# NanoJapan: Preparing Globally Savvy Researchers

*By Cheryl Matherly and Sarah Phillips*

**JEFFREY LEE, A** sophomore majoring in mechanical engineering at Rice University, described the moment during the 2010 NanoJapan Program when he really understood the global nature of science research: "The best example . . . came when a professor from Boston University came to [Professor Tonouchi's] lab and gave a talk at an Osaka University symposium. Sometime that week, I found myself eating dinner with an American professor, a doctoral student from China, all hosted by a Japanese professor and his lab, and I realized the truth behind the statement that science transcends international borders."

Lee's experience reinforced one of the learning objectives of the NanoJapan International Research Experience for Undergraduates. As international partnerships become increasingly indispensible to solving major science and engineering problems, U.S. researchers and educators must be able to operate effectively in teams comprised of partners from different nations and cultural backgrounds. The NanoJapan program was developed to address this need by attracting undergraduate students to the emerging areas of electrical engineering and the physical sciences, especially the study of nanotechnology. By involving and training students in cutting-edge research projects in nanoscale science and engineering, this program aims to increase the number of U.S. students who choose to pursue graduate study in this field, while also cultivating a generation of globally aware engineers and scientists who are prepared for international research collaboration. The NanoJapan program is the key educational initiative of the National Science Foundation–funded Partnerships for International Research and Education (NSF-PIRE) grant awarded to the Electrical and Computer Engineering Department of Rice University and the Center for Global Education at the University of Tulsa. The program was awarded five years of funding in 2006 and has been renewed for another five years.

*Jeffrey Lee, a student from Rice University, experiences bunraku, a form of traditional Japanese puppet theater, firsthand at the Bunraku National Theater in Osaka, Japan.*

NanoJapan is a 12-week summer program that places first- and second-year undergraduate science and engineering students from U.S. universities in research internships with Japanese nanotechnology laboratories. While the heart of the program is the summer research experience, NanoJapan places a strong emphasis on preparing students to work effectively in cross-cultural laboratory settings. Before beginning work in their research labs, students complete a three-week orientation program based in Tokyo that combines 45 hours of Japanese language instruction, an orientation to Japanese life and culture, and an introduction to nanoscale science in Japan. At the completion of the orientation, students depart for their research labs, working for eight weeks at universities throughout Japan. At the end of the summer, the students return to Rice University to participate in a re-entry seminar and present their summer research with other students who completed domestic research projects as part of the Rice Quantum Institute Symposium.

## The NSF-PIRE Program

The PIRE program, which funds NanoJapan, was created in 2005 to "enable U.S. scientists and engineers to establish collaborative relationships with international colleagues in order to advance new knowledge and discoveries at the frontiers of science and engineering and to promote the development of a diverse, globally engaged U.S. scientific and engineering workforce" (NSF-PIRE, 2005). Rice University and the University of Tulsa were among the first 12 recipients of this grant. The PIRE program was in part a response to what the NSF characterized as the internationalization of science and technology innovation. About 20 percent of the world's scientific and technical articles in 2003 had authors from two or more countries (compared with 8 percent in 1988), and one-quarter of articles with U.S. authors have one or more international coauthors (NSF, 2006). PIRE was also a response to the changing expectations of which skills are required for professional engineers. The National Academy for Engineering's vision for the engineer of 2020 significantly broadens

the scope of competencies to include people skills, personal creativity, attitudes and experiences as well as technical expertise (National Academy for Engineering, 2004).

The emphasis on research in Japan reflects the nature of nanoscale science. In 2005, the U.S. and Japan accounted for more than 75 percent of global investment in nanotechnology research. Investment in Japan ($4 billion) exceeded that in the U.S. ($3.4 billion), making Japan the leader. To further advance nanotechnology science and develop new ideas from the lab into commercial products, it is important to stimulate cooperation between these countries. Japan understands the urgent need to internationalize its scientific enterprise and has committed to spending $70 million over the next 10 years to attract leading scientists from around the world (Forward: Nano Investment, 2005). However, obstacles to such international collaboration remain, especially linguistic and cultural barriers that divide students and researchers. By breaking down these barriers through programs like NanoJapan, the already high level of funding in both countries can have even greater scientific and societal impact, since future generations of researchers will have a better understanding of both the culture and the state-of-the-art technology in each country.

### The NanoJapan Research Experience

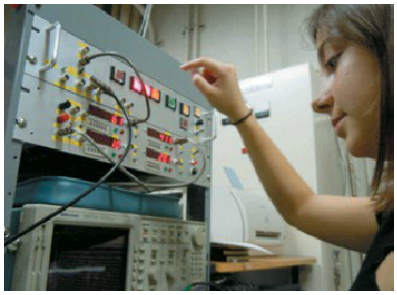
Indeed, the research experiences are selected and designed with this goal in mind. Each of the participating labs agrees to host a NanoJapan student to work on a research project under the supervision of a mentor, usually an English-speaking graduate student or post-doc. It is unusual for first- and second-year undergraduate students to conduct research in Japanese universities, yet the hosting professors report that the students contribute both to the research and the general "internationalization" of the lab. The Japanese graduate students must speak English with the U.S. students, providing them with essential practice in the language they need most in order to participate in the international science community. One hosting professor explained, "It is very important for Japanese young generation to work in an international environment. In this sense, it is highly beneficial for my students to work together with foreign students who are conducting activities across national boundaries. All the NanoJapan students we welcomed in these three years were excellent, well educated, and active for scientific research. They provided very nice stimuli and atmosphere to our laboratory, leading to enhanced research activities."

At the same time, NanoJapan, which recruits students early in their academic careers, is intended to be a catalyst for students to pursue other international and research experiences. Eighty students have participated in NanoJapan since the program was established in 2006. Among the alumni to date, 10 students have participated in additional study abroad programs, including Ethan Schaler, a graduate of the University of Maryland, College Park, who received a Bridging Scholarship to return to Japan for a semester of study at Tohoku University as part of the Global Engineering Educational Exchange (Global E3) program. Five alumni have gone on to pursue additional summer international research internships, such as Benjamin Lu, who traveled to Swaziland as part of Rice University Owls Beyond Borders program.

### Program Impact

The NanoJapan program has also encouraged students to pursue further research and study in nanoscale science at the graduate level. Of the 27 alumni who have graduated to date, 20 have enrolled in graduate programs in science, technology, engineering and mathematics (STEM) fields. This includes two students who are completing their PhD studies abroad, one at the King Abdullah University of Science and Technology (KAUST) and one at the Australian National University. NanoJapan alumni have also received a number of prestigious academic fellowships, including three National Science Foundation Graduate Research Fellowships, one Hertz Fellowship, and two Barry M. Goldwater Scholarships (NSF-PIRE NanoJapan, "Where Are They Now?"). Schaler, a Goldwater scholar, said, "I based a large amount of my application on my research in Japan—especially at RIKEN [research laboratories]—and my research proposal essay in particular was a combination of work that I performed at RIKEN and the University of Maryland, College Park."

In a post-program evaluation, 100 percent of the NanoJapan participants reported that, based on their experiences in Japan, they believe that foreign collaborators can provide valuable contributions to U.S. science projects, and 81 percent report that they are confident that they can be a valuable part of an international research collaboration. All of the NanoJapan participants also report that the international dimension of the program was an important factor in their decision to apply.



*Aleksandra Simicevic, a student from Louisiana State University, works in the Nojiri Lab at Tohoku University.*

Former NSF Director Arden L. Bement explained, "International cooperation in science is not a luxury; it is a necessity—and the foundation for the future" (NSF, 2006). As the program embarks on its next five-year funding period, we look forward to contributing to the development of a globally competent generation of scientists and engineers and expanding international opportunities for these underrepresented groups. ■

***Cheryl Matherly** is Assistant Provost for Global Education at the University of Tulsa and Education Director for the NanoJapan program. **Sarah Phillips** is the TeraNano PIRE Education & International Initiatives Manager at Rice University.*

### References

Forward: Nano Investment. (2005). MIT Technology Review.

NSF-PIRE NanoJapan. (n.d.). Where are they now? Accessed January 6, 2011 from http://nanojapan.rice.edu/Where%20Are%20They%20Now.html.

National Academy of Engineering. (2004). The engineer of 2020: Visions of engineering in the new century. Washington, DC: National Academies Press.

National Science Foundation. (2006). Investing in America's future: Strategic plan FY 2006–2011. NSF 06-48.

National Science Foundation, Partnerships for International Research and Education (PIRE). Accessed January 6, 2011 from http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12819.

National Science Foundation. (2006). Science *and engineering indicators 2006*. Accessed January 6, 2011 from http://www.nsf.gov/statistics/seind06/c0/c0s1.htm.