



Dale Threadgill, left, investigating the existing water supply reservoirs. The dining hall at the Ecolodge, above, one of the facilities to benefit from a new waste water treatment system.

Ecolodge San Luis: For UGA Engineers, a Course in Study-Abroad by Alan Flurry

Eco-tourism is a burgeoning business in many parts of the world, an open door to exploring an environment that is nearly in balance with its human cohabitants. Linking this exploration to higher education creates opportunities for combining research and instruction in this pristine environment. The UGA facility in San Luis, Costa Rica, formally known as the University of Georgia Ecolodge San Luis and Research Station, presents the University with opportunities to expand its already formidable study-abroad program. Engineering students engaged in this unique learning environment benefit not only from exposure to a variety of academic and cultural perspectives, but also experience their intersections with the many factors that impact design and problem solving around the world.

One such student, third-year biological engineering major Erik Jarrett, recently returned from Costa Rica, where he spent the entire Fall semester at the Ecolodge. For him, there was nearly as much self-discovery living in and around the rainforest as that which came from his work within the program's focus on ecological research. "I viewed the program as a way to learn how to learn, to learn how to see from new perspectives," Jarrett says.

Intensive for a study abroad program, Jarrett took 17 credit hours during the fall in Costa Rica. Including home stays with a village family, language courses and a hands-on research regimen, he reports that the program was structured to allow the students to commit themselves to the rigors of the work and to succeed. "I felt like they more or less gave us the tools to learn with, gave us information about the area and provided us with the flexibility to focus on what we wanted to focus on, to discover," he says. Jarrett worked in groups with other UGA undergrads from ecology, anthropology, religion and political science, among other majors. "It was a very diverse group of people," Jarrett recalls, "and I can see the importance of being integrated into the rest of campus."

Faculty of Engineering Director Dale Threadgill, who visited the Ecolodge San Luis in mid-December, 2003, sees the opportunity for engineering to take its part in the study-abroad spectrum while contributing to the sustainability of the facility. "With the programs in Oxford and Cortona focused more on the liberal arts than the sciences, you really don't think of engineering in regard to study-abroad," he says. "This last

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NanoSEC: Platform for a New Frontier

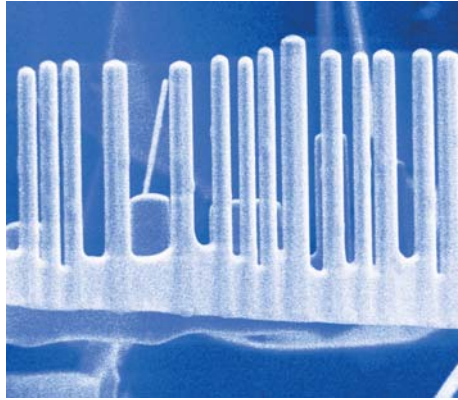
Scale. It's easy to lose a sense of in a time when we can fly across the continent in a few hours or publish our ideas on the internet to a potential audience of billions. In so many ways, advances in technology have allowed our world to shrink, marking the progress toward our desires for efficiency and convenience. But how about the unseen world that lurks beneath the visible, at the molecular level that scientists and engineers now think hold the keys to a new world of discovery in practically every imaginable area of life, and perhaps even a few beyond that. One would assume that here, the possibilities, the risks and the opportunities must be, well, magnified.

"It's not clear at this point how great an impact nanotechnology will actually have on us, but I think one way or another it will be large," says Bill Dennis, UGA Professor of Physics and Director of the Nanoscale Science and Engineering Center (NanoSEC) at the University. Established in 2002, the center serves as the platform for furthering research-level multi-disciplinary collaboration and creating the instruction and outreach opportunities for the university community that such work enables.

A prime example is the three-credit-hour course being offered for the second time this spring semester titled, **Nanotechnology: From Molecules to Machines**. A multi-instructor course running the gamut from the atomic to the macro scale and back, the course is a survey of innovation and experimentation from every corner of science and engineering at UGA. It illustrates just how far across the academic spectrum nanotechnology stretches, representing the cutting-edge direction in practically every field. From chemically assembled nanostructures to nanolithography to computational nanomechanics to protein nanoassemblies and nanobiotechnology, this course offers UGA graduate and undergraduate students a real opportunity to learn about these exciting new endeavors from the researchers pushing these important new fields forward. "We also have some ideas for other classes," Dennis says, "where students can gain experience in nanofabrication

techniques and a multi-instructor course in computational techniques for modeling nanosystems."

These courses will form the centerpiece for a graduate nanotechnology certificate program



Zinc Oxide nanostructure fabricated by UGA researchers using a vapor transport technique.

to be offered through the NanoSEC. The Integrative Graduate Education and Research Traineeship Program (IGERT) set up by the National Science Foundation represents just one possible source for supporting students enrolled in the nanotechnology certificate program. "These types of awards will greatly enhance the visibility of UGA programs and give us a new inroad in educating the future workforce in nanoscience and engineering," says Guigen Zhang, assistant professor of biological engineering and NanoSEC member. The cross-disciplinary nature of this work is intuitive and innovative, bringing to bear the imagination of new facilities and new technology to redress problems in search of solutions.

But even though nanotechnology is interdisciplinary in scope, that still might not give the best grasp of where it sits as a science or engineering field. "What defines nanotechnology is the scale and more specifically, some functionality has to come out of that scale," explains Bill Dennis. So it's not just enough to shrink something down to the nano size if it merely results in a smaller one of those objects that is functionally not different. Not a discipline of physics or chemistry, it is a truly cross-disciplinary field that is still in the process of being defined at a scale where disciplines recede in the pursuit of explaining and discovering new processes.

Fostering its implications for engineering continues to be a profound endeavor, just as the NanoSEC has been from the beginning. At the April 2001 symposium, *Towards 2010: Comprehensive Engineering at UGA*, participants identified nanotechnology as an important theme for advancing engineering and science at the University. Just two and a half years later, Guigen Zhang, William Kisaalita and Yiping Zhao were awarded a \$1 million grant from the NSF to develop nano-biosensors using the new Micro-Nano fabrication lab developed in tandem with the Faculty of Engineering. "The idea is to have a common, central voice so that we can try and get improved facilities that will benefit all of us," Dennis explains, pointing out the importance of bringing faculty together through interdisciplinary seminar series and the UGA Engineering Grants program. "Getting people to talk and share ideas continues to be a very powerful force in moving these news ideas forward," he says.

And as prudent as it is for the University to continue to position itself to take advantage of government interest in new fields like nanotechnology, it is just as imperative to prepare tomorrow's campus population for what lays ahead. NanoSEC has developed several strategies for introducing nanotechnology to high school kids, to let them know it's out there and that it will impact them. "If you look at some of the projections that nanotech will have on the global economy," Dennis says, "these kids in school at the moment are probably going to have nanotechnology-related careers and they don't even know it yet." The center has developed presentations and plans on providing tours, methods of outreach that also provide a compelling way to highlight nanotechnology in recruiting interested students to UGA.

Like the Faculty of Engineering, the NanoSEC provides a platform for bringing the strengths of cross-disciplinary research together, with similar emphases on entrepreneurship and networking directed toward the infinite possibilities for materials and devices within the sub-atomic universe. For more information on the NanoSEC and to follow the work of some of UGA's leading-edge scientists and engineers, visit their new website at www.nano.uga.edu and find out what's lurking in a whole new world within a world.



FACULTY PROFILES

Trained as a theoretical physicist in computational statistical mechanics (CSM), Heinz-Bernd Schüttler, Department head of UGA Physics and Astronomy, has found the collaborative relationships around campus to position himself on the frontier of metabolic engineering. Working with Jonathan Arnold of Genetics and Faculty of Engineering colleague Thiab Taha of Computer Science, Dr. Schüttler employs the Monte Carlo simulation techniques from CSM to extract quantitative information about relevant model parameters that describe the system of interacting genes and proteins involved in the gene regulatory processes of the cell.



Schüttler

“Genome sequencing was a major breakthrough and had to come first,” Dr. Schüttler points out, “but to get the whole picture of the properties of these systems and how they behave is, once again, completely new.” The answers, he and others assert, may not be hidden in one single gene, which is why establishing the parameters of gene systems for profiling experiments are so important. Ostensibly, CSM has no connection to understanding the machinery of metabolic molecules, proteins and genes. But as this new area of molecular biology unfolds, it marks a departure from the pre-eminence of traditional academic disciplines on the basis of discovering just such new connections. Arnold from Genetics has joint appointments in Statistics and in Physics. Taha is an expert in identifying algorithms to solve the chemical rate equations which are the mathematical tool used to describe gene regulatory systems. Schüttler brings expertise in

Monte Carlo methods to pick and adjust the model parameters for the data sets. Through this cooperation and the language of mathematics that overlaps each discipline, the mountains of data from profiling experiments can begin to be reduced to dependable, efficient mathematical models. From these models can be deduced the effects of environmental changes on gene behavior.

“These sorts of models are what you need to be able to predict and thereby engineer the behavior of these systems,” Schüttler says, adding that he, as a theoretical physicist, would never be able to do any of this without collaborators from other disciplines. “At some point, these [models] will have predictive capabilities; they will be able to tell what will happen in an experiment that hasn’t been done yet, which will be very useful.” So as research in traditional disciplines evolves through interdisciplinary collaboration to solve new problems, a whole new generation of students and researchers will be affected by this breaking down of barriers and thinking across disciplines to access solutions. This dynamic situation fosters new breakthroughs and the creation of new technologies at UGA that will impact medicine and biological engineering through metabolic regulation and modification in the years to come.

Mark Risse of Biological & Agricultural Engineering has witnessed an evolution as the focus of his research and education programs has become a topical issue for state and local governments. An Associate Professor and Extension Specialist in animal waste management, environmental assessment and water quality, Dr. Risse serves as the water quality coordinator for the College of Agricultural and Environmental Sciences. In this role he oversees the coordination between Georgia’s county extension agents and the UGA engineering expertise they require to serve their respective communities. With water quality issues becoming more

environmentally and politically urgent throughout the state of Georgia over the last few years, the role of UGA Extension engineering has taken on a dimension that transcends its technical origins.

“The legislature is now mandating the development of source water protection plans, TMDL implementation plans and water conservation plans for every city and county government,” Risse explains,



Risse

pointing out that the network of county extension agents throughout the state are the localities’ best option for educating the public on these issues. “Making that link between county agents and how the university can help these communities deal with water issues through them is one of our major efforts,” he says.

Developing workshops and making presentations to governments, commissions and the public has made Risse a critical resource on conservation and water quality issues. Last year the Atlanta Regional Commission began promoting rain gardens as a strategy for ordinary homeowners to pre-empt storm water runoff. UGA Extension engineering’s significant experience with strategies like rain gardens and other stormwater management practices helped enable its county agents become a knowledgeable and effective conduit for this solution and firm up the chain of resources that connect the state and its land-grant University to the citizens. “To solve these problems, it’s more about putting people in touch with people and coming up with innovative ideas and finding new creative partnerships,” Risse says, proving that engineering will always include design that makes as much of human resources as natural or material ones.



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semester in San Luis, there were students from art to engineering involved, so study-abroad might not be such a novelty for engineers, at least not at UGA." Upon the request of Associate Provost for International Affairs Mark Lusk, Threadgill and another engineering faculty member visited San Luis to consult on the design of an environmentally sensitive wastewater treatment system at Ecolodge San Luis. Such an opportunity fits well with the integrative emphasis toward ecological engineering at the University, marshalling the resources of UGA ecology, engineering and environmental design.

Research emanating from the Ecolodge creates a learning laboratory where students gain practical experience from a course uniquely suited to a location.

The designs under consideration for a sustainable wastewater treatment system will also allow for the possibility of conducting research into the efficacy of various treatment options in the cloud-

forest climate around the lodge, according to lead designer Matt Smith, Associate Professor of Biological & Agricultural Engineering at the UGA campus in Tifton. The plan is to install three primary types of treatment systems: free-water surface and subsurface flow constructed wetlands and facultative lagoons. "It's not often that we get the chance to install multiple treatment units in parallel so that we can truly compare their performance - full scale - side by side," Smith says. This opportunity for research also presents the facility as a demonstration site for the residents of the local villages as well as the students who visit the UGA facilities.

Back in Athens, Erik Jarrett is still getting reacquainted with his life here after his semester in Costa Rica. He says the experience solidified his decision to enlist in the Peace Corps after graduation, and has added perspective to his engineering education and where he would like it to take him. "Coming back, I feel a little more

connected with the world," he admits, and considering the variety of new awareness the time at San Luis brought to him, it's a connection that will only grow stronger.

For further information about the University of Georgia Ecolodge San Luis and Research Station, please visit <http://www.uga.edu/oie/frecolodge.htm>

The Faculty of Engineering Open Membership Period runs through February 16, 2004. Interested UGA faculty and industry professionals are encouraged to visit <http://www.engineering.uga.edu> and complete the online application.



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