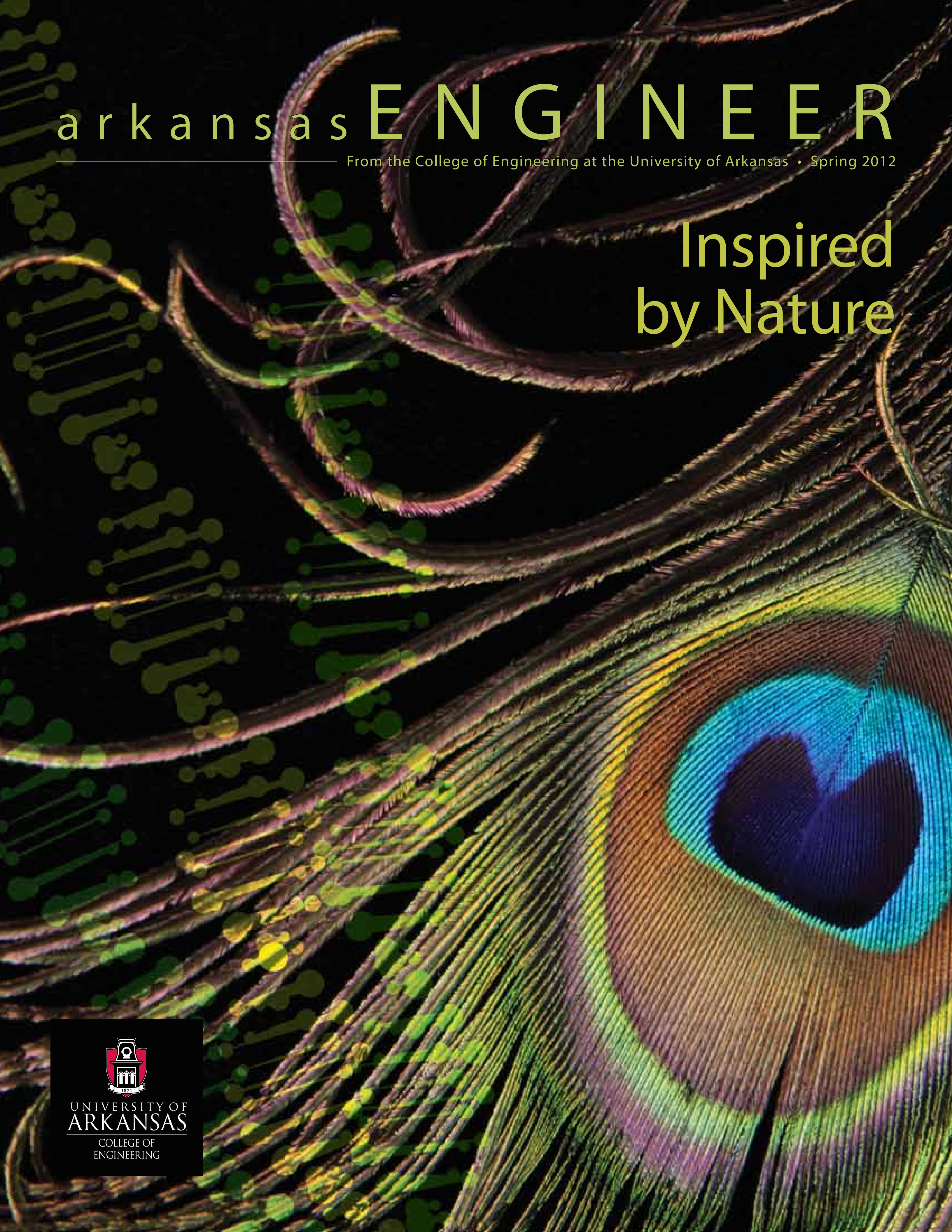
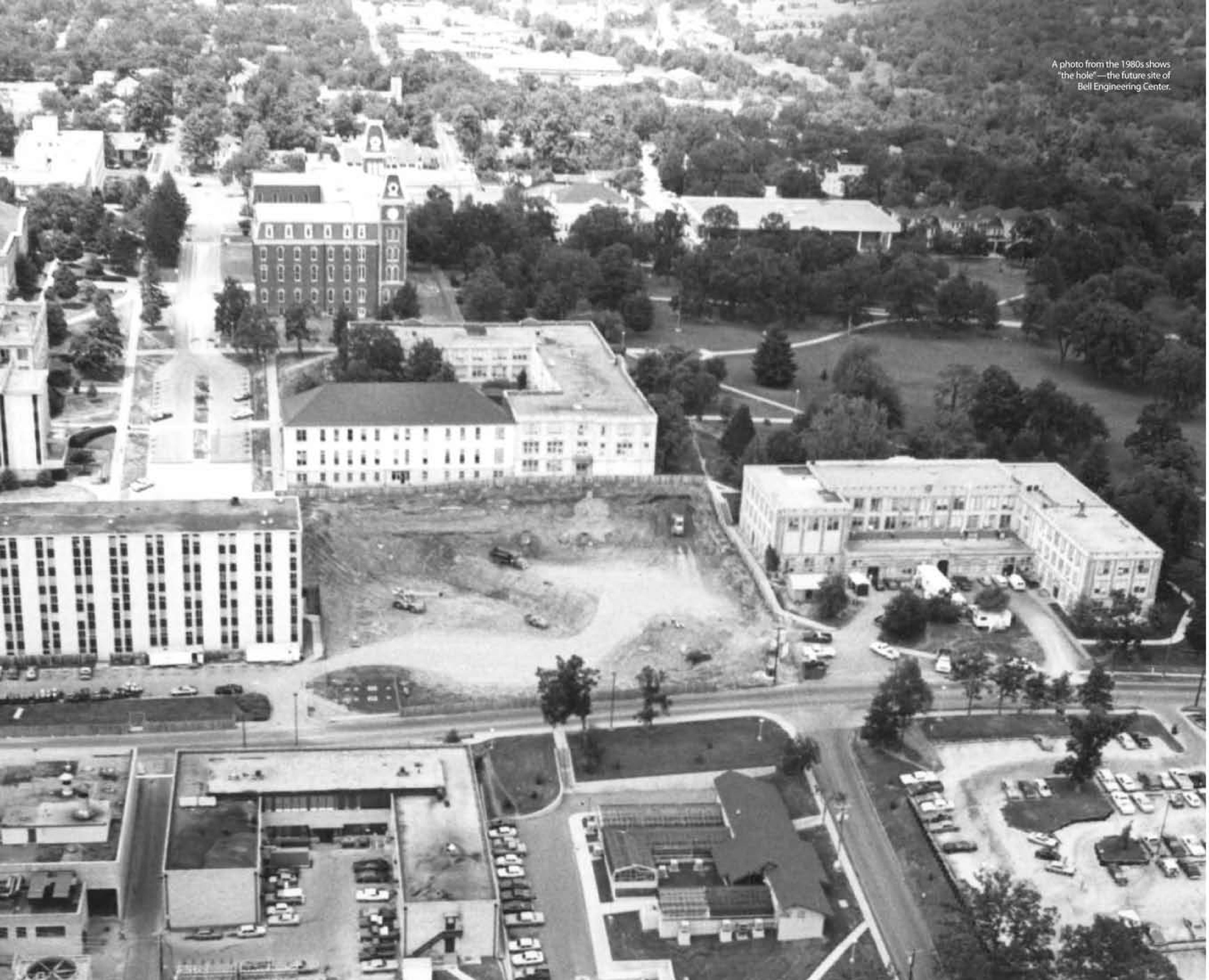
arkansas ENGINEER

From the College of Engineering at the University of Arkansas • Spring 2012

Inspired by Nature



UNIVERSITY OF ARKANSAS
COLLEGE OF ENGINEERING



A photo from the 1980s shows "the hole"—the future site of Bell Engineering Center.

IN EVERY ISSUE

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Earlier this month, I made a difficult announcement: in July, I will be stepping down as dean of the College of Engineering. While I am reluctant to leave my position, and I will miss the students, faculty, staff and alumni, I have been given an opportunity I could not turn down—an offer to serve as vice chancellor at Galgotias University. Galgotias is a brand new private, multidisciplinary research university near Delhi, India. At an Indian university, the vice chancellor position is equivalent to CEO, so I will be leading the effort to establish this school. I will not be leaving for good, however. After a two-year term at Galgotias, I will return to the U of A as a member of the mechanical engineering faculty.

Associate Dean Terry Martin will be serving as interim dean during the search for my replacement, so I know the college will be in good hands. I have no doubt that the university will find a new dean who can help the College of Engineering continue its upward trajectory. In the past nine years, I have watched the college make great strides in enrollment, retention, research activity and reputation, and I am confident that these gains will continue.

In the pages of this magazine you can see just a few of the reasons why this college has been such a great place to work, and why it will always have a place in my heart. Its pages are full of faculty accomplishments, stories of our amazing alumni, and exciting announcements such as the recent recognition of our Engineering Career Awareness Program and our new biomedical degrees.

In the features section, you can learn about research in a couple of important areas: bio-inspired engineering and computer security. You can also read about the history of Bell Engineering Center, which turned 25 years old this year. These articles remind us of how much progress the college has made over the years, as well as the bright future ahead of us.

While I am looking forward to the challenges and opportunities I will find at Galgotias, I will also be excited to return to Arkansas to reconnect with my friends and colleagues and to see what new accomplishments and innovations have taken place.

Ashok Saxena

Ashok Saxena

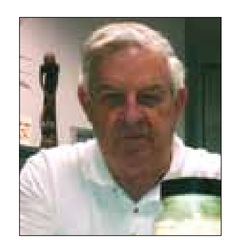
Dean of Engineering
Irma F. and Raymond F. Giffels Endowed Chair in Engineering

Awards and Recognition

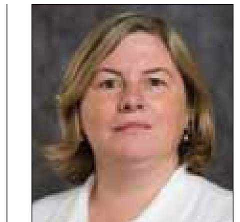
The National Science Foundation has announced that a team from the University of Arkansas is one of only 21 teams selected for the inaugural class of the Innovation Corps, or I-Corps, program. This team includes **Nilanjan Banerjee**, assistant professor of computer science and computer engineering, Xiangyu Liu, an undergraduate and a member of the Honors College and Douglas Hutchings, a graduate of the University of Arkansas micro-electronics and photonics program.

Jamie Hestekin, associate professor and holder of the Jim L. Turpin Endowed Professorship in Chemical and Biochemical Separations, was one of 85 young engineers selected to attend the National Academy of Engineering's 17th annual U.S. Frontiers of Engineering symposium. This symposium is a gathering of engineers between the ages of 30 and 45 whose research and technical work has been judged by the academy to be exceptional.

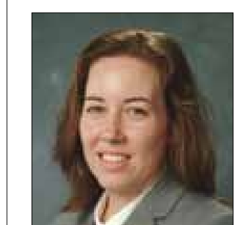
Kim Needy, head of the department of industrial engineering and holder of the Twenty-First Century Professorship in Engineering, has been elected as the new president of the Institute of Industrial Engineers. IIE is the world's largest professional society dedicated solely to the support of the industrial engineering profession and individuals involved with improving quality and productivity. An IIE Fellow, Needy's research interests include engineering management, sustainability and supply chain optimization.



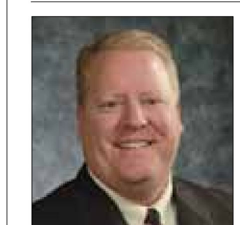
Roy Penney, professor of chemical engineering, has received the Award for Excellence and Sustained Contributions to Mixing Research and Practice from the North American Mixing Forum, an affiliate of the American Institute of Chemical Engineers. One of Penney's most important contributions to this field was leading an engineering effort to design a chemical reactor system to mix and react dextrose with fatty alcohol from palm oil to produce alkyl polyglocoside.



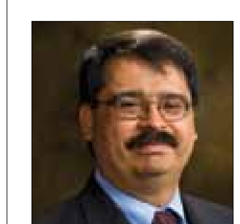
Susan Gauch, head of the department of computer science and computer engineering and holder of the Rodger S. Kline Computer Science and Computer Engineering Chair in the College of Engineering, has been selected to take part in the Hypothes.is Reputation Fellows Program. An expert in intelligent search, Gauch will take part in the Hypothes.is project, which is developing tools to improve the quality of information on the Internet, using the model of community peer-review.



Heather Nachtmann, associate professor of industrial engineering, has been named a fellow of the American Society for Engineering Management. Nachtmann has served as the director of the Mack Blackwell Rural Transportation Center at the U of A. Her current research focuses on economic, operations, and security analysis of transportation systems; cost and quality issues in the healthcare supply chain; and advanced methods for engineering economic analysis.



Darin Nutter, associate professor of mechanical engineering, has been named a fellow by the American Society of Heating, Refrigerating and Air Conditioning. Nutter's contributions to this field include research for the industry, teaching, and providing support for students interested in this career field. Nutter conducts experimental and numerical research to investigate the fundamental heat transfer and thermodynamics in buildings and in heating, ventilating and air conditioning systems.



Manuel Rossetti, professor of industrial engineering, has been selected as the John L. Imhoff Chair in Industrial Engineering for a two-year period beginning in January 2012. This chair was established in 1983 to honor the memory of John L. Imhoff, founding head of the University of Arkansas department of industrial engineering. Rossetti will be the fourth recipient to hold this title. Rossetti's research focuses on transportation, manufacturing, health care and simulation.

on the move

College Welcomes Record Number of Future Engineers

In the fall of 2011, the number of new freshmen enrolling in the College of Engineering increased by 30.3 percent, from 532 in 2010 to 693 in 2011. This continues a trend: since 2005, new freshmen enrollment in the college has increased by 85 percent. In addition, the number of engineering students transferring to the University of Arkansas has increased by 57 percent over the past six years. These factors, along with an increase in graduate student enrollment, have led to a 12.9 percent increase in total enrollment growth over the previous year, the largest percentage increase at the university.

Dean Ashok Saxena attributes these increases to efforts by the college's recruitment office, and to programs such as the Engineering Career Awareness Program. He also credits transfer agreements with other schools, which ease the way for talented engineering students to come to the University of Arkansas. Once they are here, College of Engineering students benefit from programs like the Freshman Engineering Program, which provides academic and social support.

"It's been a pleasure to see our hallways and classes filled with these talented young people," said Saxena. "They are so important to the future of our country, and we are working hard to challenge them, as well as providing the support and guidance they need."

U of A biomedical engineering students conduct cancer research.

First Biomedical Engineering Degrees Offered in State

College of Engineering students will be able to earn a bachelor's degree in biomedical engineering or a doctoral degree in engineering with a concentration in biomedical engineering beginning in fall 2012.

Previously, the college has offered a master's degree in this subject, and undergraduates and doctoral students could earn degrees in biological engineering, with a biomedical focus.

"These new degrees further the university's mission of being a partner, resource and catalyst within the state and beyond," said Provost Sharon L. Gaber. "Their creation at the U of A broadens both the educational and economic opportunities that can be found — and launched — in Arkansas."

"Biomedical engineering is an important and growing field," said Dean Saxena. "We already have a top-notch biomedical engineering faculty teaching talented students in this area, and creating these degrees will increase both teaching and learning opportunities in biomedical engineering, and provide a new option for students looking for preparation for medical school."

Four faculty members are already teaching a biomedical curriculum, and the college is searching for a fifth faculty member to join this group. The college expects to award the first bachelor's degree in biomedical engineering as early as the spring of 2014. This will allow the college to request ABET accreditation for the bachelor's degree in the fall of 2014, and if this request is successful, spring 2014 graduates will be included among graduates from an accredited program.

Mobile Electricity Demonstration Travels the State

The Vertically Integrated Center for Transformative Energy Research has a new tool to promote K-12 science and engineering education. VICTER's outreach trailer made its initial voyage on Sept. 6, and demonstrated its experiments to more than 475 students over two days in eastern Arkansas. The trailer will be available to all of VICTER's partner universities for science camps, tours, campus visits and other outreach efforts.

The Razorback-red outreach trailer is a mobile science exhibit. It houses devices that show how electricity works and demonstrate how solar power can be transformed into electricity to power homes.

Thomas Carter III, assistant dean of academic and student affairs for the College of Engineering, poses with a group of ECAP students

Engineering Career Awareness Program Receives Award

The National Association of Multicultural Engineering Program Advocates has selected the Engineering Career Awareness Program, or ECAP, as the 2012 NAMEPA Outstanding Pre-College/Community Organization Award recipient. ECAP was recognized at the 33rd annual NAMEPA National Conference in Scottsdale, Ariz. at the closing awards banquet on Friday, Jan, 27.

The Engineering Career Awareness Program, which was initiated by College of Engineering alumnus Troy Alley, is designed to recruit students who are underrepresented in the field of engineering, and to give these students the support they need to graduate and begin their careers. ECAP provides financial assistance to qualifying students, as well as a summer bridge program and a network of academic and social support.

"The College of Engineering is very proud of this program, and of the dedicated staff members who have helped it succeed," said Dean Saxena. "We'd like to congratulate Troy Alley on having the insight to start ECAP, and most of all, we want to congratulate our ECAP students. It is their hard work and successes that have made this program so great."

University Receives Check From NanoMech

During the dedication of its new Nanoscale Material Science and Engineering Building, the U of A received a check for $375,000 from NanoMech, an innovative small business that uses nanotechnology to manufacture products with broad applications. The check is not a gift, but rather payment for intellectual property owned by the university and successfully commercialized by NanoMech.

"NanoMech is a vibrant example of what happens when research is nurtured and supported," said Chancellor G. David Gearhart. "The commercialization efforts taking place within the Arkansas Research and Technology Park continue to play an important role in producing success stories like this one.

"Although the funds being transferred to the university are not directed to support this new building or to support our Institute for Nanoscience and Engineering, the check presentation today underscores the fact that nanotechnology is a growing research field and a growth industry in Arkansas. Its study and its commercialization are helping the University of Arkansas create jobs and opportunities in the state."

NanoMech was founded in 2002 and is the commercial result of groundbreaking research by Ajay Malshe, Distinguished Professor of mechanical engineering and the Twenty-First Century Endowed Chair in Materials, Manufacturing and Integrated Systems.

engineering matters

An Emergency Network for Natural Disasters

Engineering researchers at the University of Arkansas are developing an emergency communications network that will maintain operation during natural disasters and provide critical warnings and geographic information to people affected by the disasters. The researchers are honing and testing the system now and expect to deploy a pilot network at the end of 2012.

The system, which the researchers call an emergency "mesh," is self-sustainable and solar-powered, which means it would provide continuous, uninterrupted service even when the power grid or wireless communication systems are out of commission. Users would receive critical information on popular devices such as mobile phones, personal digital assistants, tablets and laptops.

"The ultimate goal of this project is to save human lives," said Nilanjan Banerjee, assistant professor of computer science and computer engineering. "Deployment of this system could warn people to get out of harm's way and could help emergency services personnel reach victims much faster. This last part is critically important because we know that many deaths occur in the minutes and hours after a disaster strikes.

"It is also important that the system communicates using popular, ubiquitous devices, because during these chaotic and highly stressful moments, people need to rely on something that is user-friendly and already familiar to them."

Improving Radiation Therapy for Cancer Patients

Conventional radiation therapy uses a single, cumulative treatment plan that neglects changes in tumor geometry and biology over time. However, recent technological advances have made it possible to capture these changes throughout the course of treatment. Ronald Rardin, professor and holder of the John and Mary Lib White Endowed Systems Integration Chair in Industrial Engineering, and his doctoral student Behlul Saka have developed mathematical optimization models that will make radiation treatment plans safer and more efficient than conventional plans.

Working with geometric and biological data gathered from the most advanced technology used to capture tumor changes, the researchers achieve optimization in terms of delivering the maximum dose of energy to the tumor without undue risk to surrounding healthy tissues. These models will help optimize radiation treatment on a per-session and cumulative basis.

Researchers Develop Runway Anti-Icing System

Anti-icing systems could make airport runways safer and less expensive to maintain during winter months. College of Engineering researchers are developing a system that uses a conventional photovoltaic system to supply energy to a conductive concrete slab that would function as a surface overlay on runways. Energy conducted throughout the slabs allows them to continually maintain temperatures above freezing and thus prevent accumulation of snow and ice.

"Major U.S. airports do a good job of keeping runways safe and clear of ice and snow," said Ernie Heymsfield, associate professor of civil engineering. "But this is a labor-intensive and expensive process, especially for northern airports. The St. Paul, Minnesota, airport, for example, budgets approximately $4 million annually for snow removal. For various reasons, including the fact that it is grid-energy independent, our system could put a huge dent in this budget."

After initial design, Heymsfield now leads a team of researchers who are testing the slab at the university's Engineering Research Center in south Fayetteville. Initial results of the study will be presented at the Transportation Research Board's annual meeting in January 2012.

When ultraviolet light is applied to nanocrystals, they emit colorful light. These nanocrystals are investigated for their use in high performance solar cells.

Grant Helps Researchers Develop Solar Cells for Spacecraft

Researchers at the University of Arkansas and Arkansas State University will share more than $1 million in grant funding, partly from NASA with matching funds from each institution to investigate the use of semiconductor materials in photovoltaic devices that power satellites and other instruments in space.

The funds, administered by the Arkansas NASA-EPSCoR office at the University of Arkansas at Little Rock, will enhance research opportunities in the state and could create high-tech jobs. The National Science Foundation initiated EPSCoR – the Experimental Program to Stimulate Competitive Research – to encourage local action to develop long-term improvements in a state's science and engineering enterprise.

"This research will have a significantly positive impact on the quality and competitiveness of the state's academic research enterprise," said Omar Manasreh, professor of electrical engineering. "It will create new opportunities for further development in the field of novel photovoltaic materials and devices."

The ultimate goal is to fabricate and test a photovoltaic device that is capable of possessing a solar energy conversion efficiency of 40 percent or better.

Modeling Sustainable Swine Production

A tool created by U of A researchers and their colleagues will help hog farmers increase productivity, decrease costs and minimize the environmental impact of swine production in the United States.

With funding from the U.S. Department of Agriculture, the team, which includes researchers at Purdue University and Virginia Tech, is developing an integrated management tool for swine production based on a comprehensive analysis of the many processes that comprise it– from crops used for feed to methods of managing waste.

"A primary purpose of this work is to evaluate and mitigate the environmental footprint of swine-production facilities," said Greg Thoma, professor of chemical engineering and holder of the Bates Endowed Teaching Professorship in Chemical Engineering.

"What action can we take to limit greenhouse-gas emissions from these facilities without making processes more expensive for the farmer?"

Research Addresses Security of Inland Waterways

Transportation researchers at the U of A are working to develop a national decision-support system to help local, state and federal law-enforcement and emergency-management agencies identify commercially important rivers and infrastructure that may be especially vulnerable to a terrorist attack or natural disaster.

"We want to enable law-enforcement and emergency-management agencies by providing vital information about commercially important rivers and the various infrastructure connected to these rivers," said Heather Nachtmann, associate professor of industrial engineering.

The United States has approximately 12,000 navigable miles of commercially used rivers that may be vulnerable to attack, natural disaster or accidental events. The loss of these waterways and related infrastructure, such as bridges, canal locks and pipelines, would have immediate and adverse social and economic impacts on a region or possibly the entire nation.

With $200,000 in initial funding from Homeland Security, researchers are developing a system that they hope will evolve into a prototype for the decision-support system. The project includes geospatial data, computer-based cargo prioritization and freight-routing models, and an emergency response model for inland waterway transportation systems.

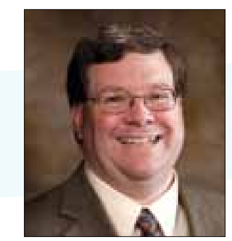
"Once you open it up to the rest of the world, you never know who can do what."

Protecting Our Networks

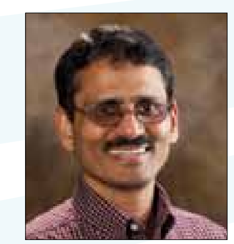
Associate Professor Dale Thompson teaches his students to "think like the bad guy," in order to identify security threats. "Don't focus on solutions yet," he tells them at the beginning of the semester. "After you get the threats, analyze the risk about how probable it is, how difficult it is to fix, how expensive."

Thompson's students sign agreements not to use their "bad guy" skills anywhere other than a disconnected lab where they practice creating threats and solutions. In the real world, however, these skills are all too easy to acquire.

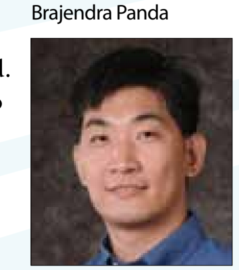
"Everything's out there on the Internet on how to do it," he explained. "Hackers think nothing of walking into someone else's [digital] house—they look at it differently."



Dale Thompson



Brajendra Panda



Jia Di

Protect, Detect, React

Brajendra Panda, professor of computer science and computer engineering, focuses on software security, which he describes as a repeating cycle. First, programmers must install security measures, with the knowledge that no security system is perfect. When criminals do find a way in, the system must be able to detect them, and then adjust to prevent future breaches, starting the cycle over again.

Panda's most recent research focuses on insider threats to database security, which pose complicated challenges. "Every organization, small or big, uses a database these days, so all the information is kept in a database," he explained. "They want to protect that as much as they can, and at the same time they want to share the information with others. That makes it difficult. Once you open it up to the rest of the world, you never know who can do what."

Insider Threats

While keeping unauthorized people away from sensitive information is a straightforward goal, threats to database security can also come from employees who need this information as part of their jobs. Panda is looking for ways to balance security with employee access.

"In the case of an outsider threat, if you have a tiny suspicion that someone is doing something malicious, you can make the decision to stop it. But in the case of insiders, just a tiny suspicion is not enough, because if you stop it, your own work gets hampered," he explained. "So maintaining the balance for insiders is very hard."

Panda's approach involves first classifying data according to how critical it is to the organization, and putting the most security resources toward the most critical data. The second step is to create a profile of each user, which includes a record of their activity on the database. Using this profile, an algorithm can compare past activity to current activity and see if a user is suddenly accessing information that has never before been part of his job. This change in activity could indicate suspicious behavior, and the algorithm can determine whether this anomalous behavior is acceptable, or if it is risky enough to take action.

It is also important to know all of the direct and indirect ways that database users can compromise security. For example, imagine that an organization wants to give a user access to employees' personal information while preventing that user from knowing whose information she is looking at. The company could deny access to the names of individuals in a database, but the user might still be able

"Different cultures and different generations define privacy differently."

to guess the identity of some employees from other details, such as salary amounts.

Users who are able to update databases pose different threats, and security programmers must be aware of the indirect ways they can affect data, as well. To illustrate this, Panda gives the example of employee classifications. While a user may not be able to change salary amounts, he may be able to change an employees' classification or rank, and affect their salaries that way.

Panda pointed out that there are other issues associated with this kind of employee monitoring. When an organization has access to all the employees' activities, that company must decide what kind of behavior is considered acceptable.

"If somebody goes to CNN's website to view the news, do we stop them?" he asks. "Certain things, even though they go beyond the job description, we don't necessarily stop them. Those are the ones that are hard to enforce." Panda explained that each company has to decide what kind of internet activity, such as checking the news or using social media sites, is acceptable in the workplace, and include that in the algorithm.

Social media also presents a different kind of security threat. "If employees go to Facebook, are they posting something that may be a company secret?" he asks. Employers have to determine how much risk social media use presents to their information, and balance that with employee privacy concerns.

Network Security

Dale Thompson also looks at the security of data, focusing on the threats to personal information that travels across the internet. In the class he teaches about network security, he explains to students the different ways that their information can be captured. For example, a criminal could send an email that looks like it came from your bank, prompting you to log into what looks like your normal bank account. However, malicious software in the email can capture your password as you log in and transmit it to the hacker.

Thompson explained that many things people post on the Internet can transmit information that they weren't intending to make public. For example, photos posted on Facebook can sometimes contain metadata embedded in the file, and accessing this data could give hackers information about where the photo was taken.

This worries some people more than others. Privacy on social media sites like Facebook has always been a complicated and controversial issue. While some people enjoy broadcasting every place they go and every article they read, others want more assurance that strangers will not be able to see this information.

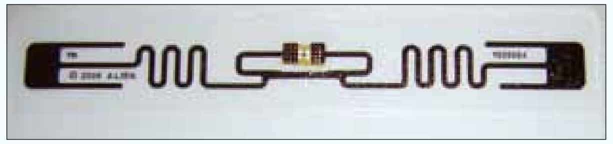
Thompson conducts an informal poll among his students every semester, asking them if it's important to them to keep their information private on the Internet, and every semester, more students report that they aren't concerned about privacy. "It used to be 10 percent didn't care," said Thompson, "and now it's 40 percent."

The Problem of Privacy

Thompson is fascinated by the discussions and debates around internet privacy, and one of his research goals is to help create clear definitions for Internet privacy, which is currently too vague a concept to be useful to engineers.

"Different cultures and different generations define privacy differently," said Thompson, and he explained that this lack of agreement means that different systems address privacy very differently, sometimes with an all-or-nothing approach. "A lot of them are extremely private and usable, or privacy is an afterthought." He explained that this lack of agreement has kept engineers from focusing on privacy issues, leaving that up to social scientists.

Even though engineers don't usually study privacy, it can still affect them. Thompson explained that privacy issues had an impact on the field of radio frequency identification, or RFID, which allows computers to gather information from small tags attached to objects. "RFID was called Orwellian when it first came out," Thompson explained. "It's slowed them down because they did not adequately address those issues. They didn't see it coming."



An ultra high frequency RFID tag can read information from 15 or 20 feet away.

RFID Security

Radio frequency identification also presents its own set of security issues. Working with Jia Di, associate professor of computer science and computer engineering, Thompson is looking for low-cost ways to keep data on these devices secure. He focuses on ultra high frequency radio frequency identification (or UHF RFID) tags, which can be read from 15 or 20 feet away. These tags can be used to keep inventory in warehouses and stores or in the new Passport Card used for travel to Mexico and Canada.

Thompson and Di are looking for ways to identify RFID cards without relying on the information encoded into them. A tag's "fingerprint," or the distinct features of its hardware, can be used to tell if the tags have been tampered with or switched, either accidentally or for malicious purposes.

Each UHF RFID tag uses a unique signal to send information and receive energy from a card reader, and this signal can be used as a fingerprint to identify the tag. Thompson compares this to identifying a person from the sound of their voice as opposed to what they say.

Biggest Issues

Panda and Thompson agree that what makes the internet so useful—easy access to information and communication tools—is what makes it so insecure. "Almost everyone has access to some computer or digital gadget connected to the internet," said Panda. "Now that we've opened it up to the whole world, we do not know who's getting into the system. Is it my next door neighbor or someone in another country? We want to share information, but we have no control over who gets it."

Thompson hopes that as the Internet becomes more integral to our lives, people will grow up understanding more about digital ethics and security. "These days, they're teaching kids how to be safe on the Internet in kindergarten," he pointed out.

Unfortunately, the bad guys will always be out there, and the Internet is the perfect place for them to organize. "The good thing about the internet is communication," said Thompson. "The bad thing is that if you have people with out-of-the-ordinary norms, they tend to group together."

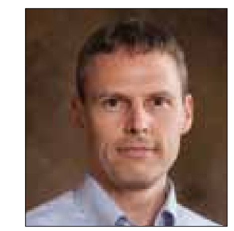
Luckily for the rest of us, these and other U of A researchers are busy designing methods to protect our systems, detect security breaches and react to them. As the threats evolve, so does the research.

Lock image courtesy of alengo, istock.com
Cable image courtesy of troyek, istock.com
Panda's research was funded by Robert Herklotz of the Air Force Office of Scientific Research.
Thompson's RFID security research was supported by the National Science Foundation.

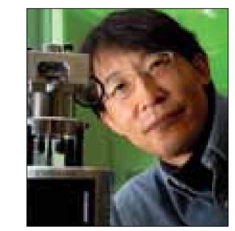
"Living things embody intelligence. At this molecular scale, nature is doing computations."

Inspired by Nature

"Nature is so amazing," says Keith Roper, associate professor of chemical engineering. "You look at what happens, the beauty and the symmetry and the complexity, but the results are so simple and so elegant. It's the same way you try to design something."



Keith Roper, Charles W. Oxford Endowed Professorship in Emerging Technologies



Jin-Woo Kim

Russell Deaton

In the field of biomimetics, or bio-inspired engineering, nature's designs form the basis of engineering projects. At the University of Arkansas College of Engineering, researchers in several different fields are looking to the natural world for ideas and tools that humans can use.

Russell Deaton, professor of computer science and computer engineering, agrees that nature's designs make a good model for engineers. "Computer science has stolen from biology for years. Living things embody intelligence. At this molecular scale, nature is doing computations. Biology is all about information processing."

A Lesson on Light

Roper is walking a group of students from Bell Engineering Center to his lab in the Nanoscale Materials Science and Engineering building across the street, and he begins their lesson by pointing to the sky.

"Why do we see blue and not yellow or red?" he asks. "Molecules in the air scatter particular frequency of light from the solar spectrum relative to all the other frequencies. The molecules don't interrupt or scatter red, yellow or orange. But they do scatter blue light."

Roper finds it interesting that certain organisms have evolved complicated optical surfaces to capture and diffract light. Imagine you are holding a peacock feather, for example. As you turn the feather, the colors shift: blue, purple, green. These feathers, along with the wings of certain moths and butterflies, have special surfaces that cause light waves to interfere with each other, making the shifting colors we call irridescence. Why, he wonders, would nature go to all that trouble? And what could engineers learn from these organisms?

In the lab, the students peer through a powerful microscope at irridescence on the nanoscale. Starting with a polymer called poly(dimethylsiloxane), Roper and his students have formed nano-sized features on one surface of the material. These features alter the local electromagnetic field of a thin layer of material, causing different colors to appear depending on the angle of the light and dimensions of the features. In some ways this surface mimics the texture of an irridescent butterfly wing, but Roper's research goal is to develop a tool that does much more than make pretty colors.

Prisms That Catch Tumors

Roper wants to use this prism effect to identify biomarkers for malignant tumors.

Roper is studying the way different biomarkers, strands of DNA or amino acids that are particular to cancer cells, interact with light. His goal is to be able to make a tiny device that could be used externally to monitor the bloodstream for these biomarkers. The device would use gold nanoparticles patterned like peacock feathers to diffract the incident light. As this diffracted light hits different proteins or DNA in the blood, it would produce characteristic patterns which could be analyzed to identify a tell-tale pattern produced by biomarkers for disease.

"If you can harness the ability to capture and diffract light," Roper explained, "you can use nanoscale

"Harnessing light absorption methods of algae could provide clean, renewable transportation fuels."

structures in a way that humans can interact with directly in complex biological systems, instead of using more expensive, complicated equipment." Diagnostic tools that use light patterns would be more sensitive to subtle indicators of disease and easier to indentfy and interpret—different colors and patterns could indicate the presence of particular disease markers without requiring expensive or toxic labels.

"It could detect metastatizing cancers that aren't detectable by other means," said Roper, "identifying if it's there and where it's located, like a policeman with a radar gun."

Algae That Makes Fuel

Recently, Roper also started studying diatoms, a type of algae made up of single-celled organisms. He suspects that diatoms may capture and focus light through optical structures, the way a lens in a microscope does.

While most plants turn sunlight into energy, diatoms do this differently. "Photosynthesis takes light and uses the light in an electron transport chain," said Roper. In this process, the plants use chlorophyll to turn light into fuel. "But diatoms don't rely primarily on chlorophyll. They utilize a different region of the electromagnetic spectrum—the way they access light is different." Because diatoms are able to thrive underwater or under the soil, where exposure to direct light is reduced, Roper suspects their method of harvesting energy from the sun is more efficient than that of other plants at wavelengths that have practical uses.

By studying their optical structures, Roper hopes to find new, more efficient ways to produce and store energy from light.

"These are exquisite, patterned, crystalline structures made by a single cell," he said. "If we could figure out how to make these structures as elegantly as diatoms do, we could reproduce them in large numbers to greatly increase our ability to harvest light." Then these structures could be used to produce chemical energy, the same way that diatoms produce the chemicals they use as food. "Algae can make liquid chemical energy that has higher fuel value and is more transportable than gaseous fuels," said Roper. "Harnessing light absorption methods of algae could provide clean, renewable transportation fuels."

Nanostructures That Build Themselves

DNA contains nature's source code. Using four different molecules—adenine, thymine, guanine

Roper is studying these single-cell organisms to find out how they turn light into energy.

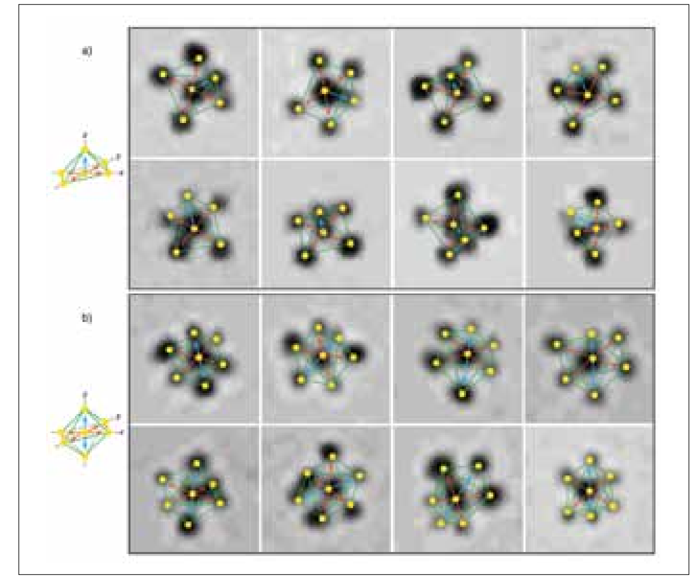
and cytosine—DNA creates the instructions that are essential to life. Jin-Woo Kim, professor of biological and agricultural engineering, and Russell Deaton are hoping to use this system to create their own instructions, a set of codes that arrange nanoparticles into structures.

Kim and Deaton are affixing gold nanoparticles to strands of DNA. Then, they can allow the DNA to use its code, attaching adenine to thymine and guanine to cytosine, to self-assemble the particles into larger structures. What kinds of structures? The possibilities are endless. "It could have many different applications, and we're investigating what we can make," said Kim. "We have a Lego block."

Kim and Deaton have demonstrated that their Lego blocks, or nBLOCKS as they call them, exhibit chemical stability and water solubility, and that they remain stable at temperatures up to 100 degrees Celcius and down to 4 degrees Celcius. Using these blocks, researchers could make customized materials for biomedical applications, for example. Kim explained that they could enhance the optical response of the nanoparticles and use that for diagnostic purposes, or to localize radiation for cancer treatment. But the first step is perfecting the building blocks.

In the lab, Kim is working on the process of binding the nanoparticles to the DNA along with his post-doc, Jeong-Hwan Kim. First, he mixes the nanoparticles and the DNA in a small test tube, using plastic silica gel to keep the DNA from clumping. Each nanoparticle binds to one DNA strand, and then Kim removes the DNA from the silica gel and repeats the process, binding another

"The thing about biology, is that we don't know everything."



Using DNA blueprints, these nano-sized nBLOCKs have arranged themselves into different shapes. Lines superimposed over the TEM images illustrate the geometric trends. Adapted from Kim et al. (2011)

strand of DNA to each particle. In this way, Kim can bind up to six DNA strands to each particle, forming links on the x, y and z axes.

In order to be sure that the correct number of nanoparticles are bound to the DNA strands, Kim performs several tests. He measures the response of the particles to light with an ultraviolet-visible spectrometer and separates the particles according to size with gel electrophoresis. With these two tests, he can tell if both gold and DNA are present in the samples, and he can tell which particles have the most strands of DNA attached.

Finally, once the other two tests have verified that the particles have the correct number of strands attached, Kim examines the nBLOCKS under a transmission electron microscope, or TEM, and an atomic force microscope to measure the locations and angles between DNA strands on the particle. Getting DNA geometry correct is an important part of the process—if the geometry is not exact, the three dimensional structures that result will be lopsided.

Designing with DNA

The next step of the research will be putting these blocks together to form shapes, and the shapes that result will be determined by the code in the DNA. If the codes are correct, the strands of DNA will find each other and self-assemble into the correct shapes, taking the particles along with them.

It's Deaton's job to use computational modeling to figure out the code behind the shapes they want to make. "It really boils down to how many DNA sequences we have to use," he said. "If we use a different sequence for every connection we want to make, then we have a lot of control."

However, even with strands that are 20 bases long, the researchers would run out of unique sequences eventually, and this would limit the size and complexity of the structures they could make. In addition, the researchers are limited by cost, because they must pay for each unique strand of DNA.

The key is figuring out how to build structures in which some of the links are duplicate sequences, while ensuring that these copies won't interfere with the overall design. "That's where the complexity really enters into the design part," said Deaton. "We'd like to use as few DNA sequences as possible, but deciding on what that number actually is, is a hard problem."

Perfecting this system will be a long process, but Kim points out that nature can teach engineers lessons about patience, as well. "That's another thing we can learn from nature. Everything doesn't happen at once; things happen stepwise and then merge together."

Much More to Learn

"The thing about biology," said Deaton, "is that we don't know everything. It's not a quantified thing—there are a lot of missing components."

Roper agrees. He explained that biotechnology has made some incredible advances, especially in the area of pharmaceuticals, "but not in ways that were originally envisioned…The deeper you get into it," he said, "the more you find layers on layers on layers of regulatory balance in every organism," he said. "We're on the tip of the iceberg. If we were aware of all the ways we interact with our environment, it would boggle our minds."

Roper's research takes place with help from current and former graduate students: Wonmi Ahn, Phillip Blake, Drew Dejarnette, Gyoung gug Jang, Braden Harbin, and Laura Velasco. It is supported by Shi Chi Liu of the Sensors and Sensing Systems Program in the Division of Civil, Mechanical, and Manufacturing Innovation at the National Science Foundation, the Ralph E. Martin Department of Chemical Engineering, the Institute of Nanoscale Material Science and Engineering, the microEP graduate program, the University of Arkansas Foundation, and the Walton Family Foundation. Part of the algae project was completed with funds from Statoil, with co-PIs Bob Beitle and Jamie Hestekin.
Deaton and Kim's research is supported by the National Science Foundation, the University of Arkansas Division of Agriculture and the Arkansas Biosciences Institute.
Rainbow image courtesy of jmci, istock.com
Algae image courtesy of Carolina Biological Supply Company
nBLOCK image courtesy of Kim, J.-W., Kim, J.-H. & Deaton, R. DNA-linked nanoparticle building blocks for programmable matter. Angewandte Chemie International Edition 50, 9185-9190 (2011)

"We had four departments in Engineering Hall. There was no space for expansion, no room for research, no lab facilities. Everybody realized we had to do something."

Twenty-Five Years in Bell

In January of 1987, the students, faculty and staff of the College of Engineering began the spring semester in a brand new building: Bell Engineering Center. The new building provided designated space for four of the college's departments–chemical engineering, civil engineering, electrical engineering and industrial engineering—as well as plenty of room for classrooms and teaching labs, and these changes proved to be revolutionary for the college.

Before Bell

"Before Bell, the situation was very grim," remembered Neil Schmitt, who was dean at the time of the move. "We had four departments in Engineering Hall. There was no space for expansion, no room for research, no lab facilities. Everybody realized we had to do something."

Ed Clausen, professor of chemical engineering remembers the "holding pen," one large room in Engineering Hall that functioned as an office for all of the college's graduate students. There were over 80 graduate students, and "they all supposedly had a desk in that room," said Clausen.

When Bell was finished, Engineering Hall was also renovated. At the same time, new research labs were being created at the Engineering Research Center (which was then called Engineering South). "Having new instructional and lab facilities and having new research facilities really propelled the College of Engineering from a small teaching college into a nationally competitive college," said Schmitt.

Built to Last

It was James Halligan, the dean before Schmitt, who got preliminary approval from the university to create a new building in 1981. "Over that weekend, he went out and had people dig the hole," said Clausen, and this hole was the only evidence of what was to come for several years, until Schmitt finally secured the funding to begin construction in 1984.

In addition to the state funds used for construction, the college also needed money for teaching and lab equipment. Most of these funds came from Melvyn L. Bell, a College of Engineering alumnus who named the building in honor of his mother and father, Owen and Hildur. At the building's dedication, Bell stated, "My hope is that future generations will not only benefit from this gift but perceive it as a symbol of the virtues for which my parents stood and the love we shared as a family."

Designed by the architecture firm Polk, Stanley and Gray, Bell was intended to be architecturally pleasing as well as suit the specific needs of the college. "The first time I walked in, I was amazed," remembered Schmitt. "It's true that the architecture is insightful. Coming from where we were, it was a striking contrast."

Schmitt explained that the college worked closely with the architects to make sure each of the four departments housed in Bell had their own designated space, with faculty offices set apart in interior hallways to cut down on noise. Four study areas, one for each department, were included at either end of the building to give students a place to gather and work.

The most notable feature of Bell Engineering is the large ramp that runs north and south, from one corner of the building to the other. Schmitt explained that the ramp is on the site of an old road, Campus Drive, which was one of the main arteries on campus.

When the college got permission to put a building on top of this road, they agreed to maintain a direct entrance to campus, and this agreement is the reason for the ramp, which provides a route from Dickson Street to the heart of campus. Today, Campus Drive is no longer a feature of the campus, and the ramp inside Bell the only evidence of its path.

Another innovative feature of the building was the easy access provided for wiring and other infrastructure. Schmitt explained that the wiring is in the hallway ceiling so that it is easy to repair and upgrade. All the labs are connected through central chases, space between the walls that can be easily accessed to put in new

infrastructure, such as compressed air.

"The design has proven to be very functional and very efficient," said Schmitt. "Bell is a striking building today and will be 50 years from now."

A Different Time

In the early eighties, when the College of Engineering was working with the architects to design Bell, faculty members did not routinely have computers in their offices. By the time the new building opened, however, times had changed and the college had to make sure faculty and students had access to this new technology. A large space on the first floor (where the Welcome Center is now) was designated as a student computer lab.

The college has gone through several other changes since Bell was first built. In 1983, Schmitt remembers, only around 14% of engineering students were female, and "we may have had one female faculty member." Schmitt is glad to see that, along with the rest of the nation, the College of Engineering has been steadily increasing these numbers. "Having women faculty role models is very important," he said.

This time period also marked a change in the College of Engineering's relationship to its alumni and other supporters. As part of the agreement for the new building, Schmitt was asked to raise $1 million for the labs in the building. As far as he knew, no one at the university had ever raised this much money for a single project, but the College of Engineering far exceeded this goal, raising $12 million.

Schmitt credits Susan Vanneman, the college's director of development at the time, with reaching out to engineering alumni. "Our alumni said 'no one ever asked us,'" explained Schmitt. "They were very generous."

Around this time, the Academies, elite groups of College of Engineering graduates, were being established, and these organizations also helped raise funds for the new building, as well as strengthening ties between the college and its alumni.

An Engineering Tradition

Bell Engineering Center has held up well over the years, proving itself to be adaptable to the academic and technological needs of students and faculty. Today the building is one of the most remarkable on campus, and it is the building most closely associated with the College of Engineering.

In addition to spaces for learning, research and studying, Schmitt mentioned one more feature of Bell that students found useful. As they passed the statue of the Bells in the front entrance, students would rub Owen Bell's head for luck. "It got very shiny," he said.

alumni news

In Memoriam

William Andrew "Bill" Wright Jr


Bill Wright

Andrew "Bill" Wright, Jr., 88, of Richmond, Va. died October 22, 2011. He was preceded in death by his sister, Dorothy Wright Brown. Survivors include his wife and devoted companion of 62 years, Martha Mills Wright; sons, William Andrew III, Gary, Tim and Chris; five grandchildren; and four great-grandchildren.

Wright was born in Durant, Okla. in 1922. During the World War II, he served in the Army Air Corps 27th Air Transport Group as a technical sergeant and flight engineer aboard the B-17, B-24, C-47 and other aircraft. His son, Tim Wright, related that one of the few stories he would tell from the war involved transporting the Glenn Miller Band across Europe.

Wright received a degree in mechanical engineering from the University of Arkansas, and two of his sons are U of A graduates as well. He proposed to his wife Martha in 1948 while they were listening to the radio broadcast of an Arkansas versus SMU football game.

Wright, a former chief engineer at Reynolds Metals Company, retired in 1986, after 30 years. Other than his family, his only other passions were reading and aviation. Before moving to Virginia, Bill and a cousin had been the proud owners of a small airplane that provided his sons with some of their most cherished memories.

Alumni Achievement


Lang Zimmerman

Lang Zimmerman, BSCmpE '85, was recently appointed to the Arkansas Economic Development Commission by Governor Mike Beebe. As a member of this commission, Lang will use his experience in telecommunications on the Technology Growth Committee.

Zimmerman's career began at General Dynamics in Fort Worth, Tex., where he worked on computers that rans the weapons systems on F-16 fighter planes. He returned to Arkansas to help the family telecommunications company, Yelcot Telephone, to grow and expand. A Yelcot subsidiary, Mountain View Telephone Company, recently won part of the bid to connect all Arkansas two-year and four-year colleges on the Arkansas Research and Education Optical Network (ARE-ON).

Zimmerman is also the co-founder and managing partner of Big Creek Golf and Country Club, an award-winning golf course in Mountain Home.


Mantooth and Mueller in front of the solar arrays at L'Oreal.

Working Together

When Kay Mueller, BSChE '99, environmental manager at L'Oreal in North Little Rock, wanted to help reduce her company's carbon footprint by installing solar panels, she turned to her alma mater for advice. U of A engineering professors Alan Mantooth, Roy McCann and William Springer provided L'Oreal with designs for a solar array, and helped the company adapt them. Kay explained that having the university as a resource meant she could take on this ambitious project without needing to have all the answers herself. "I called them a lot to ask questions," she said.

In November, Governor Mike Beebe and North Little Rock Mayor Patrick Henry Hays helped cut the ribbon on the plant's new solar arrays. They are expected to produce about 20,000 kilowatt hours per year, and they represent a first step in exploring alternative energy sources for the facility. Kay explained that the culture of innovation at L'Oreal encourages employees to come up with creative ideas like this one, and makes the company a rewarding place to work.

The Right Product at the Right Time


Vince Mazur

Three years before a 9.0 magnitude earthquake hit Japan, Vince Mazur, BSEE '84, decided that he wanted to design and manufacture a Geiger counter, a device that measures the amount of radiation in the environment. Mazur did some research, ordered parts, and a couple years later, Mazur Instruments had their first 100 units manufactured. The product is called the PRM-8000 Geiger Counter and Nuclear Radiation Monitor.

At the time, a Geiger counter seemed like a unique product focus. After all, the world hadn't seen a major threat from radiation in decades. But Mazur enjoyed evolving the technology, and he knew

that the problem of radiation was always around, even if no one recognized it.

"I would tell people that we're one event away from a whole new level of awareness about radiation," he explained. And he was right.

Since the Japanese quake, Mazur Instruments has sold hundreds of the devices. "They're literally around the world," Mazur said, adding that Mazur Instruments is beginning to get some attention from the world's leading nuclear research organizations. "Last December I met with CERN,the European Organization for Nuclear Research, and they're considering utilizing our device," he said. "We're also pleased to have the Italian National Institute of Nuclear Physics as a customer."

A New Face of Engineering


Joe Wyatt

Joe Wyatt, a senior in the department of biological and agricultural engineering at the University of Arkansas, has been included in the National Engineers Week Foundation's first annual *New Faces of Engineering College Edition.*

According to National Engineers Week, this list includes "15 of the most promising college engineering students from the United States—and across the world."

Student Recognized for Cancer Research


Jimmy Vo, working in the lab.

Jimmy Vo, a junior studying biomedical engineering, has received the Thomas J. Bardos Science Education Award for Undergraduate Students from the American Association for Cancer Research. This award will fund Vo's attendance at the association's annual meeting for the next two years.

At this year's conference, which takes place in Chicago in March, Vo will present his findings from research he conducted regarding a new approach to treating cancer. Vo has been working with David Zaharoff, assistant professor of biological and agricultural engineering. They are studying Interleukin-12 (IL-12), a protein that stimulates the body's immune system to attack a range of cancerous tumors.

In his research, Vo used a mouse model of breast cancer to demonstrate that a combination of IL-12 and chitosan, a polysaccharide derived from the shells of crustaceans such as shrimp and lobsters, can reduce breast cancer metastasis and increase overall survival.

Twice a year, engineering students polish their resumes, iron their best clothes and walk the aisles of Engineering Expo, looking for that perfect job or internship.

Student/Professor Team Receives Awards

Po-Hao Adam Huang, assistant professor of mechanical engineering, and his former graduate student, Kyle Godin, have received awards from the American Institute of Aeronautics and Astronautics for their research on satellite propulsion. Huang was awarded the Abe M. Zarem Educator Award and Godin received the Abe M. Zarem Award for Distinguished Achievement.

Godin's project focused on developing a solid state gas generator, using micro- and nano-scale fabrication principles, that can orient small satellites, known as nano satellites. This tiny device uses a localized heat source to release small bursts of nitrogen gas, which then provides the agile attitude control needed during orbital maneuvers.


Clockwise starting at top left: Mary Bonaduce, an undergraduate majoring in biological engineering with an emphasis on ecological engineering, works in the Water Quality Lab at the Arkansas Water Resources Center; Rayven Hill, electrical engineering undergraduate, InKwang Kim, postdoctoral student and Liming Ji, doctoral student, working in an electrical engineering lab; civil engineering student practice surveying skills; a field trip to a construction site in Little Rock gives civil engineering students a first hand look at a real-world project.

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