arkansas ENGINEER

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UNIVERSITY OF ARKANSAS
COLLEGE OF ENGINEERING

Water Quality

In Julian Fairey's lab, researchers look at different ways to remove contaminants from drinking water. Inside these plastic jars, chemicals called coagulants are causing small particles to stick together, making them easier to remove from the water.

On the cover:
Ranil Wickramasinghe's research group is working on a new class of membranes, thin films that can be used to filter water. The researchers are modifying the surface of these membranes to make them magnetically responsive. This will help prevent fouling, or build-up on the surface of the membrane.

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Terry Martin

Interim Dean of Engineering
Professor of Electrical Engineering

This issue of our magazine comes at an exciting time. I am very pleased to welcome alumnus and dear friend John English back to the College of Engineering. Dr. English will become dean of engineering on July 1. He comes to us from Kansas State, where he has served as dean since 2007. Before that, he was head of the industrial engineering department here at the University of Arkansas. Dr. English is an accomplished engineer, professor and administrator with a record of successful leadership both at Kansas State and here at the University of Arkansas, and we are all very happy that he plans to return home to Fayetteville.

Dr. English is stepping into his new role at an important time for the college and the university. The University of Arkansas has set a new goal of becoming one of the top 50 public research universities in the nation, and the College of Engineering is working hard to support this goal, through our efforts in both research and education. As I walk through the halls of Bell Engineering Center and the newly-named John A. White Jr. Engineering Hall, I feel optimistic about this goal. We've had record enrollment again this semester, and our hallways and classrooms are full of bright and talented future engineers. In our labs and offices, U of A engineering professors are hard at work mentoring students and focusing on technological advancements to solve the challenges of our world.

One of these challenges is water quality. Water is essential to life: it quenches our thirst, flushes away waste and supports our natural environments. But if our water systems aren't clean and healthy, our health and ecosystems suffer. Researchers like Julian Fairey are making sure that your drinking water is as clean as possible, while Wen Zhang and Ranil Wickramsinghe are finding more efficient ways to treat wastewater. The Arkansas Water Resources Center tests water quality around the state, and businesses like Garver and BlueInGreen keep our water clean and healthy, while providing jobs for local engineers. And in Belize, Arkansas engineering students are helping developing communities improve their water supply.

I hope you find this issue interesting and informative, and I invite you in to join me in welcoming our new dean.

Terry Martin

Last fall, historic Engineering Hall was formally dedicated as the John. A. White Jr. Engineering Hall, in honor of former chancellor and College of Engineering alumnus John A. White Jr.

It is exciting to return to my alma mater as the dean of engineering. With its talented faculty, staff and students, the college at the University of Arkansas is one of the leaders in engineering education and research, and it is poised for greater prominence.

John English

John English will be the ninth dean of the College of Engineering, and he will hold the Irma F. and Raymond F. Giffels Endowed Chair in Engineering.

A respected expert on quality and reliability engineering, English has published numerous articles and book chapters in these fields as well as in the areas of logistics and material handling. His awards include the Halliburton Research Award, the Dr. Theo Williamson Award from Integrated Manufacturing Systems and the Continuing Professional Development Best Paper award from the American Society for Engineering Education. He is a fellow of the Institute of Industrial Engineers.

English received a bachelor's degree in electrical engineering and a master's degree in operations research from the University of Arkansas. He holds a doctorate in industrial engineering and management from Oklahoma State University. He was a faculty member in the University of Arkansas department of industrial engineering from 1991 to 2007 as well as head of the department from 2000 to 2007. In this role, English helped increase the reputation of the department. From 2000 to 2005, English was the founding director of the Center for Excellence in Logistics and Distribution, a National Science Foundation Industry and University Cooperative Research Center. While director of the GENESIS Technology Incubator at the University of Arkansas from 1999 to 2001, English helped start-up companies commercialize technological advances.


Ed Pohl


Lalit Verma


Norman Dennis


Christa Hestekin

Online Program Recognized by U.S. News and World Report

U.S. News and World Report has listed the College of Engineering's Master of Science in Engineering program as 25th out of 66 online graduate engineering programs in its Best Online Programs rankings.

The Master of Science in Engineering program, directed by Ed Pohl, associate professor of industrial engineering, has been offering online degrees since 2009. It is taught by graduate faculty from the College of Engineering. This program is designed for students who want to further their education in a variety of engineering topics, and its graduates are well-prepared for a career in engineering and management of engineering systems, processes and organizations.

The Master of Science in Engineering program is open to students with a bachelor's degree in any engineering field and incorporates classes from the traditional master of science degrees in biological, chemical, civil, computer systems, electrical, environmental, industrial, mechanical and transportation engineering, as well as operations management.

Professor Elected President of Agricultural and Biological Engineering

Lalit Verma, head of the department of biological and agricultural engineering, has been elected as the 2013-2014 president of the American Society of Agricultural and Biological Engineers. Verma, who is currently serving as president-elect of ASABE, will take office as president in July.

The American Society of Agricultural and Biological Engineers is a scientific and educational organization dedicated to the advancement of engineering applicable to agricultural, food and biological systems. Founded in 1907, ASABE has members in more than 100 countries. ASABE members serve in industry, academia and public service and are uniquely qualified to determine and develop more efficient and environmentally sensitive methods of cultivating food, fiber and timber for an ever-increasing world population.

Verma is a fellow of ASABE, the American Institute for Medical and Biological Engineering and the Institute of Biological Engineering. Verma is also internationally recognized for his research in rice and forage post-harvest engineering and technology.

Two Professors Selected for Frontiers Symposium

Norman Dennis, University Professor of civil engineering and interim associate dean of the College of Engineering, and Christa Hestekin, assistant professor of chemical engineering, were selected to attend the National Academy of Engineering's fourth Frontiers of Engineering Education symposium. The symposium was held in Irvine, Calif., in October.

Seventy-two engineering educators from across the nation were invited to the symposium, where they shared ideas and learned about research and best practices in engineering education. The focus of this year's forum was innovations in the context, curriculum, and delivery of engineering education.

"The Frontiers of Engineering Education program creates a unique venue for engineering faculty members to share and explore interesting and effective innovations in teaching and learning," said NAE President Charles M. Vest. "We want FOEE to become a major force in identifying, recognizing, and promulgating advances and innovations in order to build a strong intellectual infrastructure and commitment to 21st-century engineering education."

Haggard Chosen as National Institutes for Water Resources President

Brian Haggard, professor of biological and agricultural engineering, has been elected president-elect of the National Institutes for Water Resources. Haggard will serve as president-elect until October and then serve a year as president.

The NIWR consists of water resource research centers in each state that serve under a congressional mandate to form the primary link between water experts in the nation's universities and those who manage and use water.

Haggard is also the director of the Arkansas Water Resources Center of the University of Arkansas System Division of Agriculture. At the water center, Haggard coordinates with researchers working on several projects funded from sources including the Arkansas Natural Resources Commission and the U.S. Geological Service.

Brian Haggard

Mantooth Elected Society's Vice President of Operations

Alan Mantooth, a Distinguished Professor in the department of electrical engineering, was elected as the 2013-2014 vice president of operations for the Power Electronics Society in November.

The Power Electronics Society is part of the Institute for Electrical and Electronics Engineers. The Power Electronics Society is one of the fastest growing technical societies in IEEE and works to facilitate and guide development and innovation in power electronics technology.

As the vice president of operations, Mantooth will coordinate and supervise committees in the society, coordinate chapter activities and work to refine the Technical Interest Profile of the society through membership interests and emerging trends in the field.

Alan Mantooth

Matlock named Executive Director of the Office for Sustainability

Marty Matlock, professor of biological and agricultural engineering, has been named as the first executive director of the campus-wide office for sustainability at the University of Arkansas. Provost Sharon Gaber and Associate Vice Chancellor for Facilities Mike Johnson appointed Matlock to demonstrate the increased emphasis on sustainability across all campus activities.

Matlock will coordinate program implementation and strategy development for sustainability activities across the U of A community. He will work with Johnson to coordinate the director and staff of the office for sustainability in a number of initiatives. The U of A Sustainability Council, composed of representatives of academic units and student groups, will advise the office for sustainability.

Marty Matlock

Osborn Wins Gold Medal Award From Professional Society

Scott Osborn, associate professor of biological and agricultural engineering, is the winner of a Gold Medal award presented by the American Society of Agricultural and Biological Engineers. Osborn won the Massey Ferguson Educational Gold Medal, which honors people whose dedication to the spirit of learning and teaching in agricultural engineering has advanced with distinction agricultural knowledge and practice.

Osborn was selected in recognition of his exceptional achievements in teaching and for his leadership in developing new curricula in the rapidly developing area of biological engineering and in reform of engineering education to more fully integrate design and discovery-based learning.

Scott Osborn

A New Way to Improve Immune Response

David Zaharoff, assistant professor and holder of the Twenty-First Century Endowed Professorship in Biomedical Engineering and doctoral student Bhanu Koppolu have encapsulated protein antigens in chitosan and demonstrated that the combined material enables or improves immune responses.

Vaccine development over the past decades has shifted toward antigens, which are toxins or other foreign substances that induce an immune response. Medical researchers have focused on encapsulating polypeptide antigens in nano- and micro-particles, an approach that has several advantages. The particles prevent antigen degradation, facilitate ingestion of chemical agents into antigen-presenting cells and can be engineered to carry adjuvants, or substances in addition to the primary antigen or drug.

One material that Zaharoff has focused on is chitosan, a natural polysaccharide derived primarily from the exoskeletons of crustaceans. Chitosan-based vaccine delivery systems have many advantages. The particles are easy to produce, and polypeptides can be encapsulated during particle formation or absorbed into particle surfaces after formation. Most importantly, chitosan's muco-adhesiveness and ability to loosen gaps between layers of tissue make it an excellent vehicle for delivering vaccine agents.

The researchers' in vitro experiments demonstrated that antigens encapsulated in chitosan enhanced activation of antigen-presenting cells. The combined material also increased the release of cytokines – proteins that produce an immune response – and caused a proliferation of antigen-specific T cells, or lymphocytes, which also actively participate in immune response.

The Solar Impulse HB-SIA, which is flying across the United State this summer, using only solar energy. © Solar Impulse/ Jean Revillard.

U of A Engineer Contributes to Solar Plane Project

Solar Impulse, a fuel-free solar plane, is making a trip across the United States this summer. This plane is the brainchild of Bertrand Piccard and Andre Borschberg, two pilots who have a goal of showing the world what can be achieved with solar energy.

The next step in the project is a solar plane capable of flying around the world. This plane, the Solar Impulse HB-SIB, is currently under construction, and Robert Saunders, a graduate of the College of Engineering and an instructor in the electrical engineering department, is designing its autopilot system. Saunders' employer, TruTrak, has partnered with Solar Impulse in this endeavor. The plane is scheduled to attempt a round-the-world flight in 2015.

New Program Promotes Graduate Education

Manuel Rossetti, holder of the John L. Imhoff Chair in Industrial Engineering, would like more Arkansas students to gain experience in graduate school and use this experience to improve the state's engineering work force. Rossetti, professor and holder of the John L. Imhoff Endowed Chair in Industrial Engineering, has initiated a new program to achieve this goal.

The Student Integrated Intern Research Experience aims to increase the number of highly skilled employees in Arkansas who are ready to apply engineering research. It will serve engineering students with financial need, connecting them with faculty and industry through mentorships.

Students in the program may participate in either co-operative education, earning class credit through a paid job, or an internship. They will work with faculty and industry mentors to identify a research project related to their job or internship. This project, which will become the student's master's thesis, will help the student and mentors understand how engineering research can be applied on the job, and it will highlight the benefits to companies of hiring engineers with graduate degrees.

A Solar Energy Storage Solution

When it comes to solar energy, storage is a big challenge. One approach is to store it in the form of heat, using molten salts, oils or beds of packed rock, but these methods can be expensive or can damage storage tanks. Researchers at the U of A have developed an alternative, which could increase energy production at solar power plants while decreasing costs.

Civil engineering professor Panneer Selvam and doctoral student Matt Strasser designed and tested a structured thermocline system that uses parallel concrete plates instead of packed rock inside a single storage tank. The plates were made from a special mixture of concrete developed by Micah Hale, associate professor of civil engineering. The system takes heat from solar panels and transfers it through steel pipes into the concrete, which absorbs the heat and stores it until it can be transferred to a generator. Modeling results showed this method has an efficiency of 93.9 percent, doesn't damage the storage materials and would cost only $0.78 per kilowatt-hour.

Graduate student Ellen Brune is taking her research beyond the lab.

Student Uses Research to Start Biotech Company

Engineering researchers at the U of A have developed a method to simplify the pharmaceutical production of proteins used in drugs that treat a variety of diseases and health conditions, including diabetes, cancer, arthritis and macular degeneration.

Ellen Brune, a doctoral student in chemical engineering is the primary researcher and inventor of the technology. With assistance from the National Science Foundation Innovation Corps program, she has started a company, Boston Mountain Biotech LLC, to shorten development time so that new drugs can get to patients faster. Current protein pharmaceutical development is a complicated, time-consuming and expensive process because manufacturers must separate and extract contaminant proteins.

Terahertz Imaging System Will Advance Methods of Detecting, Treating Cancer

The acquisition of a state-of-the-art terahertz imaging system will enable University of Arkansas researchers to further their investigation of an alternative method of detecting and treating breast cancer. The unique system, made possible by a $400,000 grant from the National Science Foundation and $171,428 in matching funds from the university, will deepen scientists' understanding and use of terahertz radiation and imaging techniques as they apply to a variety of applications.

"Among many important applications, this system will allow us to continue our work on developing a non-hazardous and non-invasive imaging system for breast-cancer," said Magda El-Shenawee, professor of electrical engineering and principal investigator for the NSF award. "But it's really more than that…The system includes therapeutic applications as well. Because of the unique properties of terahertz light, the system will help reduce cancer recurrence by contributing to the thermal ablation of tumors."

Co-investigators of the NSF grant are Greg Salamo, Distinguished Professor of physics, and Steve Stephenson, research professor in biological sciences, at the University of Arkansas; Robert Griffin, professor of radiation oncology at the University of Arkansas for Medical Sciences; and Gilbert Pacey, professor of biochemistry at Miami University in Ohio.

The system will also help researchers at the Institute for Nanoscience and Engineering guide the fabrication of nanoscale materials and devices and help biologists study the water content of plants and the presence of fungi in various types of both living and dead plant material.

Everything that lives needs water, preferably clean water.

When you fill a glass from the tap, turn on your lawn sprinklers or enjoy a day of fishing at the lake, you are benefitting from the time and efforts of water quality researchers and companies. They are dedicated to keeping our drinking water clean, processing our wastewater and keeping our natural water systems healthy. At the University of Arkansas, faculty in several different engineering departments are looking at water quality from different perspectives, finding new ways and more efficient ways to keep our water clean. And by working with local industry, these researchers ensure that this important work makes its way to our homes and our local ecosystems. The water quality research on campus benefits students, as well. Student researchers get to apply their classroom knowledge in the real world, and this experience helps them find jobs. And through the Belize service learning program, engineering students are applying their skills to help people in developing communities get access to clean water.

Julian Fairey is exploring ways to use carbon nanotubes to improve the process of drinking water treatment.

A Nanoscale Approach to Cleaner Water

By Camilla Medders

The practice of using chlorine to disinfect drinking water is arguably the most important public health achievement in the last one hundred years. However, like many beneficial processes, disinfection is not without its drawbacks. When chlorine is added to water, it reacts with natural organic matter to form a suite of chemicals, called disinfection byproducts, or DBPs. Since the 1970s, scientists have identified over six hundred DBPs, many of them suspected carcinogens. Julian Fairey, assistant professor of civil engineering, is studying the use of carbon nanotubes to reduce the formation of these byproducts in drinking water.

The Downside of Disinfection

All drinking water sources contain organic matter, derived from algae, land plants, soil and other natural substances. While particulate matter settles out during typical treatment processes, nano-sized particles called colloids remain in the water and react with chlorine to form disinfection byproducts such as trihalomethanes, haloacetic acids, bromate and chlorite. These chemicals are regulated by the Environmental Protection Agency, and other DBPs, such as nitrosamines, could be regulated in the next few years. Fairey's research could lead to methods of producing drinking water with lower concentrations of DBPs.

What's in the Water?

In Fairey's lab, researchers use several machines to analyze the chemistry of water at different stages of the drinking water treatment process. Fairey and his students look at "raw" waters, sampled from lakes and rivers from across the United States, to determine how the chemistry of natural organic matter relates to treatment and DBP formation. To curb DBPs, the researchers must first understand the chemical and physical nature of the organic matter in the waters, and Fairey explained there are substantial differences in matter found in raw water from different locations.

"Raw waters vary considerably," he explained. "There are a lot of differences in the properties of the DBP precursors, and how those precursors behave in treatment varies from one location to another," Fairey continued. "We're trying to identify fundamental properties of natural organic matter as related to DBP formation and control."

In addition to studying the precursors, Fairey and his students analyze water that has been chlorinated to see what chemicals are present. "We look at what various treatment processes are doing and what various treatment processes are not doing and try to improve them," Fairey explained.

The Need for a New Approach

The most common way to reduce DBP formation in drinking water is called enhanced coagulation. In this process, a coagulant is added to the water, causing the particles and some organic matter to stick to larger particles and settle out.

Unfortunately, enhanced coagulation typically doesn't remove enough organic matter to curb the formation of DBPs sufficiently. "What is left over from the enhanced coagulation process in many cases is still fairly potent in terms of disinfection byproducts," said Fairey. "So we're trying to develop a new technology to deal with the fraction of natural organic matter that remains after enhanced coagulation."

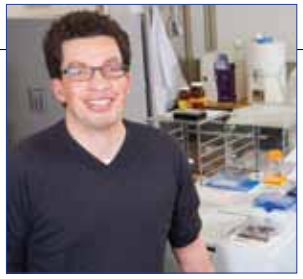
Creating a Super Filter

Fairey is investigating the use of carbon nanotubes to remove natural organic matter from water. He has been awarded a Faculty Early Career Development, or CAREER, award from the National Science Foundation. The award supports Fairey's research with $404,969 over five years.

Carbon filters are common; they can be found in household water filtration systems. These filters have holes, which trap chemicals the way a sponge traps water. However, activated carbon has substantial bulk material that cannot be utilized for adsorption. Fairey is developing a filtration system using carbon nanotubes, which are sheets of carbon molecules rolled into cylindrical shapes without the wasted bulk material. A carbon nanotube filter would contain more surface area for adsorption relative to activated carbon filters, and would consequently be able to adsorb much more of the organic matter.

The Perfect Surface

Fairey explained that while carbon nanotubes have been extensively studied in other fields such as electronics, optics and materials science, their tunable surface properties have not been tailored to remove precursors of disinfection byproducts. He plans to change that by optimizing the surface chemistry of carbon nanotubes for enhanced adsorption of natural organic matter. Using different chemicals, Fairey will chemically alter the surface of the nanotubes until he has found the best chemistry for adsorbing DBP precursors. Fairey's research could help water utilities meet current and future DBP regulations, leading to cleaner, safer water coming from your tap.



We look at what various treatment processes are doing and what various treatment processes are not doing and try to improve them.

Julian Fairey, assistant professor of civil engineering

Algae:
A Green Way to Process Wastewater

By Camilla Medders

In Wen Zhang's lab, flasks of pale green water sit on a table. Magnets under the flasks spin plastic cylinders, stirring the water. The color comes from particles of Chlorella Vulgaris, a type of algae. Zhang and her students are cultivating this algal species to study its use in reducing phosphorus in wastewater.

From Pollution to Prevention

The idea of adding algae to the wastewater treatment process is counterintuitive. Since algae thrive on an overabundance of phosphorus in water, algal blooms in lakes and ponds are a sign of water pollution, and they can lead to further water quality issues. Zhang explained that the problem is the decomposition of the algal cells.

"When algae are alive and carry on photosynthesis, that's definitely good, because they are degrading nutrients and producing oxygen," she explained. "But when algae die, bacteria in the water decompose the algal cells. And when they do that, they consume a lot more oxygen in the water, and that will drop the oxygen levels significantly, to a level where it becomes dark and smells.

"We are trying to reverse this process," Zhang explained. She is hoping to use the relationship between phosphorus and algae to improve the efficiency of wastewater processing.

Lowering the Goal

Traditionally, bacteria are used to remove nutrients such as nitrogen and phosphorus from wastewater. Zhang explained that currently, wastewater treatment plants can achieve phosphorus levels of around 8-10 milligrams per liter of water using this method. In 2002, however, Oklahoma passed a regulation requiring that total phosphorus concentration in scenic rivers not exceed 0.037 milligrams per liter of water. Zhang explained that Arkansas is also expected to pass regulations to reduce the amount of phosphorus discharge from wastewater treatment plants soon, possibly to levels below 1 milligram per liter of water.

To reach this goal using only conventional methods, treatment plants would have to add additional phases to their systems, which would be costly, or use chemicals to precipitate the phosphorus out of the water, which creates chemical waste.

The algae growing in these flasks will soon be used to test a new approach to wastewater treatment.

Zhang is developing an alternative: adding algae to the treatment process. She envisions a reactor with algae attached to surfaces inside. As part of the treatment process, wastewater would enter the algae reactor, and the algae would remove phosphorus from the water. In addition, the algae could easily be harvested and used to produce biofuels.

Testing the Hypothesis

Currently, Zhang and her students are investigating all the steps in this process. The algae they are growing in the lab will be put in a specially designed bioreactor, which they will fill with wastewater effluent from a local treatment plant. The researchers will measure phosphorus levels in the water before and after it is exposed to the algae in order to see how effective their system is.

Zhang also hopes her algae will also be a good source of biofuel. Giving the algae a surface to attach to stimulates the cells to produce extra-cellular polymeric substance, or EPS, which acts like a glue. EPS contains lipids, which can be extracted and converted into biodiesel, a sustainable alternative to fossil fuels.

Zhang, who came to the university in the fall of 2011, sees a lot of potential for the project. "If this is the right direction," she said, "not only will this lower phosphorus, but it can also help with energy consumption."

If this is the right direction, not only will this lower phosphorus, but it can also help with energy consumption.

Wen Zhang, assistant professor of civil engineering

Adding more oxygen increases treatment capacity without increasing footprint of the facility

Scott Osborn, associate professor of biological and agricultural engineering

BlueInGreen:
Pioneers in Water Treatment

By Camilla Medders

Behind the Arkansas Research and Technology park lies a peaceful-looking pond surrounded by reeds. But this retention pond is more than just an incongruous piece of nature in a high-tech setting. It's an outdoor lab, a place for BlueInGreen, LLC, a Virtual Incubation portfolio company founded by U of A engineering professors Marty Matlock and Scott Osborn, to test and refine its water-treatment technology.

A few feet from the shore, a miniature version of the company's patented SDOX machine is being used to study processes to keep the pond healthy. The unit, which is owned by the U of A Technology and Development Foundation, draws small amounts of pond water into a tank, where it saturates the water with oxygen before pumping it back. This process is an efficient and cost-effective way to put oxygen into water, and BlueInGreen's unique technology has earned it national recognition.

The Need for Oxygen

In wastewater treatment, oxygen is a vital ingredient, because it supports the bacteria that break down waste products. The more oxygen available in the water, the more efficiently the bacteria function. "The cheapest way to get rid of some of the bad stuff in the water is bacteria," explained Osborn. "Adding more oxygen increases treatment capacity without increasing the footprint of the facility." Oxygen also keeps the bacteria from smelling bad, because when bacteria run out of oxygen, they switch to anaerobic processes, which produce unpleasant odors.

A New Approach

Traditional methods of dissolving oxygen in water are not very efficient. In most wastewater treatment facilities, large amounts of water are pumped full of bubbles, mixed with air in a surface agitator or flowed over a drop structure to produce turbulence. These methods can result in wasted oxygen, as the gas escapes across the surface of the water or bubbles back into the air.

The SDOX machine takes a different approach, spraying particles of water into oxygen gas. The result is water that contains up to 350 milligrams of oxygen per liter. In Arkansas streams, the required level of oxygen can be up to 10 milligrams per liter, which means a little bit of SDOX-treated water goes a long way.

The company's technology is currently in use at the Noland Wastewater Treatment Facility in Fayetteville and Lake Thunderbird in Oklahoma. An SDOX machine helped clean up a creek that was contaminated by sewage during Hurricane Sandy, and the company is studying the use of its technology in salt water, with the aim of cleaning up oil spills and restoring dead zones in the Gulf of Mexico. In 2010, the company received the Innovative Technology Award from the Water Environment Federation.

Creating Jobs

Several of BlueInGreen's employees are U of A students or graduates, including Darryl Fendley, who earned a master's degree in environmental engineering from the U of A, and Jessica Hart, who has a bachelor's degree in biological engineering, and got involved with the company while working with Osborn as an undergraduate. Fendley enjoys being on the cutting edge of water quality. "We're pioneering a new way to do something," he explained. "There's not a lot of other people trying to do this kind of thing."

Into the Future

Clete Brewer, president and CEO, sees BlueInGreen as a company that provides a "total package solution," to its clients, offering expertise and project management along with equipment. Brewer explained that the company is ready for the next phase of business success. "We're over the curve of the 'prove it' mentality," he explained. "The future is going toe to toe and winning."

Darryl Fendley and Jessica Hart, two U of A graduates who are applying their skills as BlueInGreen employees.

Student Researchers at the Arkansas Water Resources Center

By April Robertson

Morgan Welch, a graduate student studying biological engineering, stands in the middle of a bridge dangling a clear, horizontal cylinder, known as an alpha-sampler, by a rope, easing it into Mullins Creek to scoop up a sample from the middle of the water.

After retrieving a couple of samples, Welch repeats the process at two urban creeks in Fayetteville, Niokaska Creek at Gulley Park and Spout Springs near Walker Park. Sampling from these three creeks allows him to look at how urban development changes the quality of the water.

It's the first step in establishing better water quality: finding the root of the problem.

Typically, he takes samples during daylight hours at each site weekly to establish chemical conditions during base-flow and storm events at the stream. Upon returning to the lab, he analyzes the water for various forms of nitrogen, phosphorus and solids or sediment to evaluate the water quality at each creek.

Welch's research will help establish how nutrients in urban streams change seasonally, how urban development affects water quality, and how loads from urban areas compare to those from agricultural areas.

Welch works for the Arkansas Water Resources Center, which collaborates with the U of A to train water scientists and engineers. Brian Haggard, director of the AWRC and a U of A engineering professor, explained that his students learn valuable skills working for the center. "These students are learning to perform water sampling, analysis and creative problem solving, which will help them find good jobs, and keep our state supplied with talented engineers to address water resource needs."

The Illinois River Question

Jason Corral hops out of his truck, shrugs on a red jacket, straps on wading boots and heads into the White River. He steps from stone to stone, stops suddenly and plunges a large metal pole into the rushing water. He consults the electronic meter on his waist, which is collecting data by way of acoustic Doppler current meter.

Corral is a biological engineering graduate student at the U of A who conducts nutrient dynamics research on the Illinois River and Lake Frances, a shallow lake on the border between Oklahoma and Arkansas. His research sampling trips often begin this way, using the acoustic Doppler current meter to track the flow rate–the discharge and velocity–of water by shooting sound waves into the water and tracking the rate at which they return. Since the rate varies so widely from point to point in rivers and streams, he will begin in one spot, take the flow rate measurement, then move up the stream to repeat the process, then downstream to repeat the process once more. Back at the lab, he'll calculate the average of the three numbers to record an accurate daily measurement.

Graduate student Morgan Welch analyzes water samples from urban creeks in Northwest Arkansas.

Next, he scoops up a sample or two of the water with a plastic bottle. Later, he'll analyze it for levels of phosphorus, nitrate and other nutrients.

Two States, Two Sets of Regulations

The Illinois River is important because the regulations on clean water differ between the two states. "Oklahoma considers it a scenic waterway and Arkansas considers it to be on the level just under that," Corral said. This means that limits on the amount of phosphorus allowed in the water are lower on the Oklahoma side.

Arkansas researchers like Corral have been monitoring water quality on their state side, showing steady improvements. The problem is that by the time the water from the Illinois River makes it to Oklahoma, the water chemistry may change, increasing in nutrients, like

Continued on page 14

These students are learning about water sampling, analysis and creative problem solving, which will help them find good jobs and keep our state supplied with talented engineers to address water resource needs.

Brian Haggard,
Director of the Arkansas Water Resources Center and professor of biological and agricultural engineering

What is the Arkansas Water Research Center?

The AWRC is one of a national network of 54 institutions that make up the National Institutes for Water Resources.
It was founded in 1964 when US Congress passed the Water Resources Research Act.
The AWRC has been housed in the UA System Division of Agriculture since 2008, when Brian Haggard was named Director.

AWRC receives funding from state and federal agencies including:

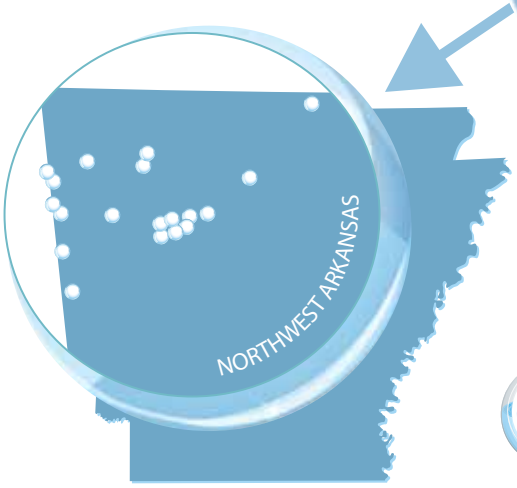
- Arkansas Natural Resources Commission
- US Environmental Protection Agency
- Arkansas Game and Fish Commission
- US Geological Survey

COLLABORATES with local non-profits including:

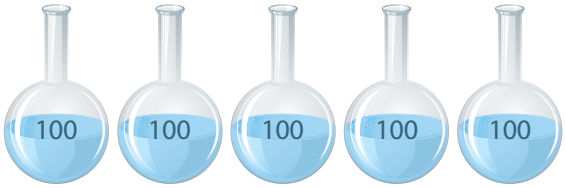
- Beaver Watershed Alliance
- Lake Fayetteville Watershed Partnership
- Illinois River Watershed Partnership

AWRC

NIWR — THE NATIONAL INSTITUTES FOR WATER RESOURCES



AWRC **COLLECTS WATER SAMPLES** from around 20 sites in Northwest Arkansas on a weekly basis



The AWRC water quality lab **ANALYZES** approximately 500 water samples each month, and even more during the rainy season.

FUNDS U of A research projects, **HOSTS** a conference every year

What does the AWRC do?

- Their mission: to train future water scientists and engineers. AWRC has supported water research at the University of Arkansas, Arkansas State University and the University of Arkansas Monticello.
- The AWRC receives ~$92,000 each year from the USGS to fund research projects by faculty, undergraduates, masters and doctoral students.
- At their yearly conference, over 120 students, faculty and agency personnel share results from water related research.
- Another mission: to monitor and help improve water quality in the state of Arkansas.
- The AWRC runs a fee-based water quality laboratory that faculty, industry and the general public can utilize for water sample analysis.
- The AWRC Water Quality Lab analyzes water samples for nutrients, sediments and other common pollutants.
- The AWRC collects water samples from the tributaries within the Illinois River.
- The AWRC collects water samples from the tributaries that feed into Beaver Lake—the drinking water supply for northwest Arkansas.

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phosphorus and nitrogen, that are a potential problem for the aquatic health of the river. These nutrients facilitate the development of algae, which limits the amount of oxygen and impacts the fish and other animals that live in the water.

Corral gathers samples of water from the Illinois River above and below Lake Frances to establish whether it is contributing to a decline in water quality. His research will also focus on sediments in the small lake, which are an important source of nutrients.

Phosphorus loading leads to the degradation of water quality and of the ecosystem, so Corral's goal is to establish where it happens. A lot of times, phosphorus is tied up in sediment, so before leaving, he takes a sediment core. "Lake Francis has stored a lot of sediment," said Haggard. "We suspect that these sediments are transferring phosphorus and maybe nitrogen to Oklahoma, releasing them back into the water."

To take a core, Corral plunges a device made largely of PVC pipe into the water and waits for the weight on top to do its work, sending it straight to the floor for a bit of sediment with a layer of water on top. He will incubate these cores in the lab and measure the amount of phosphorus and nitrogen released from the sediment into the overlying water over time.

Alumnus Profile: Bryan Bailey (MSBE '11)

Bryan Bailey

As a U of A engineering student, Bryan Bailey worked with professor Brian Haggard for three years, spending a year and a half of that time in the Water Quality Lab at the AWRC. "My engineering education gave me all the fundamentals I use every day," Bailey explained.

Bailey's experience at the U of A led directly to his current job. Haggard explained that when he got a call from an alum who was looking for graduating students, "I put him and Bryan in contact and boom, Bryan had an engineering job."

Bailey works for Shepherd Engineering Design Company, an engineering firm based out of Oklahoma City. The company specializes in solid waste engineering and wetland science engineering. At Shepherd, Bailey focuses on environmental services.

The best thing about his job, Bailey explained, is "dealing with clients. Hearing what their issues are, what they need done. I get to develop or design something that will solve their problem. It's nice to see the end result."

Moving Toward a Solution

In the past, levels of phosphorous were often evaluated because of their link to poultry farms and agriculture, where interactions between fertilizer and soil caused phosphorus to accumulate at the soil surface. Over the last decades, phosphorus concentrations have been linked to urban development and wastewater treatment plants. It's important to understand where phosphorus and other pollutants come from, because it allows researchers to come up with solutions.

If the results of Haggard and Corral's research suggest that Lake Francis is responsible for increased phosphorus in the Illinois River, a possible solution would be to induce sediment treatment or dredging. Sediment treatment is a process that uses chemicals to bind the undesirable nutrients, while dredging removes the nutrients altogether.

The fluctuation in the water quality of the Illinois River between the states of Arkansas and Oklahoma has been an important issue, and the long-term data shows that phosphorus is decreasing in the Illinois River – a success story.

Engineering student Jason Corral is learning both inside and outside the classroom.

Membranes are typically low-cost. They are modular, which means you can scale up very easily, and typically they are environmentally benign.

Ranil Wickramasinghe,
Professor and Ross E. Martin Endowed Chair in Emerging Technologies

Next Steps in Water Quality:
Garver Engineering and the U of A

By Camilla Medders

"Garver's Water Design Center is a knowledge center," explained Steve Jones, a Garver vice president and director of water services. "It brings together engineering disciplines for complex water and wastewater designs."

Garver is a multi-disciplined engineering planning and environmental services firm, and its Water Design Center combines the expertise of process, electrical, mechanical, computer and chemical engineers.

The center employs around 20 engineers and technicians, and the majority, including Jones, have graduated from the U of A. In fact, Jones explained that the university, with its supply of talented engineering graduates in all the disciplines Garver needs, was the main reason the company chose to open a Fayetteville office.

"What I notice about U of A grads is that they have a sense of commitment to the community, a sense of duty and a sense of pride," added Jon Cutright, the center's process group leader. "They have a desire to give back." The Water Design Center team explained that these characteristics are important, because the center is team oriented, a place for employees who want to be part of something bigger.

The Water Design Center focuses on projects in Arkansas and the surrounding states, but they have several national projects. Recently, the company was recognized with a Grand Conceptor award from the American Council of Engineering Companies of Alabama for their design of the Tuscumbia Water Treatment Plant, the first dual series membrane plant in the state of Alabama.

The Tuscumbia plant uses membranes, filters with tiny pores, to remove pollutants and minerals from drinking water. Garver's design for the plant involves two types of membranes: an ultrafiltration system, in which water passes through a membrane at low pressure, and a nanofiltration system, in which water is forced through a membrane at high pressure to remove dissolved species such as multivalent ions. The design center team explained that this dual process removes many of the precursors of disinfection byproducts, as well as taking out pollutants and pathogens.

The use of membranes to filter water is a relatively new approach, and Garver is working with chemical engineering researcher Ranil Wickramasinghe to improve this technology. He is developing responsive membranes that are less likely to get clogged, or fouled.

"Membranes are typically low-cost. They are modular, which means you can scale up very easily, and typically they are environmentally benign," explained Wickramasinghe. "The downside with membranes is that it's very easy for contaminant species, for the things you're trying to get rid of, to deposit on the surface of the membrane, and it clogs the membrane, which leads to reduced performance."

Wickramasinghe is using a couple of approaches to prevent membrane fouling. One of these is to induce mixing on the surface of the membrane, keeping the particles moving around so that they don't settle and block the membrane's pores. Another approach is to modify the surface of the membrane with chemicals, which can repel the foulants.

Garver and Wickramasinghe hope that better performing, more efficient membranes could lead to better water treatment and even water reuse—converting waste water into drinking water. In places where clean water is scarce, water reuse could be a valuable conservation tool.

The close connection between Garver and the U of A benefits everyone: the company, the university, our students and the community. When academia and industry work together, they can create better jobs for our local economy and better technology for everyone.

This image combines Garver's innovative design for the Tuscumbria Water Treatment Plant with a photo of the actual plant.

Belize:
An Adventure in Community Service

By April Robertson

Students at the University of Arkansas who have a love for civil engineering, water quality, philanthropy or travel have a unique opportunity in the Belize study abroad program. Started a little more than six years ago with the assistance of the not-for-profit company Peacework, the program is designed to pool students' collective skills and talents to assist communities in projects that improve the quality of life, whether that means providing cleaner water to residential homes and school buildings or building better facilities for schoolchildren.

A Multidisciplinary Experience

Engineering students are only one of the student groups that participate. They join students in education; agricultural, food and life sciences; business; biological sciences and social work to help make community-prioritized projects a reality.

"In the program, we typically have 35-70 people, 10-17 of which are engineering majors," said Thomas Soerens, associate professor of civil engineering and the group's faculty advisor. "Engineering is usually the biggest group."

Students in all majors are encouraged to branch out, mingle with the other students and try their hand at something new.

"Everyone stays together and eats meals together," Soerens said. And while working on projects in the field, each student has the opportunity to work in an area they are unfamiliar with, helping them to a well-rounded experience and teaching them to be flexible by learning other skills. For example, when the business students were focused on building a community park, engineering students got involved.

Civil engineering student Cary Beth Lipscomb explained that participating in the Belize program gave her a new perspective on engineering, as well as life in general. "I really enjoyed learning things from the field experience that can't be taught in the classroom," she said. "We did a little bit of everything and it was good to get experience in all areas. Culturally, it's such a different place from here. It made me appreciate more things and acknowledge things we have here."

Arkansas Engineers Abroad students take well water samples at the village of More Tomorrow

An International Partnership

The Belize program is that it focuses on resolving issues that the community has already prioritized. Soerens and his team prefer not to think of their projects as "helping" the community so much as partnering in projects they want to do.

By returning to the same towns each year, the program hopes to establish a healthy working relationship that can prove more profitable overall, rather than moving from town to town across different provinces and countries.

Water Makes the World Go 'Round

Over the years, the students in the Belize program have focused most closely on water quality because of its immediate connection to health. Issues with water quality are often the biggest problem for people living in developing communities, where governments provide water towers or water pumps, but leave it to the town or village to set up pipes and pumps and pay for operation of the system. It is often not a feasible expectation and leaves residents with low-quality water and limited access to it. "The EU will sometimes build a water tower in a community but the town has to maintain the operation costs, which means the electricity is too expensive," Soerens said.

I really enjoyed learning things from the field experience that can't be taught in the classroom… It made me appreciate more things and acknowledge things we have here.

Cary Beth Lipscomb, civil engineering student

Top, student build a house in the village of More Tomorrow, replacing one that was lost in a hurricane. Left, U of A students with the water system they build for the village of Steadfast. Right, U of A engineering students make new friends and experience a different culture in Dangriga, Belize.

Past projects have revolved around making facilities functional and comfortable for schools, such as creating a water bottle filling station, building an outdoor classroom gazebo, and constructing a solar heater. Students have also focused on watershed analysis for the village of Steadfast, a process that included water-quality monitoring and water filtration that flows to a nearby community.

"The goal was protecting the source," Soerens said. "If the water system is compromised by agricultural systems, the farms in watershed, with the use of pesticides," that will greatly affect the water people are drinking.

With the help of Soerens and his students, Steadfast now has a good water system and future trips can focus on making a similar impact on some of the surrounding communities.

A Little Help From Friends

In the past few years, the annual study abroad program has been supplemented with projects conducted independently by the student organization Arkansas Engineers Abroad.

The group raises funds year round for plane tickets to Belize, construction materials and the assistance of professional engineers in design of future construction projects.

The core of the group is made up of roughly 10-12 students who are passionate about using their skills to help others. They meet weekly to continually recalibrate their goals: drafting professional letters to companies that could sponsor them, meeting with department heads and faculty members to discuss the relevant connection between their classes and their international projects, which sometimes leads to additional funding, and to create local fundraisers as well as organize local service opportunities.

In the past three years, these groups have installed water pipes, conducted water quality sampling and attended multiple regional and national conferences to pick up critical techniques for doing these projects on their own.

The largest and most recent project by the student groups to date is the construction of a water tower for the community of More Tomorrow. Initial cost estimates for the endeavor were $18,000, a goal that Soerens says is nearly completed. If the financial goal is reach, students will be constructing the tower this summer.

William Cravens Inducted into the Arkansas Business Hall of Fame

Engineering alumnus William Cravens (BSIE '56) joined other local business leaders in the Arkansas Business Hall of Fame in February. William L. Cravens' career spans many years and a variety of endeavors. He served as a leader in manufacturing, public accounting, banking, information services and thoroughbred racing. After graduating from the University of Arkansas with an industrial engineering degree, he worked for General Electric, a job that took him to Kentucky, Massachusetts, Illinois and back to Arkansas. He moved to Little Rock to become a partner in the Russell Brown & Co. firm as a certified public accountant. In 1976, he moved to the First National Bank in Little Rock, becoming its president and chief executive officer. At the same time, he became a director of the Oaklawn Jockey Club, a position he still holds.

Cravens was instrumental in the merger of the First National Bank and Commercial National Bank, forming First Commercial Bank. He later joined Worthen Banking Corp. After a brief retirement, Cravens returned as vice-chair and later chair of Alltel Information Systems. He also helped establish Pinnacle Bank, where he served as chair. He is a long-time supporter of the U of A, and was inducted into the College of Engineering Hall of Fame in 2006.

Alumnus Profile: Brock Hoskins, BSCE '89

When Garver decided to expand into Northwest Arkansas, they sent U of A engineering alum Brock Hoskins to lead the effort. Hoskins, who had worked in the Little Rock office for nine years, became the regional office manager, then was promoted to his current role as chief operating officer and executive vice president of Garver.

Hoskins has a strong relationship with the university. He is on the Strategic Advisory Council for the department of civil engineering and in 2006, he received an Outstanding Young Alumni Award from the college.

Hoskins explained that College of Engineering graduates make such great employees that even Garver offices in other states rush to hire them. "A big part of our success is because of the great people we've been able to attract, and a big part of that includes people from the University of Arkansas," said Hoskins.

A Fashionable Way to Support Cancer Research

Purchase a tie or scarf from the Life Tie project, and 50 percent of the cost will support cancer research at the U of A College of Engineering.

Visit thelifetie.com and use the discount code ARKANSAS.

David Zaharoff, assistant professor of biomedical engineering and cancer researcher

Scholarship Honors Life of Engineering Alumnus

Tyler Halsey (BSCE '06, MSCE '08) was a talented engineer and a cherished friend, husband and family member. When Tyler lost his life in a motorcycle accident at age 30, his family and friends wanted to honor his memory and help other engineering students. In order to do this, Tyler's parents, Mike Halsey and Janice Hull, teamed up with Richard Welcher, Tyler's friend and colleague at Tatum-Smith Engineers, to create an endowed scholarship.

The Halsey Scholarship is a merit-based scholarship. It will support promising junior and senior civil engineering students who are interested in structural engineering.

Establishing this kind of scholarship, which must reach a minimum level of $25,000, can be a challenge, but Tyler's friends and family were eager to show their support. "The generosity that has been shown is overwhelming," said Mike. "I think that it is in part to acknowledge our loss but even more is a testament to the person Tyler was."

"Tyler worked hard and played hard," remembered Janice. "He accomplished a lot in 30 years, both personally and professionally. Tyler had to work much harder than most to accomplish what he did. Born with a severe hearing loss, we were told that he would never be able to attend any mainstream schools growing up. Instead, Tyler overcame this adversity to graduate college and become a licensed Professional Engineer."

Richard explained that as an engineer, Tyler was one of a kind. "Colleagues asked following Tyler's death if we were going to be looking to hire a replacement soon. I told them that we would never be able to hire another Tyler Halsey and to compare engineers we'd hire in the future to him would not be fair. He was an outstanding guy and I miss my friend greatly."

Tyler's last and most challenging engineering project was the Janie Darr Elementary School in Rogers, Ark., which will open in the fall. Richard explained that the design of the building "posed many structural engineering challenges which Tyler handled with a degree of knowledge and skill that was uncommon to find in someone as young in the practice as he."

Tyler's friends and family plan to continue support for the Halsey Scholarship. In March, the U.S. Pizza company donated 10 percent of sales from their five locations to the fund.

Tyler will always be loved and missed by everyone who knew him. "He lived his life with a grace, dignity and ease that I both admire and envy," said his father.

College Benefits From $1 Million Planned Gift

Jack R. Jacobs of Tulsa, Okla., has made a planned gift of $1,000,000 to establish the Dana Jacobs Memorial Endowed Scholarship in the College of Engineering at the University of Arkansas. The gift, which is designated to the department of electrical engineering, will be used to support students in the department who have a financial need and the academic ability needed to succeed.

Jacobs is a 1951 graduate of the Sam M. Walton College of Business. He calls this gift his "payback" because of his experience on campus and successful career. "I've been blessed," he said. "So, I wanted to help other people."

The scholarship is named in honor of Jacobs's middle son, Dana, who passed away in 2000. Dana worked in the electrical engineering field, which is why Jacobs felt compelled to choose that designation.

Kirk and Nancy Pond Establish Access Arkansas Scholarship

Kirk and Nancy St. John Pond of Cape Elizabeth, Maine, are contributing $50,000 to the College of Engineering to establish the Pond Family Access Arkansas Scholarship in Engineering. The gift will benefit the department of electrical engineering and be matched with an additional $16,667 from the Pat and Willard Walker Charitable Foundation's Need-Based Scholarship Challenge.

Access Arkansas provides need-based scholarship support, particularly for undergraduates. It was launched in 2007. In 2009, the Pat and Willard Walker Foundation created a one-third matching gift for every dollar committed starting at $50,000.

Clockwise from upper left: Mechanical engineering students work with machines and materials, from tiny nanomaterials to large industrial systems.

Students participating in the SAE Baja competition design and build an off-road vehicle to compete in a national contest.

At the college of engineering, students have access to the latest technology to help with classes and research.

These days, many engineers do their work on computers, using models to predict real-world results.

Industrial engineering students find the best ways for people and systems to work together.

Civil engineering students look at ways to improve our society's infrastructure, including water treatment.

Clockwise from upper left: Computer engineers design and improve the hardware that makes our smart devices work.

Whether it's for class or for a research project, time in the lab is a valuable experience for engineering students.

Electrical engineers look for new ways to produce energy and use it safely and reliably.

Some biological and agricultural engineering students look for new ways to produce fuel and medications from plants.

Other biological and agricultural engineering, students study ecosystems and look at ways to improve the efficiency of agriculture.

As part of our new biomedical engineering program, students learn how technology can improve health, and they can prepare for a career in medicine.

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Hog Callers: Students Helping Students

"I wouldn't be able to come here without scholarships"

Brittany Stacy,
~~engineering student and former Hog Caller~~

Brittany Stacy is a junior in the computer science and computer engineering department. She loves using programming to solve problems and hopes to one day have a career in computer forensics. Brittany is able to attend the U of A because of private funding like that raised by the Hog Callers. "I wouldn't be able to come here without scholarships," she said.

Brittany pays her tuition with several scholarships, and supports herself working 16 hours a week. Last year, she worked as a Hog Caller for the Arkansas National Phone Campaign. This campaign is an essential part of the university's fundraising program, as well as a valuable on-campus job opportunity for Razorback students. Student callers have a passion for the U of A and love what they do. Brittany's favorite thing about this job was talking to alumni, hearing about their time at the university and updating them on things that had changed.

"It's a really good job for a student trying to pay for school," she said. Students who participate in the phone campaign are often calling on behalf of their own college or department, ~~and money they is donated to the annual fund through this campaign may go directly to help them or their friends~~. "Without those contributions, a lot of us wouldn't be able to afford school," said Brittany.