The WILLIAM STATES LEE COLLEGE of ENGINEERING
UNC CHARLOTTE

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Environmental Assistance Office Improves Area Pollution Prevention

The goal of the UNC Charlotte Environmental Assistance Office (EAO) is to increase effective pollution prevention practices in the greater Charlotte area by bringing together students and faculty to team up with government agencies and small businesses.

"The EAO provides non-regulatory, client-confidential pollution prevention assistance," said Executive Director Regina Guyer. "The mission of our office is to increase effective and sustainable pollution prevention practices in the region and provide our students with out-of-classroom experiences."

As an interdisciplinary group, the EAO is made up of students and faculty from Civil and Environmental Engineering, Geography and Earth Science, Chemistry, Biology, English, Health and Human Services, Infrastructure and Environmental Systems, and Computer Science. The work of the group provides valuable experiential research opportunities for students.

"The project nature of our work provides students with practical learning opportunities," Guyer said. "We emphasize interdisciplinary teamwork and create customized teams to meet our partners' needs. Students are involved in multiple aspects of project development and execution as they work under the supervision of EAO staff."

One of the EAO's partners is Charlotte-Mecklenburg Utilities (CMU). Together, CMU and EAO are reaching out directly to the public through an awareness campaign that fosters environmentally sound practices in the home. Research projects have also been conducted in partnership with CMU to investigate sewer system loading and treatment process evaluations.

The EAO works in partnership with two divisions of Mecklenburg County's Land Use and Environmental Services Agency (LUESA). With the Air Quality division, the EAO is helping to promote clean air for the region and providing research reports, outreach activities and small business assistance. With the Solid Waste division, the EAO has provided environmental assessment on the performance of recycled concrete aggregate for erosion control and on recycled gypsum wall board used as a soil amendment.

The EAO also coordinates the Environmental Academy at UNC Charlotte. The Academy brings together faculty with a wide array of expertise who share the common goal of promoting environmentally friendly practices. The Academy sponsors colloquia and research on environmental issues and serves as a resource of expertise for the region.

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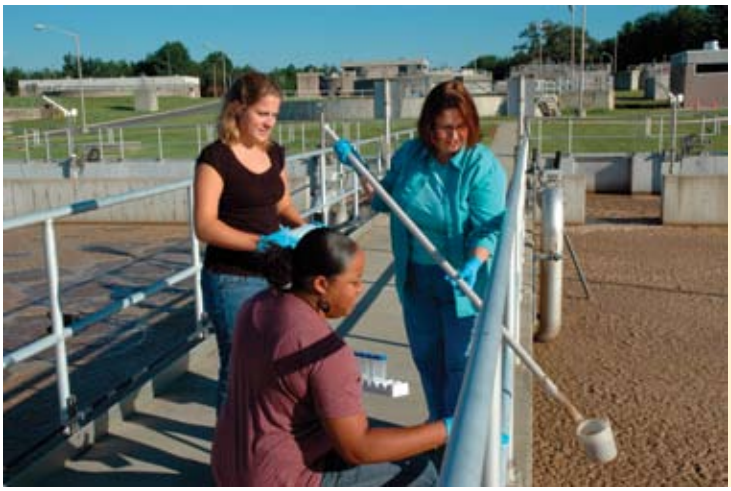


As part of a research project to evaluate treatment processes for Charlotte-Mecklenburg Utilities, UNC Charlotte EAO Executive Director Regina Guyer, standing right, and students Cayce Hefner, standing left, and Brittany Miles take wastewater samples at the Mallard Creek Water Reclamation Facility.

Environmental Assistance Office ... *continued*

Presented by the Environmental Assistance Office and the NC Division of Water Quality, the NCForWater 2008 forum focused on water quality and monitoring.

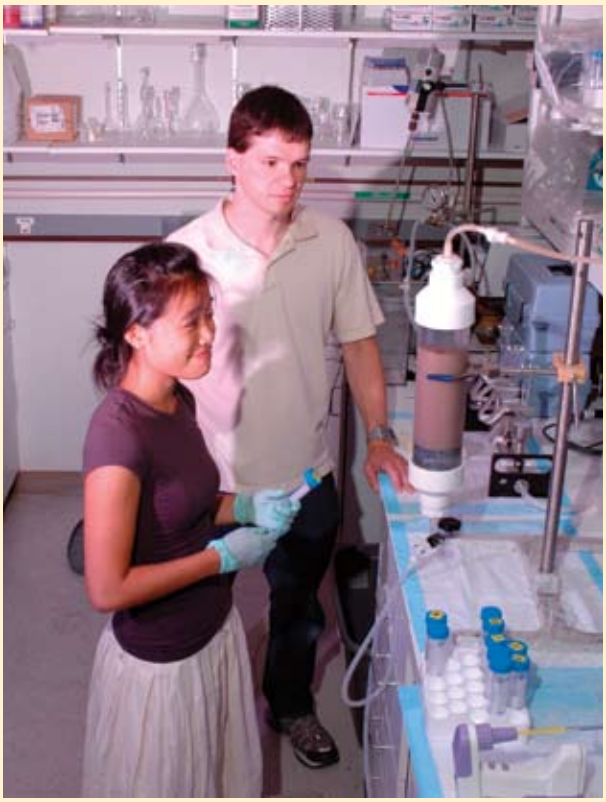
In May 2008, the EAO partnered with the North Carolina Division of Water Quality to present NCForWater 2008, a forum on water quality monitoring. During this two-day forum, more than 40 presentations were made by regulators, researchers, consultants and public groups involved in water-monitoring programs throughout North Carolina. Approximately 250 attendees participated in discussions related to all aspects of water quality and ecological monitoring.

For more information on the Environmental Assistance Office see www.eao.uncc.edu, email eaoforsb@uncc.edu, or call 704-687-3968.

Rapid Sand Filter Delivers Clean, Safe Drinking Water

As an efficient, inexpensive, low-tech way to treat water, the research of Civil and Environmental Engineering Assistant Professor Dr. James Amburgey could bring clean, safe drinking water to potentially billions of people.

Simplicity is the primary objective of the rapid sand filter system Dr. Amburgey is developing. "The idea is to make it as simple as possible," he said. "All that is needed is some PVC pipe, sand and inexpensive treatment chemicals. The only way to practically deploy a system to the people of less developed countries is for it to be inexpensive and simple."



Dr. James Amburgey working with student Alice Wang on the rapid sand filter prototype.

Dr. Amburgey's research specialty is drinking and recreational water treatment. He has done work in the past with slow sand filters, but his latest research with rapid sand filters is demonstrating the ability to clean water much more effectively and 30 to 50 times faster.

"One significant challenge with sand filters is in removing Cryptosporidium oocysts," Dr. Amburgey said. "One 'crypto' is five microns in diameter, but the gaps between grains of sand are approximately 75 microns. So, we have to get the crypto to stick to the sand grains."

To achieve this, Dr. Amburgey has developed a chemical pretreatment scheme based on ferric chloride and a pH buffer that is added to the water. In its natural state, Cryptosporidium is negatively charged, as are sand grains, so they repel one another. The chemical pretreatment changes the Cryptosporidium surface charge to near neutral, which eliminates the natural electrostatic repulsion and causes it to be attracted to and stick to the sand grains via van der Waals forces.

In research using a prototype of this system in his lab, Dr. Amburgey and his students have done preliminary tests on waters from local rivers, creeks and wastewater treatment plants. Their results are typically greater than 99 percent removal for Cryptosporidium-sized particles.

"A common problem in drinking water treatment facilities is that changing water quality requires changes in the chemical pretreatment dosages," Dr. Amburgey said. "Our tests, so far, have shown that this system utilizing only a single set of chemical pretreatment dosages is effective on all waters tested to date."

Another advantage of the system is that it can be adapted by using local sands or crushed rock that are indigenous to a particular region of the world.

Sustainable Development the Future of Engineering For Students and Professionals Alike

The theory of sustainable development says that community, environment, economy and culture are all interrelated and mutually dependent. With such a far-reaching scope, sustainable development is becoming more and more important to all engineering professions. The Lee College of Engineering is addressing sustainability as it educates students in its use, conducts research to further its development and partners with professionals in its application.

A multidisciplinary student team presents its plans for the sustainable renovation of a vacant 'big box' retail facility.

"Sustainability theory says you have to look at all impacts of a project," said Civil and Environmental Engineering Associate Professor Dr. Helene Hilger. "The design impacts the ecosystem, which supports the economy, which supports the social system."

Sustainable design theory advocates conserving 'natural capital' by using fewer raw materials and more reused and recycled materials. "This means wasting less material and landfilling less material," Dr. Hilger said. "To conserve energy resources, you should use local materials, so less transportation is involved. Examples are building with brick in the south and timber in the west."

The growing importance of sustainability is making it a hot topic for students and professionals alike.

"Students now have to learn sustainability theory to make them successful engineers," Dr. Hilger said. "And professional engineers also have to adopt it and begin incorporating it into the way they do their work."

Students from the Civil and Environmental Engineering sustainable design course with their class projects.

To support the professional engineering community in learning about sustainability, Lee College of Engineering faculty members have been delivering talks to area, state and national groups.

In teaching sustainability to students, the Civil and Environmental Engineering Department currently offers one course dedicated completely to sustainable design. There is also a new class being offered in fall 2008 in sustainable storm water. These course and others being developed will be part of two new tracks in land development and sustainable design.

During the summer of 2008, Civil and Environmental Engineering along with Mechanical Engineering, and Architecture piloted a multidisciplinary sustainable design course. As their course project, student teams had to tackle the problem of renovating an abandoned 'big box' retail facility in Charlotte. With help from city and county officials and several UNC Charlotte faculty members, the students developed two conceptual designs for a sustainable renovation of the vacant complex.

A number of research projects in the College of Engineering also now have strong sustainability components. One is in the area of storm water, in which researchers are looking at ways to treat and minimize storm runoff by using bioretention basins, grass swales and a whole group of other technologies in place of curb and gutter.

Another research project is looking at the feasibility of grinding up gypsum board and using it as a soil additive at newly developed sites, either on top of soil or tilled into it just before grass is seeded. Also putting construction waste material to use, a third project is studying ways to break up old concrete and use it for erosion control.

On a larger scale, researchers are working to establish a regional construction and demolition recycling center. The center will create a stock pile of materials and study methods for reuse.

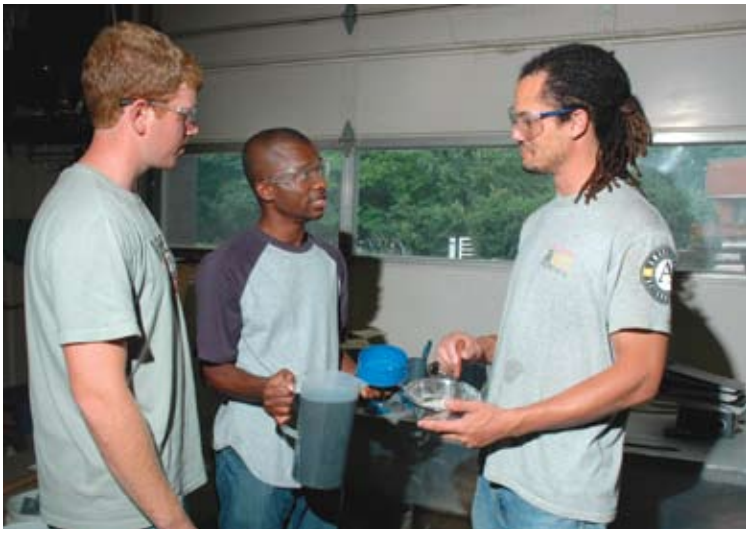
Another long-term project being proposed is the establishment of a center for sustainable design. The interdisciplinary center would bring together researchers from all the engineering disciplines, architecture, sociology, geography and earth sciences, biology, economics and anthropology. The center would have strong ties to the doctoral program in Infrastructure and Environmental Systems.

Fly Ash Concrete Provides Many Green Advantages

The remarkable thing about Ph.D. student Brett Tempest's fly ash concrete is that it is very green. Green in the sense that it is good for the environment.

The environmental advantage of fly ash in concrete goes far beyond just using it as aggregate filler. Chemically activated fly ash is actually used in place of portland cement, which results in a tremendous reduction in CO_2 emissions.

"What's difficult to explain to people is there's no portland cement in this concrete," Tempest said. "Most people think you can't make concrete without portland cement, but you can."



Portland cement is made by heating limestone to very high temperatures, which releases the CO_2 inherent in the limestone. For every ton of cement produced, a ton of CO_2 is released.

A 3"x6" cylinder of fly ash concrete in a universal testing machine.

"It's not just the energy needed to heat the limestone that accounts for the CO_2 production," Tempest said. "It's the releasing of the CO_2 from the limestone itself. That is what portland cement is, and there's no way around it."

In testing, the fly ash concrete is proving to have superior chemical and temperature resistance compared to cement-based concrete. The compression strength of the material is currently at about 3,000 psi.

A Department of Energy grant, made to the Department of Civil and Environmental Engineering in the amount of $492,000, provides 80 percent of funding for future development and improvement of the fly ash concrete.

Ph.D. students Brett Tempest, right, and Olanrewaju Sanusi, center, and master's student Mitch Taylor research the best fly ash and activating solution mix for their concrete.

Engineering Technology Meeting Increasing Demands For Environmental, Sustainability Skills

For the Department of Engineering Technology and Construction Management, teaching environmental engineering and sustainability theory to students is of increasing importance, because these are skill sets that employers are now demanding.

In spring 2008, the ET Department offered a technical elective class in energy auditing and conservation. The class was co-taught by Professor Nan Byars and Faculty Associate Dan Hoch.

"We're clearly seeing industry looking for engineers who have energy management skills," Hoch said. "By offering such a class, we are helping students develop skills that will be more sought after as energy costs continue to escalate."

In the class, students were divided into teams and assigned a local business to work with. "Each team performed an energy audit for the businesses," Byars said. "They first met with the people there, did an audit of the facilities and calculated the energy usage. They then came up with recommendations on ways to save energy and estimated what the energy cost savings would be."

The class was very well received and will be offered again in spring of 2009. "Students are realizing there is more and more demand from industry for these skills," Byars said. "So, we'll keep working to teach students such skills."

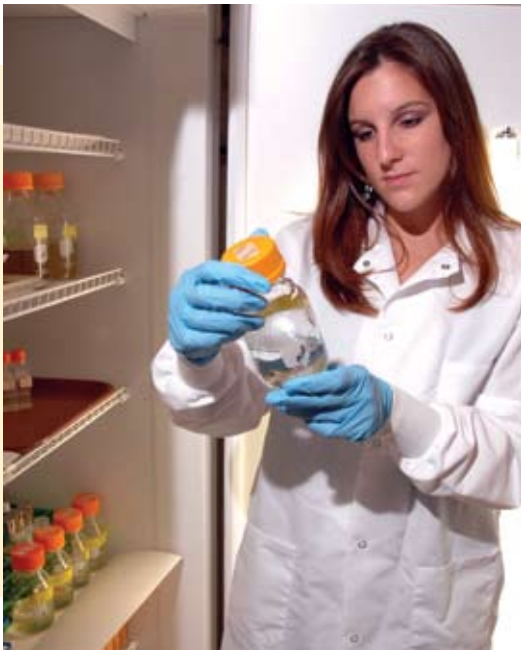
The ET Department also offered a very successful one-credit hour professional development seminar series on sustainability this past year. Assistant Professor Bruce Gehrig was in charge of the series.

"The class had 150 students, which is about 10 times that of most seminar series," Gehrig said. "We had 4-5 speakers come in and talk about how they incorporate sustainability into their projects. They also talked about how to go through LEEDS certification for projects and for professional certification."

The students got the message that companies are looking to hire more LEEDS certified engineers. "The industry speakers made it clear this would be a long-term trend," Gehrig said. "It is a permanent change in the way we will do business in the future."

Extracting Biofuel from Nature's Best Solar Cells – Algae

They are perhaps the planet's most efficient solar cells, and UNC Charlotte researchers are searching for them in greasy, dirty mud puddles. Once found, the team is working to economically extract valuable energy from these slimy organisms.



Mechanical Engineering senior Kimberly Thibert selecting an algae sample from the collection of strains that students have gathered from area ditches, puddles, ponds and streams.

The natural solar cells are algae. As photosynthetic micro-organisms, many algae use sunlight to convert carbon dioxide to lipids, which are plant oils that can be used to produce biofuels.

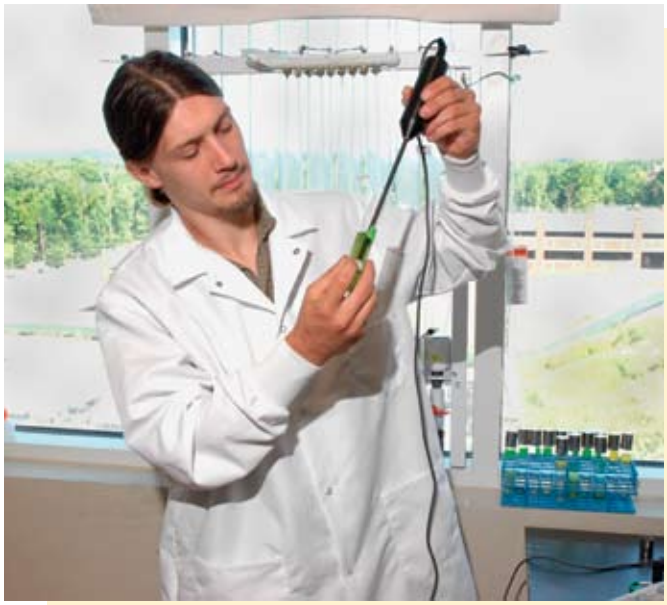
"There is a lot of theoretical potential in algae biofuels," said Mechanical Engineering and Engineering Science Assistant Professor Dr. Gloria Elliott. "It's still very expensive to bring it to market. The growing and processing of the algae is a high-tech problem."

UNC Charlotte is fortunate to have the interdisciplinary talent needed to take on the challenge. Researchers from biology are collecting and characterizing the algae, chemistry is working on lipid-to-biofuel conversion strategies, mechanical and civil engineering are working on the bioprocessing, and automotive engineering is studying performance and emissions in engines.

"We have tremendous strength at UNC Charlotte to contribute to this project," Dr. Elliott said. "We have the people to take it from cradle to grave."

The initial step in producing biofuels from algae is the collection of the algae itself. This effort is being led by Dr. Matt Parrow of the Biology Department.

"Algae are basically microscopic plant-like organisms," Dr. Parrow said. "What we're looking for in terms of good candidates for biofuels is rapid growth with simple nutritional requirements, ability to survive environmental extremes such as high light and heat, and high oil content. These are the things we need most."



Chantry Johnson, a Mechanical Engineering senior, works with a light intensity probe that is used for gathering data from algae samples taken from a laboratory bioreactor.

The best places to find such hardy algae strains are in harsh environments. So, Dr. Parrow has his students collecting algae from greasy mud puddles and newly cut ditches where the first strains of algae begin to grow.

From these collections, Dr. Parrow is isolating and cultivating the most valuable strains. With a growing number of potential strains already identified, the next step is to biopreserve them, which is Dr. Elliott's area of specialty. The next step is processing the algae for fuel. For this, the engineers are looking at a variety of techniques, seeking to use the least energy possible to get the most energy out of the algae.

"We are working with photosynthetic algae, which are essentially living solar cells," Dr. Elliott said. "They are actually nature's most-efficient solar cells. To grow them, we need bioreactors that contain water, CO_2, trace amounts of minerals and sunlight."

The team is now experimenting with a small bioreactor design and a simplified growth medium that consists of only tap water and commercial plant fertilizer. Future plans call for the scaling up of the bioreactor, which may include some industrial partnerships.

Research is also underway into the processing of the algae for fuel. This involves filtering out the water, smashing the algae to extract the oil, collecting the oil and converting it to biodiesel.

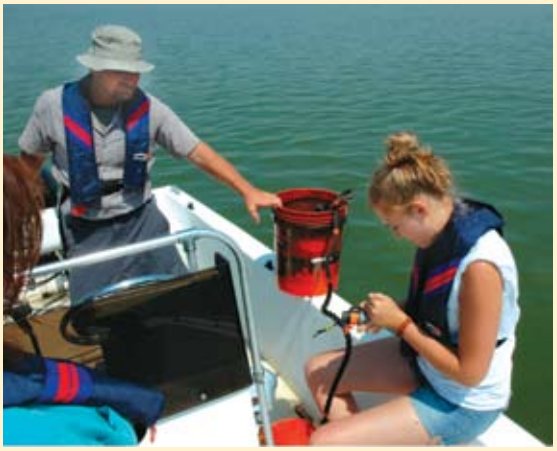
For more information on the production of biofuel from algae, contact Dr. Elliott at gdelliot@uncc.edu.

Solar Bees Improving Water Quality

Partnering with the Water and Sewer Authority of Cabarrus County, researchers from UNC Charlotte's Environmental Assistance Office have been recording water temperature at different depths and investigating algal growth in Don T. Howell Reservoir since March of 2008.

In July, six solar-powered water recirculators, known as "solar bees" for their spindly legs and wing-like solar panels, were set up in the reservoir. Their primary function is to recirculate the water at different depths in an effort to improve water quality. Comparisons are now being made of the water quality before and after the installation of the solar bees.

One of six solar bees that recirculate water in an effort to improve reservoir quality.



"Water temperature distribution in a reservoir cycles with the seasons," said EAO Executive Director Regina Guyer. "At this point, we're establishing a baseline in our data, so we can evaluate the contribution of the solar bees."

Emily Lukens, a Civil and Environmental Engineering sophomore at UNC Charlotte, and Todd Sheeks, a reservoir maintenance technician from the Water and Sewer Authority of Cabarrus County, use a data logger to download water temperature information at Don T. Howell Reservoir. At each lake data collection buoy, five sensors record temperature at different depths every 10 minutes.

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