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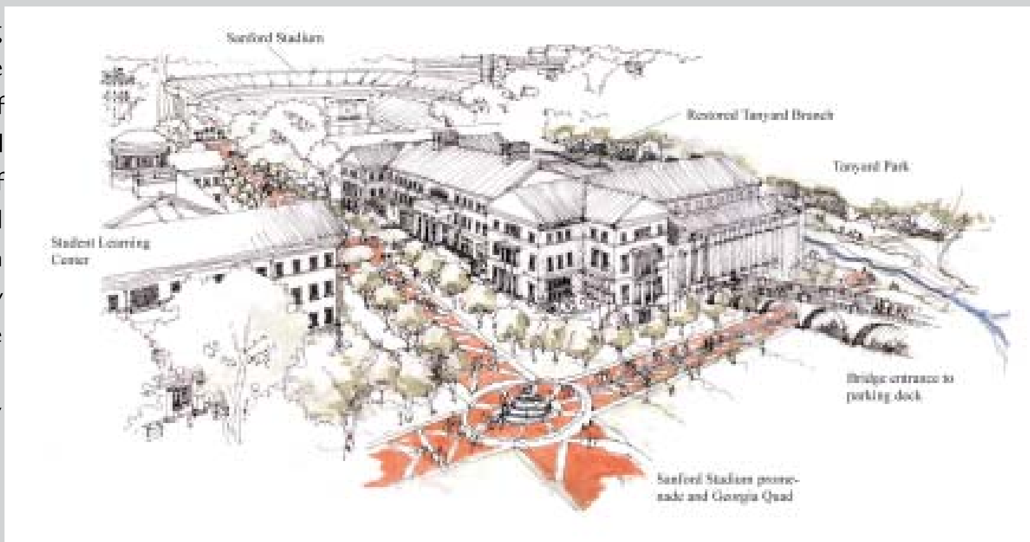
Engineering a Learning Environment

Alan Flurry

Traditionally, environmental engineering programs in the United States have evolved out of civil engineering, where they had their roots in unit process technology. These strategies often revolved around attempts to collect environmental pollutants, treat and then discharge them; these focus-on-the-result strategies have been similar whether in regard to water pollution, solid waste or air. The University of Georgia has the opportunity to create a shift from this emphasis on managing environmental problems to managing natural resources by teaming two of its own budding resources - the Faculty of Engineering and the College of Environment and Design which houses Ecology and Landscape Architecture - with a natural entity long-situated in the University's midst: the Tanyard Creek watershed.



Conceptual Perspective. Proposed UGA Central Campus Development with restored Tanyard Branch and riparian buffer.

The remnants of Tanyard Creek run quietly through and beneath the University of Georgia Campus. The watershed drains portions of downtown Athens along Milledge Avenue and Lumpkin Street emptying into the Oconee River east of Sanford Stadium. Decades of even reasonable development adjacent to campus have left the area once naturally served by the watershed heavily imprinted with impervious area and thus, vulnerable to physical, chemical and ecological damage from storm water runoff. "Most students don't even know the creek is there," says David Gattie, professor in the Faculty of Engineering and one of the architects of the nascent environmental engineering program. He and others point to the watershed situated in the midst of UGA as a piped and paved-over natural mechanism to illustrate the innovative direction of environmental engineering at UGA. "Some of the real water problems are non-point source, which are largely generated from urbanization and planning development. We want to look at the large scale picture of how environmental engineering can address those problems," Gattie explains.

The goal of the program is to take the current natural resource management and environmental engineering within agricultural engineering and couple them with ecology and environmental design to develop a novel approach. The Tanyard Creek watershed is a natural laboratory as well as a unique opportunity. Most urban watersheds are functional mysteries which cannot be explored expressly because of their urban locales, with overlapping city/county/private ownership jurisdictions. With the university as a major landowner and the continued cooperation of Athens-Clarke County, the watershed can become a research site where changes are made and an ongoing database created to monitor the effects of those changes. The hard science expertise at UGA in conjunction with engineering and environmental design will together form the environmental engineering principles for planning and development

see *Tanyard*, p.4

Faculty and Administration Partner to Advance Engineering

As someone who joined the University of Georgia nearly 33 years ago and proposed many ideas over the last two-and-a-half decades for advancing engineering at UGA, the February 6, 2003 meeting of the University Council was a momentous occasion. At this meeting the Council recommended establishing the Institute of the Faculty of Engineering, a status that has since been approved by the University President Michael Adams effective March 3, 2003. The institute status of the Faculty of Engineering authorizes it to administer the University's engineering academic programs. Immediately following the approval of the Faculty of Engineering the Council unanimously approved six new engineering degree proposals for establishing three undergraduate and three graduate degrees in the areas of Biochemical Engineering, Computer Systems Engineering and Environmental Engineering. President Adams has forwarded these degree proposals to the Chancellor of the University System of Georgia for the Board of Regents approval.

Engineering is the bridge between knowledge and the prosperous growth of society. As the Dean of Duke University's engineering school stated at our April 2002 Symposium, "Today's research universities are incomplete and obsolete without engineering — engineering is the liberal arts degree of the 21st century," the future of the University of Georgia is inextricably tied to its ability to research and develop high-tech processes and systems and to educate students for the knowledge-age and technology-dependent future.

The Adams-Holbrook administration of the University of Georgia took on engineering as a strategic issue for the first decade of the new millennium. University faculty have embraced the Faculty of Engineering as a boundaryless, entrepreneurial, networking organization, an innovative model unit for offering the future engineering education, research and outreach programs. The Faculty of Engineering approach adds new dimensions to the University's program for meeting critical educational needs of the state of Georgia in the best tradition of the land-grant mission and has the entire University unified.

The new degrees approved by the University Council provide a major step forward in the advancement of comprehensive engineering at the University of Georgia. The Biochemical Engineering program will offer exciting prospects to link engineering with biochemistry, microbiology, cell biology and other life sciences for developing new bio-based products, biomaterials and bioprocesses. By translating biochemical discoveries into effective bioprocesses and biomanufacturing methods, biochemical engineers create health and wealth. The program will deliver broad based instruction and research opportunities related to metabolic engineering and pharmaceutical engineering and innovations of bio-based products.

Computer Systems Engineering will offer opportunities to link engineering with mathematical and computer sciences for developing innovative computer applications in engineering systems. Computer systems are pervasive in all aspects of social and cultural life. By developing an understanding of electrical engineering and computer science, engineers integrate computer hardware and software representing intelligent decision support to create advanced application solutions. The degree program will deliver broadly based education and a wide range of research opportunities of computer applications in basic and applied sciences, business, humanities, language and visual arts, law and education.

The Environmental Engineering program will advance opportunities to link engineering with environmental sciences for creating sustainable designs. The program will provide in-depth understanding of mathematics, computational methods and engineering sciences and the ability to conduct independent research. Environmental Engineering will provide a wide range of research opportunities on topics related to the remediation of environmental damage from non-point sources in extensive systems, the prevention or reduction of adverse impacts on the environment from human made systems, and the creation of designs that blend to become a benign component of the system ecology.

These unique programs will enable the University of Georgia to increase its engineering academic capacity commensurate to the economic and educational dynamism of the state of Georgia. These advances will also enable UGA to partner with sister institutions in research and development of advanced technology and for providing an educated workforce for the future.

> "the bridge between knowledge and the prosperous growth of society."

The advancement of engineering at the University of Georgia is taking place in a new way. Developing academic programs are intended to educate student engineers in a liberal arts environment with the ability to integrate discoveries from multiple disciplines and to research solutions in emerging areas. The future of engineering education lay at the convergence of disciplines. The Faculty of Engineering as a new model for an engineering school differs in organizational structure from the traditional hierarchical model and captures the opportunities at disciplinary interfaces.

Goethe wrote, "What ever you can do or dream you can begin it. Boldness has genius, power and magic in it." I do believe that the UGA Faculty of Engineering is worthy of this optimism. The new engineering programs are a few powerful steps towards the magic of comprehensive engineering at UGA.

Brahm Verma

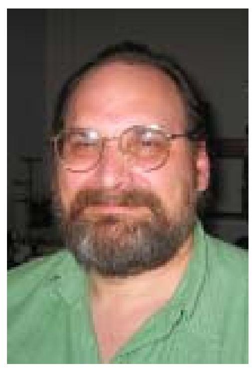
Valentine Nzengung, Associate Professor of Hydrogeochemistry, came to UGA in 1995 and to environmental remediation with an interdisciplinary background, with a Ph.D. in environmental geochemistry via Georgia Tech and the EPA. Nzengung's interest in bio-remediation, such as phytoremediation and enhanced natural attenuation, has allowed a budding expertise to coalesce around a growing environmental problem: perchlorate contamination in soils and groundwater.


Valentine Nzengung

In March, 2003 a bill was introduced in the U.S. Senate to regulate perchlorate, an oxygen-adding component in rocket fuel, on a faster timetable as a result of toxicology studies. Dr. Nzengung, however, has been focused on the solution-end of the problem since 1997, collaborating with Biological & Agricultural Engineering, Crop & Soil Sciences and the U.S. Air Force to develop, evaluate and demonstrate technologies in bioremediation of perchlorate, chlorinated organic contaminants and petrochemicals.

"We can go to some sites and stimulate chemical reduction of contaminants in ground water in situ, rather than use existing technologies such as pump-and-treat and chemical oxidation," he says. The process is more cost-effective and does not mobilize potential high concentrations of metals in anaerobic groundwater, the chief drawback of chemical oxidation. Integrating the science with systems engineering has provided Dr. Nzengung the dexterity to be innovative, and makes his combined expertise one of the models for the Faculty of Engineering as well as the environmental engineering to come.

Semiconductors are well-known as the silicon technology that runs our computers, among other things. But silicon isn't very good at emitting or absorbing light, processes that come into play on the computer screen with phosphors or cell-phones receiving electromagnetic radiation. Chemistry professor John Stickney's work on the detection components that enable this type of nanoscale transmission brings together chemistry, engineering and physics to discover new techniques in compound semiconductor production.


John Stickney

"We're trying to develop a new methodology for the growth of compound semiconductors, which are used to make lasers and the diodes you find in a CD player," he says. A surface chemist, Stickney grows compounds one atomic layer at a time to achieve smooth, high quality compounds. These compounds are then characterized by physicists for use by engineers in forming devices. Stickney points out that the path to new collaborations using his patented new techniques is helping the growth of engineering at UGA.

"The interface between physics, chemistry and engineering is very blurred to some people," he admits. Developing the devices to do the work Stickney has initiated at the atomic level is a rising challenge he hopes will inform future joint appointments in the Faculty of Engineering.

Pattern recognition techniques are the next emerging frontier in information gathering and their applications will push computer science deeper into an array of disciplines. For Computer Science professor Suchi Bhandarkar, image analysis and processing form important components of his work in engineering, forestry and genetics.

Bhandarkar broadly classifies his research in this area as computer vision, designing algorithms to recognize objects and perform image analysis. To date, its applications vary from *ex vivo* surgical planning techniques, in collaboration with UGA engineering and the Medical College of Georgia, to CT scanning of logs to improve sawing techniques. But the possibilities appear limitless.

"Wherever you need non-destructive evaluation and testing, computer vision engineering is applicable," Dr. Bhandarker asserts.

A graduate of the prestigious IIT in India and Syracuse University, he has been at UGA since 1989. Opportunities for improving manufacturing techniques with his research coincide with the expansion of engineering at the university. The need for recognizing patterns in data presage the development of 'smart' sensors that integrate data gathering with analysis, resulting in the convergence of computer science and engineering. Integrating and analyzing information from several sensors in real time will reap benefits from breakthroughs, from vehicular surveillance to mapping of the human genome.


Suchi Bhandarkar

Tanyard, from p.1

in urban ecosystems. "We can then begin to establish some fundamental understanding of urban ecosystem response to substantive changes in the built environment," Gattie says.

The changes proposed for the watershed are indicative of the shift in approach to environmental engineering. Managing rainfall and day lighting the Tanyard Branch to re-incorporate it into the urban ecosystem are prime examples of this new direction. One of the historical strategies of environmental engineering has been to redirect storm water runoff from buildings and parking lots. The new approach will integrate environmental and engineering design in the hydrologic cycle so as to manage the resource instead of managing the problem. In linking systems and process knowledge with design know-how, UGA can offer a comprehensive approach to environmental engineering, one that can be measured and implemented in the real setting of Tanyard Creek.

Benefiting Students

One distinctive element of urban ecosystems generally is also true of Tanyard Creek; students can walk the entire watershed and not gain an understanding about it. Gattie sees great benefit in students spending four years living in an environment that they actually begin to understand. "The urban watershed would be an implicit part of the educational experience," he says.

Jack Crowley, Dean of the College of Environment and Design, agrees: "With the campus as a living laboratory, we're teaching students what to expect and how to conduct themselves when they leave here. If we don't practice it on our campus, that's a tragically missed opportunity," he says. Demonstrating 'best practices' as a way of solving problems on the UGA campus brings all of the principle ingredients of the new environmental engineering into focus, synthesizing campus expertise for re-thinking problems and finding innovative, practical solutions. "There's nothing quite as good as being able to show a student a solution that happens right out in front of the classroom – in a broader sense, Tanyard Creek becomes the classroom," Dean Crowley says.

With water availability becoming more of an issue, the pressure to be innovative will be all the more incumbent on major research institutions. "We want to create a sustainable environment in which to study sustainable design," says Vicki Collins, research technician in UGA's Water Quality Lab. Indeed the time when water was always free and abundant has already passed, and with it, a cultural shift must take place in which conservation and reuse displaces simple flood management. Learning how to properly manage this and other natural resources will be of increasing value in time and UGA is well-situated with both expertise and topography to offer the best of this dynamic learning environment.

For further details on the Tanyard Creek Restoration, please visit www.uga.edu/seeds/.

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