ENGINEERS ARE more important to our future than ever. The challenges we face, whether it’s finding technologies that minimize our carbon footprint or developing computational strategies to model the molecular processes that cause cancer, all require the specialized knowledge and analytic skills that form the backbone of engineering education.

But it is equally true that today no country has the resources to address these challenges by itself. Research and development, design and manufacturing increasingly transcend borders. As a result, we need engineers who bring to their careers a global perspective and whose education includes an international experience. Increasingly, these engineers are coming from the University of Virginia.

Nationally, fewer than 3 percent of engineering undergraduates have participated in an international program of any sort, according to the Institute for International Education. At the Engineering School, that percentage is 12 percent and rising. U.Va. engineering students are successfully integrating an international experience into their undergraduate curricula, whether in the form of research, coursework or service to communities in need.

Engineering School faculty now direct study abroad courses in Germany, Guatemala, Brazil and Argentina. Our chapter of Engineering Students Without Borders has undertaken projects in such places as Cameroon, South Africa and Belize. And both the Engineering School and the University provide support, guidance and encouragement to students seeking research projects in many different countries, as the stories in this issue of IMPACT reveal.

At U.Va., our goal is to train engineers to make their mark as global citizens.  

---

**Finding Opportunities Abroad**

**New International Initiatives**

**Cancer Research/Tuberculosis Diagnosis**

**Computational Analysis/Bioremediation**

**Collaborative Engineering**

---

**On the cover:** Ian Czekala (Aero ’10, Col ’10) in Chile in front of one of the first of 66 antennas that will comprise the Atacama Large Millimeter Array, the world’s largest telescope.
INTERNATIONAL EDUCATION is one of the Engineering School’s top priorities, according to U.Va. Engineering School Dean James H. Aylor. “The world has become so globalized that an international experience must be part of every engineering student’s education,” he says.

Last fall, Aylor was part of a delegation of University of Virginia leaders who spent more than a week in China meeting with representatives from some of China’s most prestigious universities. Their visit set the stage for international exchange programs and research collaborations with Peking University and Tsinghua University in Beijing and Shanghai Jiao Tong University. These arrangements should start bearing fruit in fall 2010.

The trip to China was just the latest in a series of efforts designed to promote international education at the Engineering School. In 2007, Aylor created an international programs initiative at the Engineering School and appointed Associate Professor Dana Elzey to lead it. Elzey has been busy. In conjunction with the Volkswagen Group of America, the Goethe Institute and the Technical University of Braunschweig, he launched the Global Ingenuity Program for Rodman Scholars. At the end of the spring semester, U.Va. students will spend two weeks in Germany, working closely with Technical University students on a series of research and design topics identified by Volkswagen’s Palo Alto research group. The Volkswagen Group of America will offer up to five Global Ingenuity applicants a summer internship in the United States when they return.

Elzey has also been developing a research exchange program with the Shibaura Institute of Technology (SIT) in Tokyo. This program will allow upper-level Engineering School undergraduates to work (in English) on supervised research projects for eight weeks during the summer at SIT.

Dean Aylor expects that additional initiatives will follow. “Our hope is that in five years’ time at least half of our students will take classes or conduct research overseas,” he says.

THOMAS JEFFERSON was a great proponent of what he called the “general diffusion of knowledge.” In his view, society advances when those with knowledge share it with others. The new undergraduate research publication The Spectra is solidly in this tradition. This student-run journal will provide a venue for undergraduate engineering and applied science students to share their insights and discoveries with others. “There is so much great undergraduate research that goes on here,” says Chris Belyea (ChE ’10), the publication’s editor-in-chief. “The Spectra will spotlight the best.” FOR INFO: spectra@email.virginia.edu
Diana Burk (BME ’10) ran cross-country for U.Va., and like many long-distance runners, she’s both disciplined and determined. A biomedical engineering major, Burk is fascinated by how the brain works. “This is the new frontier,” she says. “In the next few decades our knowledge of the brain is going to expand dramatically.”

Last spring, Burk sought out a research internship, preferably overseas, to find out if neuroscience was the right path for her. She googled “Spain” (she speaks fluent Spanish) and “neuroscience,” but didn’t find anything suitable. Widening her search, she came across information about a small summer internship program offered by the Max Planck Institute in Freiburg, Germany. The internship included living expenses and lodging at the institute’s guesthouse. She applied and was accepted.

In May, Burk found herself working in a laboratory at the institute, assigned to develop a new mouse model for glioma, a type of brain tumor that is nearly always fatal. As with many cancer researchers, Burk’s focus was on finding a way to prevent tumors from stimulating the formation of blood vessels that keep them alive. Mouse models help scientists better understand the chain of events that enable tumors to do this.

Typically, researchers genetically alter a mouse to overproduce a protein such as Ras that is linked to cancer. Cells from this model are transplanted into the brain of a second mouse. Aggressive, rapidly growing brain tumors result.

Burk’s challenge was to test a mouse model based on a protein called platelet-derived growth factor beta (PDGF-β). PDGF-β sets in motion a chain of events that indirectly causes Ras production. As a result, the tumors in mouse models based on PDGF-β develop more slowly than those based solely on Ras, giving researchers the opportunity to test methods of early detection and treatment.

Burk found that the combination of neuroscience and the idea that she was producing something useful was irresistible. “We worked every day in the lab from 9 a.m. to 7 p.m., even coming back in the middle of the night,” she recalls. “It was sometimes frustrating and monotonous, but I never got bored. I just wanted to keep going. It was a great test for me.”
IN SEPTEMBER 2009, the Biomedical Engineering Department launched BMEplanet.org, the online home of a global biomedical engineering network it has developed to accelerate education, research and innovation. The site features announcements of internships, scholarships and other funding opportunities as well as collaborative tools such as project workspaces. Currently, over 300 academic departments and industrial organizations plus 500 individual members from 44 nations are part of this professional networking Web site.

BME Planet Fosters Global Collaboration

IN AFRICA, progress in eradicating tuberculosis has not just ground to a halt, it has shifted into reverse. World Health Organization statistics show that the incidence of tuberculosis in Africa more than doubled between 1990 and 2005, and in eight countries it quadrupled. This resurgence has been driven principally by the AIDS epidemic. People with AIDS are particularly vulnerable to tuberculosis infection, which accounts for 30 to 40 percent of AIDS deaths.

Clinics in Africa desperately need a quick, inexpensive way to diagnose tuberculosis. Kenneth Tran (BME ’11) spent two months last summer working with researchers at the University of Cape Town developing an automated optical microscope that would fit those requirements, with the added advantage that it could be operated without a trained technician. While other researchers focused on creating the algorithms at the heart of the autodetection system, Tran concentrated on refining the hardware. “We had to consider the trade-offs between cost and image quality,” he says. Tran investigated the feasibility of retrofitting optical microscopes, which rely on costly mercury vapor lamps, with inexpensive, off-the-shelf LEDs.

Tran had gained experience developing inexpensive optical diagnostic systems as a researcher for Dr. Paul Yates, a professor of ophthalmology and biomedical engineering at U.Va. Working with Yates, he created an inexpensive digital camera that can take diagnostic images of the retina, enabling primary care physicians to diagnose diabetes and degenerative vascular disease of the eye quickly and easily.

Tran credits the Biomedical Engineering Department for helping him find the Cape Town project and partially funding his trip. His experience has definitely made a difference in his career plans. “I visited a number of hospitals and got to talk to patients,” he says. “It made me realize that I could make a bigger difference as a physician than as a researcher.”

During his two months at the University of Cape Town, Kenneth Tran helped modify an optical microscope with off-the-shelf parts so that it could be used in AIDS clinics to diagnose tuberculosis.
WILLIAM JACOBS (MSE ’10) applied for an internship abroad as a way of finding out whether the approach to computational science that he had been pursuing as part of the Computational Materials Group in the Engineering School was the one he would like to specialize in. Working with Associate Professor Leonid Zhigilei and Professor Robert Kelly, Jacobs currently is conducting a computational investigation of hypersonic impact on carbon nanotube-reinforced polymer composite materials. “Essentially, we build our models from the ground up, from atoms to crystals to materials,” he says. He was interested in exploring the approach used in computational fluid dynamics, in which researchers begin with large empirical assumptions and work backwards.

This past spring, encouraged by a friend who had found a summer internship at a Max Planck Institute in Germany, Jacobs applied for a Research Internship in Science and Engineering from the Deutscher Akademischer Austausch Dienst (DAAD), the German Academic Exchange Service. The DAAD funds 350 internships each year for undergraduates from the United States, Canada and the United Kingdom with research groups at top research institutions across Germany. He received a three-month internship at the Technical University of Munich.

Jacobs was assigned to work on a team developing an improved design for rocket nozzles. Nozzles optimized for fuel economy at high altitudes are unstable during launch because of excessive side loads. As part of the effort to understand these loads, Jacobs correlated the results of wind tunnel experiments with computational fluid dynamic models. “Though I really enjoyed living in Germany and working with my German counterparts, the trip confirmed that the computational techniques I’ve learned at U.Va. really are for me,” he says.

Jacobs secured a Harrison Research Award from the University for his work with Professor Zhigilei. A Jefferson and Rodman Scholar, he recently was one of 278 students selected nationally for a Goldwater Scholarship.
KATHRYN STROBEL (ChE ’10) had a very specific reason for conducting her research overseas: a laboratory at the Helmholtz Center Munich in Nueherberg, Germany, had the exact equipment she needed to explore the role of chemotaxis in groundwater remediation. But she freely admits that the opportunity to travel outside the country was also an incentive to pursue this specific line of research.

Strobel is a member of Chemical Engineering Professor Roseanne Ford’s laboratory, which investigates the use of bacteria to break down contaminants in polluted aquifers. Strobel focused on chemotaxis because it is the process by which simple organisms or cells move toward or away from chemicals in their environment. “Understanding how chemotaxis works in groundwater will help us increase the transport of bacteria toward contaminated sites,” she says.

From a graduate student in the lab, Strobel learned about a 2-D aquifer model at the Helmholtz Center. The model consists of a tank that can be filled with sand and a system that pumps water horizontally through it to replicate groundwater flow. Realizing that this model would make the ideal test bed to learn more about the role of chemotaxis, Strobel took the initiative to contact the center and received an invitation to use the model. She then applied for a Harrison Undergraduate Research Grant from the University, which funded her month-long stay in Germany early last summer.

After she learned how to use the equipment, Strobel placed a chemical attractant, in this case benzoate, at a specific location in the tank, added bacteria to the water, and conducted a series of experiments, two using strains of bacteria that were chemotactic for benzoate and two using nonchemotactic mutants. She found that the chemotactic bacteria moved significantly closer to the benzoate than the nonchemotactic strains.

Strobel traveled overseas a second time last year to present her results at the fifth Universitas 21 Undergraduate Research Conference hosted by the University of Glasgow. “The U21 experience was great for me,” she says, “It helped me make the transition from conducting research to communicating its importance to a broad audience.”

Universitas 21

THE UNIVERSITY OF VIRGINIA is a founding member of Universitas 21, an international network of 21 leading research-intensive universities in 13 countries. Its goal is to foster collaboration and cooperation among its member universities and to create opportunities for research and education that none would be able achieve on its own. In addition to its annual undergraduate research conference, Universitas 21 fosters extensive student exchanges among member universities.
**Engineering ‘Big Science’ in Chile**

**THE LARGE** Hadron Collider and the Human Genome Project are just two examples of big science, research projects that are unprecedented in their ambition, their scope and, most significantly, their cost. As Ian Czekala (Aero ’10, Col ’10) notes, big science projects have become so costly that many can only be funded by a group of international collaborators.

The Atacama Large Millimeter Array (ALMA) telescope under construction in the northern Chilean desert is a case in point. It will include at least 66 large antennas, and it is expected to cost more than $1 billion. The European Southern Observatory, a group of North American partners led by the National Radio Astronomy Observatory (headquartered in Charlottesville), and Asian organizations from Japan and China are financing the project.

With joint funding comes joint design, joint testing and joint construction. Czekala, who is also majoring in astronomy, secured a Harrison Undergraduate Research Grant to explore the technical and managerial issues that arise in such a high-stakes international collaboration.

At the end of 2009, he traveled to Chile, formally interviewed more than a dozen astronomers, administrators and engineers on the project and spoke to a dozen more. “I found that controlling communication on a project of this complexity and scale is imperative,” he says. “You need to balance the need to keep people informed of changes with the certainty that over-documentation slows progress.”

In the course of researching collaborative engineering at the Atacama Large Millimeter Array project in Chile, Ian Czekala noted that many managers choose to assign a single team to a large task rather than break the task into segments, each with its own team. He observed that this approach helps spread knowledge more effectively among team members and is more responsive to changes in workflow.