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Marine Engineering Certificate Moves Forward

Earlier this year, faculty from UGA engineering and marine sciences brought forth a proposal to create marine engineering certificates for undergraduate and graduate students to begin in Fall 2003. The effort to blend some of the foremost university resources in research and instruction is evidence of UGA faculty motivation to develop a nationally respected program that fulfills the needs of students interested in marine engineering systems.

As the University of Georgia perennially attracts a higher caliber of undergraduate students, it is to be expected that the post-undergraduate direction of these students will continue to evolve. Anticipating this evolution is the rationale behind the marine engineering initiative.

"We're looking to lend our expertise to projects which can benefit marine systems such as instrumentation needs and coastal processes," says engineering professor Sid Thompson who chaired the committee which worked on the proposal. "At the same time, we're trying to understand marine sciences better to see where we can merge our areas of expertise."

Already the UGA Faculty of Engineering, a university-wide academic unit, includes several members of the marine sciences faculty; thus the new certificates are another product of this platform for academic collaboration. On another level, the certificate program fosters the linkage between engineering and marine outreach. This provides the opportunity to link facilities and expertise to a program offering for students that, in turn, benefits the state.

The Program

In its initial phase, the marine engineering program will emphasize modeling of near-shore and coastal processes. The modeling will focus on waves-tides-surges and current transport. Near-shore and coastal modeling is needed for numerous engineering design projects in the marine environment including structure design, pollution prevention and clean-up, as well as beach and coastal protection.

Students completing the certificate requirements will be prepared for research positions in universities, environmental agencies and in marine industries. The program expects to have 12 to 15 students at a given time. The certificate will be awarded upon completion of requirements for a UGA B.S., M.S. or Ph.D. degree with a major in engineering or marine sciences.

Acoustic instrumentation designed to measure boundary layer turbulence and vertical profiles of current and Reynold's stresses deployed off the Georgia coast.

"This initiative will provide an important mechanism for Public Service and Outreach to Georgia's coastal communities," says Randy Walker, Director for the Marine Extension Service. As resources become available, the UGA program will expand to include other areas common to marine engineering such as underwater acoustics and signal processing, coastal structures, marine instrumentation and marine aquaculture.

The 2003 Annual International Meeting of the Institute of Biological Engineering (IBE) will take place at the Georgia Center for Continuing Education January 17-19, 2003. For more information visit www.ibeweb.org

Turning Opportunities into Activity

By Guigen Zhang, Ph.D.

When asked to reflect on my first year as a research professor in the department, I was encouraged by the things which came to mind and how they reflect on the people and engineering at UGA. As the beneficiary of an interdisciplinary education, I find this environment most rewarding for research and teaching. Ten years ago when the interdisciplinary idea was relatively new, people argued that the next generation would be jacks of all trades and masters of none; the reality instead is a new breed of students who are the masters of new trades.

During my initial interview at UGA, I was struck by the diverse environment for biomedical fields. My primary interest, the substantial resources and reputations in the biological sciences were important to me as signals to campus priorities. At that time, two things were on the horizon of engineering at UGA: the Biomedical Institute and the Faculty of Engineering. These weighed heavily on my decision to come here. Less than a year later they have both become a reality.

Based on my interdisciplinary background, I've already had the chance to turn these opportunities into activity. Within a couple of months of my starting date, I began communicating with faculty at the Medical College of Georgia; we have since established two projects funded by the UGA-MCG Biomedical Initiative. The engineering needs on campus have also allowed collaboration with Biological Sciences, Animal and Dairy Sciences, Veterinary Medicine and the Physics department, where we're working with the next generation of biotechnology and nanotechnology. I truly believe promoting comprehensive engineering and interdisciplinary collaboration will provide us the key to turn pre-existing opportunities at UGA into competitive activity. After all, competition in scientific research is very rigorous and we must not fall behind.

"Competition in scientific research is very rigorous..."

From an educational standpoint, I'm impressed by our good students, by their ability to adjust to emerging fields and new experiences. Because of the unique environment campus-wide and the broad field of engineering, they have the ability to rise to challenges that traditional engineering students would not. The vertical training of today is simply not sufficient to prepare students for future challenges. We ought to continue to take advantage of all that UGA offers, not just in engineering. My experience this year with mentoring projects that require a range of knowledge from biomedical and mechanical engineering to cellular biology and computer modeling has been fascinating. Our students handle this array of knowledge very well; I feel like we have an advantage in training them to take on the complex problems of the real world.

Never in the history of our intellectual pursuit have joint efforts between scientists and engineers become so important as they are today. I believe we have an edge on this by being flexible and having a uniquely structured curriculum system. The challenge is to define what we will need in the future and not go back to traditional disciplines just to struggle against them. If we can promote the interdisciplinary side with UGA's advantages and resources and focus on training students with that kind of broad flexibility, we will do a decent job of preparing the next generation work force and its educators, thus fulfilling our mission as a land-grant institution to the state of Georgia, the nation, and the global community.

Guigen Zhang is an assistant professor of Biological & Agricultural Engineering at UGA and an adjunct professor at the Northwestern University Medical School.

Illustrating the Evolutionary Computation methods he employs in applications like better aircraft design, Khaled Rasheed, an Assistant Professor of Computer Science, uses the example of giraffes and tall trees. "If you approach problem solving the way nature employs natural selection and survival of the fittest, a whole population learns how to generate better individuals."

Khaled Rasheed

Evolutionary Computation is a form of artificial intelligence, an umbrella of methodologies, encompassing genetic algorithms and evolutionary strategies. For his Ph.D., Dr. Rasheed developed a genetic algorithm for design optimization specifically for solving engineering design problems, saving time on evaluations by considering the history of optimization.

If Rasheed seems naturally predisposed toward engineering, it is no mistake. In his native Egypt, the computer science department was part of the engineering school, where he became a certified engineer. With this merger effect embodied by young researchers like Rasheed, it is little wonder that old barriers are falling in the face of new approaches.

These efforts illustrate the vast changes in computer science, its open marriage with engineering and the further relegation of disciplines beneath an overarching search for solutions. Using all of the energy, theory, and innovation it can muster to surmount modern problems means that cross-discipline collaboration, if not pollination, might mimic the evolutionary principles Dr. Rasheed brings to engineering, marking a new era already in its ascent.

Working at the interface of biology and engineering, William Kisaalita, an Associate Professor of Biological & Agricultural Engineering, sees biology as an essential component in engineered systems designed to meet many emerging societal needs. His biochemical engineering background has led to the development of expertise in growing and manipulating cell cultures, positioning himself and his students to make crucial engineering contributions in accelerated drug discovery.

Dr. Kisaalita's skills span three areas - specialized instrumentation development, manipulating cells and florescent spectroscopy – which have opened up new questions for him and other researchers. His suspicions that traditional, two-dimensional cell culture approaches do not produce cells that do not mimic the behavior of cells in the body have led him to a collaborative partnership with a physics professor from UGA's Nanoscale Science & Engineering Center. The object of the joint effort is to develop three-dimensional structures powerful enough to grow cells in packs, a goal that would have been out of reach just a short time ago.

William Kisaalita

"Knowing the shape of a particular cell receptor, pharmaceutical companies can use their synthetic chemists to generate thousands of drug candidates against the disease," Kisaalita explains. The challenge is to quickly determine the few candidates with promise. Traditional animal experiments are very expensive and 99% of drug candidates may kill the animal. With his cell-based systems in place, companies can very quickly test thousands of drug candidates, narrowing down this huge field to very few on which to run detailed experiments.

Based on his thirty plus years working in a relatively new science, Bernard Patten is an eminent scholar at UGA in the field of systems ecology. Over that time he and his students and coworkers have been able to conceptualize much of what confronts this discipline and its directions, and nothing is more revealing of the science and the scientist than the healthy dose of humility he exhibits before these challenges.

Bernard Patten

"The within and across-scale complexity of an ecosystem or an organism, or even a cell, is beyond our imagination," Patten says pointedly, determined that this young science needs to confront these daedal intricacies and be developed in its hard aspects, as physics and chemistry were. The fact that biocomplexity has come into vogue recently as an NSF initiative is heartening to Patten, a Regent's Professor in the Institute of Ecology, but he insists it doesn't make the issue any easier.

"The details of natural complexity can never be described; we can only unravel it in principle and theory," he says and admits that it is this network theory of ecology, and its mathematical nature, which aligns him with engineering. He is encouraged that the UGA engineering program, through modeling, simulation and analysis, stands to offer more theory to ecology once it begins to understand the nature of environments and look at them with the scrutiny that engineering has always looked at things.

"There's a lot of research to be done in the future in ecology and environmental engineering; it's just opening up," Patten says.

MIT Researcher Recalls UGA Roots

By any measure, the success of an academic program is defined by the success of its students. The Department of Biological and Agricultural Engineering need look only as far as Naveen Agnihotri, a UGA alumnus who recently completed a Ph.D. in neurobiology from Columbia University and has now moved on to Boston to conduct his postdoctoral research at the Massachusetts Institute of Technology.

There he has moved back to his computational roots to work with Sebastian Seung, Assistant Professor of Computational Neuroscience in the Department of Brain and Cognitive Science and the Department of Physics at MIT. Their focus will be investigating the properties of large networks of neurons, trying to understand how the properties of individual neurons and their connections allow large networks of neurons to solve various computational problems.

But as a beginning graduate student, Dr. Agnihotri found himself at a crossroads, thinking his interest in the brain did not mesh with his chosen field of engineering. As he retells it, Dr. William Kisaalita assured him it was not too late, saying, "Don't worry, we'll teach you everything [about biology] you need to know."

Agnihotri says that because of UGA's strong basic science programs, all one had to do to take biochemistry and neurobiology was walk down the street. At that point in his academic career, Dr. Kisaalita became his mentor and Agnihotri's ideas about his own career began to flourish as he was allowed to collaborate with a professor in biology. "William encouraged me to go where I would learn the most appropriate experimental techniques for the project I wanted to do."

Attesting that UGA is uniquely positioned to make these kinds of interactions happen, Dr. Agnihotri says he owes much to the support that made it possible for him to study something he had always wanted to do. "The breadth of the department was immense; there are people working on a wide variety of topics over the entire spectrum of engineering." *We couldn't have said it better.*

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