durham, North Carolina, to add a modern medical school as part of Singapore’s push to become a biomedical hub. Launched in 2005, the Duke-NUS Graduate Medical School has attracted senior academics such as infectious-disease expert Duane Gubler, formerly of the University of Hawaii,

The small size of the two cities—Hong Kong has a population of about 7 million, and Singapore’s is only 5 million—encourages looking outward. “If we only recruited within Singapore, it [would be] like saying MIT could only recruit from Boston,” says Barry Halliwell, NUS deputy president for research and technology, who came to the university on a sabbatical from King’s College London in 1998 and decided to stay.

The Internet has eased if not erased the sense of isolation from Old and New World academic centers by providing immediate access to journals. “It doesn’t matter where you are,” Ben Letaief says. E-mail and the electronic exchange of information also make long-distance collaborations easier, he notes.

Reputations as cosmopolitan cities help, too. “Hong Kong is a really international city; even if you are a Westerner, you can settle in—no problem,” says Tony Chan, a Hong Kong native who spent 2 decades at the University of California, Los Angeles, and who headed the largest research directorate at the U.S. National Science Foundation before becoming president of HKUST

A Life Outside Work

Outstanding job opportunities in Hong Kong and Singapore may be the prime draw for globe-trotting academics. But their families, their interests, and their social lives are also important considerations.

Quantum information scientist Stephanie Wehner and her nine-person group have turned out a string of papers, including one in *Science*, since joining the Centre for Quantum Technologies at the National University of Singapore (NUS) 2 years ago. She also teaches one course a semester. But “I do have a life outside work,” she says. She has taken up ocean canoe racing, training several times a week and competing in the annual Around the Island Race in Hong Kong. “It’s extremely easy to live here,” she adds. It helps that Hong Kong and Singapore are arguably the most cosmopolitan cities in Asia, with diverse expatriate populations and English in common use.

Biologist Paul Matsudaira worried about finding good schools for his two young children when he began thinking about coming to NUS. He had participated in an alliance with Singapore while at the Massachusetts Institute of Technology in Cambridge and began bringing his family along in 2004 for part of the summer. But the year they spent with him during his 2008–09 sabbatical eased his concerns. The difference in the quality of the educational experience at Singapore’s American School compared with what they received back home “was like night and day,” he says. “Our kids loved school.”

After that experience, the local schools became a reason to join NUS, not a roadblock. “Our daughter wants to graduate from the American School,” he says. She is now 12 and entering seventh grade.

The Singapore government is also beginning to shed its reputation for being puritanical. The increased openness extends to lifestyles. Lee Kuan Yew, Singapore’s über-influential found-

ing prime minister, in recent years has called for acceptance of homosexuality, saying it should not be criminalized and gay people should not be harassed. Seismologist Kerry Sieh, director of the Earth Observatory of Singapore at Nanyang Technological University, believes that attitudes are indeed changing.

“I feel safer here as a gay person than I do in the United States,” Sieh says. “I wouldn’t have come here” if top officials were not supportive, he says. Still, he says those changes need to spread to the “intellectual ferment” throughout the city. “They’ve got to become more open to the arts, more open to freedom of thought and expression.”

Sun Kwok, an astronomer who gave up a position at the University of Calgary in Canada to become dean of science at the University of Hong Kong (HKU), says he’s been pleasantly surprised by the government’s decision to limit development and preserve natural areas in the hinterlands of the crowded metropolis. At the same

Manoa, to head the school's program on emerging diseases, and cancer researcher David Virshup, who left the University of Utah in Salt Lake City to lead efforts on cancer and stem cell biology.

One factor behind Hong Kong's increasing research capacity was its switch to the international norm of 12 years of primary and secondary schooling, followed by 4 years for a bachelor's degree. The old system of 3-year undergraduate programs, retained from colonial days, "was an elitist approach that is no longer suitable," Kwok says. The transition began in 2009, and the first students from the new system are entering university this fall. "We are trying to educate a larger population and trying to give a better, well-rounded education," Kwok says.

The shift presented an opportunity to overhaul the curriculum, too. Nonscience majors are now required to take integrated science courses that will give them a broad perspective on important scientific advances, Kwok says. Coursework for science students, he adds, will be "more interdisciplinary and will get students involved in research at the undergrad level."

Both schools are increasing faculty by more than 20% to cover the increased teaching load—HKU to 1100 and HKUST to 510—and have spread recruiting over several years. "Hiring everybody at the same time is not a recipe for building excellence," HKUST's Chan says.

And the emphasis is on youth. "Because we are preparing for the future, I encourage faculties to recruit junior people," says HKU President Lap-Chee Tsui, a geneticist who grew up in Hong Kong and worked for years at University of Toronto in Canada before returning in 2002.

Officials at all these schools say their salary and support packages are competitive with Western institutions. "To support new staff, we put in a lot of [seed] money," Tsui says.

Of course, once researchers set up their labs, they must apply



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NATIONAL UNIVERSITY OF SINGAPORE

for grants just like anywhere else. No country ever has enough money to fund everything that its scientists would like to do. But NUS's Halliwell thinks that "the success rates are reasonable" for government programs. "They don't throw money away, but if you have a good project you'll probably get [funded]," he says.

The opportunity to compete is just what HKU earth scientist Kono Lemke was looking for. A German national with an undergraduate degree from the Technical University of Berlin, Lemke earned a master's degree from the University of Bristol in the United Kingdom and a Ph.D. from Stanford University in Palo Alto, California, before taking a postdoc at ETH Zurich in Switzerland.

Searching for career-track jobs, he discovered that European institutions typically wanted replacements for retiring professors. In contrast, he says, "HKU was looking for people who could not just fill a gap but could bring something into the university that wasn't there already."

In Lemke's case, that means blending chemistry and earth science to study the possible origins of life in high-temperature, high-pressure geological environments. At HKU he has gotten support to recreate the geological conditions that might have fostered the evolution of inorganic to organic material. In Europe, "it would be quite hard to find a position that would cater to [someone with] that background," he says.

He's also grateful for the chance to test his ideas. Friends who landed assistant professorships in New Zealand, the United States, and Europe have become computational scientists, he says, because they can't get funding to conduct experiments.

time, he admits that moving from Calgary has put a crimp on his favorite pastime. "I can't go skiing anymore," he laments. Instead, "every weekend I go to the beach."

The common use of English can create unexpected job opportunities for spouses. HKU earth scientist Kono Lemke says his wife, a Chinese-Malaysian, had difficulty finding a job when he worked at ETH Zurich in Switzerland because she didn't speak German. But her English and Chinese skills were an asset when they moved to Hong Kong in 2008. The university also gave them "a reasonably good housing package" that has proven "quite important if you want to start a family," says Lemke, who has a 2-year-old son.

There are also plenty of options for those with an interest in local politics. Barry Halliwell, an NUS chemist who has lived in Singapore since 1998, is a member of several civic organizations wrestling with the challenges facing an aging society. "You can be as big a part of the community as you wish," he says.

—D.N.



Beyond the lab. Kono Lemke (left) says Hong Kong offers more job opportunities for his wife; Barry Halliwell (right) participates in many civic activities in Singapore.

Ageless opportunity

Young scientists aren't the only ones going to the Far East. For Sieh, 61 and one of the world's leading earthquake experts, the Earth Observatory represents a "stunning opportunity" to build an institution tackling challenges that threaten civilization.

Sieh has worked extensively in Indonesia and knew that Singaporean officials and academics were worried about the region's natural-hazards risks. So when Singapore's National Research Foundation announced its Research Centres of Excellence program in 2007, Sieh and Nanyang Technological University proposed an institute to study climate change, sea-level rise, tsunamis, earthquakes, and volcanoes.



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In some cases, Western scientists have relocated to rediscover a sense of scientific adventure. Biologist Paul Matsudaira joined the Whitehead Institute for Biomedical Research in Cambridge, Massachusetts, in 1985, just 3 years after its founding. "It was like a start-up," Matsudaira says, with enormous possibilities, plentiful resources, and excitement at the mandate "to do the best science we could."

But after 24 years, Matsudaira confesses, "I was getting complacent." He wanted to push biological imaging in new directions, but his idea was one of thousands competing for scarce resources. After working in Singapore under an alliance that links the Massachusetts Institute of Technology, NUS, and Nanyang Technological University, he spent a sabbatical year at NUS and realized that "there's outstanding research that goes on every day at places other than where I was."

The clincher was NUS's support for a biological imaging center. "People ask me, 'Why would you ever want to leave MIT and Whitehead?'" says Matsudaira, now head of biological sciences at NUS. His answer: "It [offers] the possibility that I could build something here that's unique in the world."

Researchers in fields such as earth sciences, environmental studies, and ecology find that a move to Southeast Asia opens up virgin scientific territory. Sieh mentions visiting a little-studied major fault in Myanmar that is the length of California's San Andreas Fault and runs through the capital of Naypyidaw. In contrast, researchers must

work ever harder to discover something new about the San Andreas. "The things we don't know about geological processes and geological history in Southeast Asia are just breathtaking," Sieh says.

Leszek Karczmarski says similar opportunities in marine biology lured him to HKU's Swire Institute of Marine Science. Originally from Poland, Karczmarski has studied the ecology and conservation of marine mammals, particularly dolphins, in South Africa, the United States, and Central and South America. But the Pacific Ocean west of Hawaii and between Japan and Australia is "aqua incognita," he says.

In 2010, he left the University of Pretoria in South Africa for a post at Swire, which was created to focus on marine conservation and ecology, and quickly ramped up research efforts. He has 12 postdocs and grad students conducting fieldwork in Southeast Asia, South America, South Africa, mainland China, Taiwan, and Egypt. He's also set up a small field station in a remote corner of Hong Kong for students to study local issues. "Something like this would take a few years in a number of other places," he says. "Here it happened over a few months."

Karczmarski has also begun to assemble a regional cetacean research network to share data, ideas, and strategies for research and conservation. In just 2 years the nascent group has sponsored six training workshops in modern quantitative research techniques that brought together 50 participants from 10 countries. "We have now a framework in place, and the web of interactions is growing strong," he says, pointing to an increasing number of collaborative research initiatives and jointly co-authored publications.

Moving on

The growing capabilities are not going unnoticed. "People are coming after our junior faculty, especially those whose research is beginning to take off," Halliwell says.

One example is Rudiyanto Gunawan, who left NUS for a position at ETH Zurich last year for both professional and personal reasons. The 35-year-old systems biologist is now closer to the European and U.S. labs working in his area, and he felt it would be easier to attract postdocs to ETH than to NUS. He was also able to negotiate for more lab space. Finally, he thought Switzerland would be a better place to raise his daughter than "fast-paced Singapore."

He values his 4-plus years in Singapore, however, and continues collaborating with two NUS groups. And there are no hard feelings. Poaching is a sign of success, Halliwell says, as long as it doesn't go too far. "If nobody wants anybody [on your staff] you're in trouble. [But] if everybody's going, you're in trouble."

There's also a silver lining to losing good faculty members. They make for "very good advertisements for us," Halliwell says. "And they build links."

There is no question that the competition for talent is going to get tougher. China's universities are striving to gain global recognition, HKUST's Chan says, "and they want to do it like us, in less than 20 years."

Foreign faculty members are already common at many Chinese business schools and at joint programs set up by Chinese and Western universities, says Huiyao Wang, director general of the Center for China and Globalization, a think tank in Beijing. "I think the next wave will be foreign faculty coming in" at the established universities, he says. Universities in Korea, Japan, and Taiwan are also stepping up international recruitment.

If those trends continue, the Stephanie Wehners of the future will have more Asian choices when they draw up a list of the most interesting places to work.

—DENNIS NORMILE