MIZZOU ENGINEER

ENGINEERING FOR THE ADVANCEMENT OF HUMANITY

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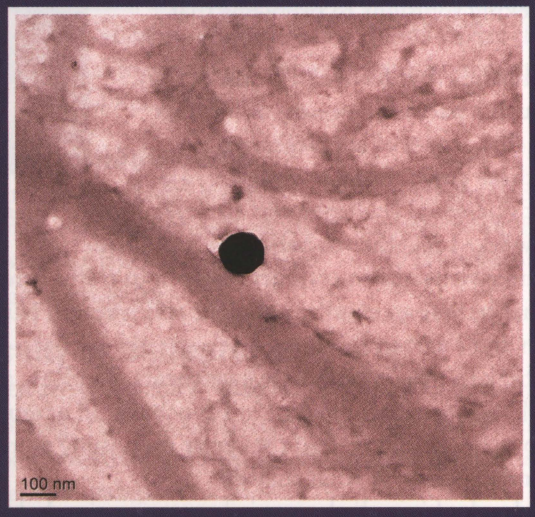
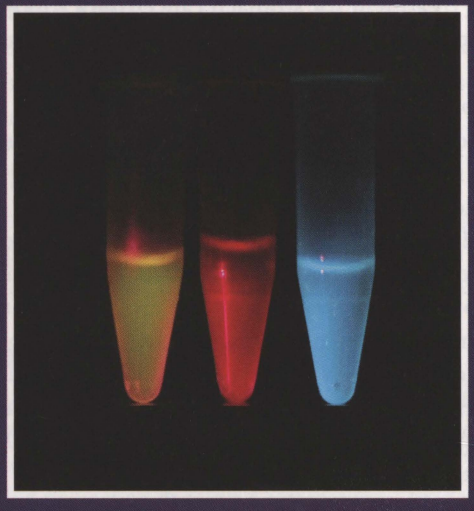
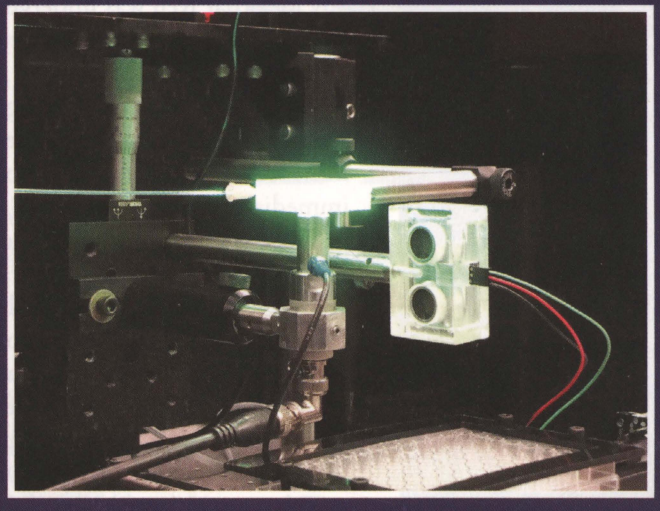
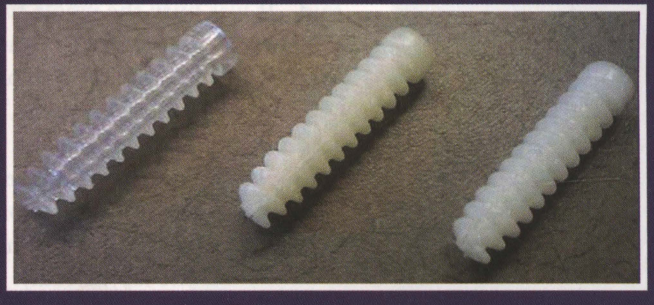






What do these five research images have in common? Almost nothing, except they all represent innovative technologies their inventors are using to launch start-ups.



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MIZZOU ENGINEER

Engineering for the advancement of humanity

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MIZZOU ENGINEER is a biannual magazine. It is our intent to capture moments in time that communicate glimpses of the past, present and future of the MU College of Engineering. We hope it also renews old acquaintances and friendships, spawns volunteerism and encourages philanthropy.

Questions, comments and suggestions may be directed to wiesefalesj@missouri.edu

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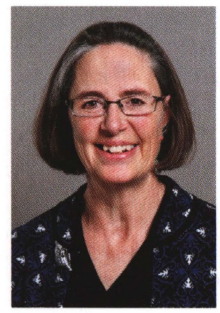
ENGINEERING IS A COLLABORATIVE UNDERTAKING. Learning to work as a contributing member of a team is as much a part of engineering curriculum and practice as is learning the necessary mathematical equations. The combined power of sharp minds is the discipline's key resource, put into practice every day in the College of Engineering's extensive network of research labs. The place virtually hums with brainpower and computers as faculty, graduate students and ambitious undergrads work together seeking solutions to problems that trouble mankind.



The partnerships and friendships that form as a result of the engineering process are as much a part of the research formula as are computations, though that aspect of engineering is not one we often touch upon in these pages. But last semester, a civil engineering graduate student's personal challenge was embraced by his research team, who did what engineers do: worked together to help solve a problem.

Yi Hou came to Mizzou three years ago to conduct research in traffic safety and driving behavior. All agree that he was an excellent student and research partner in the labs of Professors Carlos Sun and Praveen Edara.

Hou returned briefly to China to marry his college sweetheart, Rui Ren, and she accompanied him back to MU as a graduate student in French. By all accounts, they are a charming couple. Hou's lab mate, Lei Fang, said they have everything going for them — they're smart, attractive and excellent at what they do.

Feng said she remembers Hou looking a little worried at some point, but no one had any idea that Ren was undergoing treatment for stomach cancer until Hou approached Sun, his advisor, with a problem: their university-provided health insurance was maxed out.

"It took humility and courage to reach out and ask for help," Sun said.

Sun, Edara, Charlie Nemmers, civil engineering's project director of transportation infrastructure, members of Hou's research team and other civil engineering students immediately hatched a plan to hold a fundraiser lunch for the couple.

Members of MU's International Center, Friendship Association of Chinese Students and Scholars, the Asian Affairs Center, the French Department, the Graduate School and the Graduate Professional Council all agreed to help out and promote the event.

On May 8, the transportation group set up in the Engineering Time Capsule on the ground floor of Lafferre Hall and outside the building on the Francis Quadrangle. A sandwich, chips and a beverage were $5; the group's hope was to raise at least $2,000.

"A lot of people came, even people who didn't know them," Feng said. "One of them asked, 'How is she now?' and wrote a check for $500."

"Edara and Nemmers were out in the middle of the quad flagging people down," Sun said. "It was busy the whole time."

When the last sandwich was sold the group had raised $6,215, and additional donations raised the total to nearly $7,000.

"We all feel this is amazing," Feng said, adding that Hou was very moved by the response. "We all know it is a nice community, but it is the best community."

Not long after the fundraiser, Hou and Ren returned to China by air ambulance. And though the transportation research group has not had a recent update on Ren's condition, the message that through teamwork, better results are guaranteed, reinforced itself outside the lab that day.

Jan Wiese-Fales, Editor

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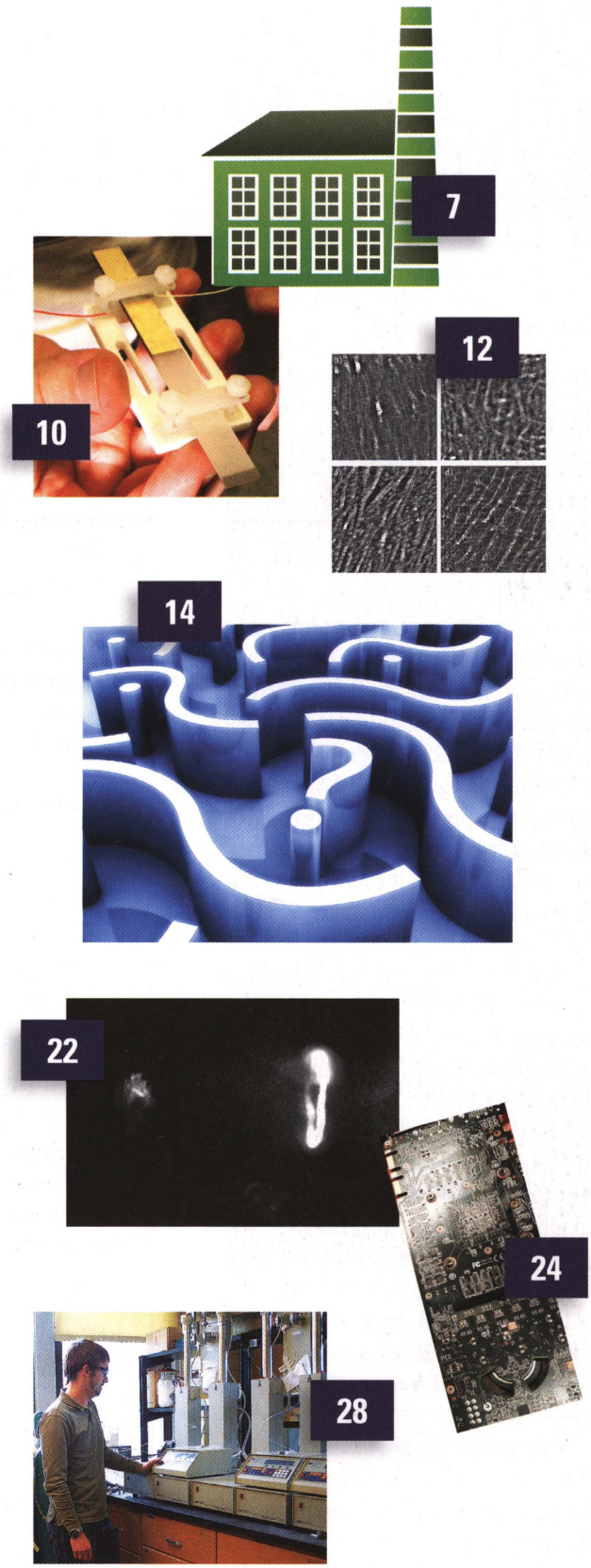
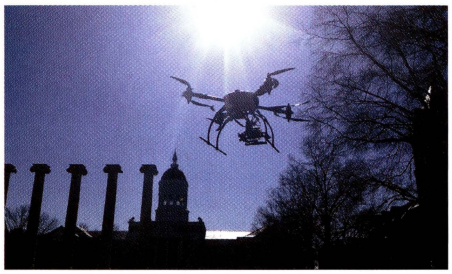
Of Note



COVER: Images represent the research innovations that five entrepreneurial MU College of Engineering faculty members are using to launch start-up companies, described on pages 14 to 21.



A news-gathering XAircraft X650 V8 drone flies in the quad near the Columns as part of a collaborative MU project.

Drones take news reporting to new heights

Generally, news outlets utilize helicopters for news coverage requiring aerial footage. But collaborative efforts of the MU College of Engineering IT Program's DroneLab and the Missouri Drone Journalism Program, have launched a project to explore a new option.

Its goal is to use drones to gather images that will enhance news stories. Funded by a $25,000 grant from the MU Interdisciplinary Innovations Fund, technical expertise is being provided by Matthew Dickinson, who serves as system administrator and instructor for the IT program in engineering's Computer Science Department.

"I've been working with drones for several years," Dickinson said. "They contacted me to do the technical side and to teach the journalism students to use the drones."

The project lead is KBIA's Scott Pham. Bill Allen, assistant professor of science journalism, teaches the class in which students learn how to fly the drones and plan stories to utilize the unique technology.

Dickinson said experimenting with different drone models to identify the type best suited to news gathering is a project goal.

The stories the journalism class pursues focus on rural issues, since FAA regulations prohibit flying drones over populated areas.

An MU story tracking the migration of snow geese using drones was featured on NBC Nightly News.

Winning paper at computational intelligence conference describes evolutionary approach to mapping

In April, two University of Missouri researchers received the "Best overall paper" award for their work in scene-matching fuzzy descriptions with satellite imagery at the Institute of Electrical and Electronics Engineers (IEEE) Symposium Series on Computational Intelligence in Singapore.

"The idea was that a person walking around in an unknown location could describe their environment using their own sort of spatial reasoning," said Andrew Buck, illustrating the mapping approach described in his winning paper.

James Keller, Curators' Professor and R.L. Tatum professor of electrical and computer engineering, (center) and Andrew Buck, a doctoral student in electrical and computer engineering, hold their awards for the "Best overall paper" at April's Institute of Electrical and Electronics Engineers (IEEE) Symposium Series on Computational Intelligence.

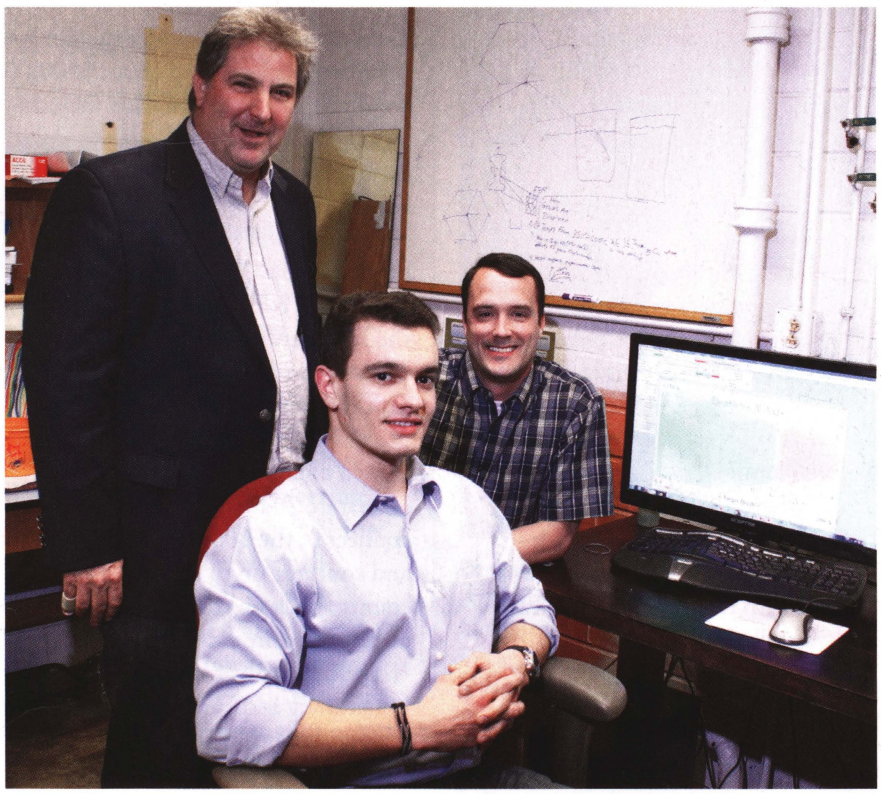
Buck is a doctoral student in electrical and computer engineering. He coauthored and presented the paper at the conference with James Keller, Curators' Professor and the R.L. Tatum professor of electrical and computer engineering.

"Everybody kind of has their own interpretation of their environment," Buck said. "It's a fuzzy map, so you might know that the road is next to the river, or the city that I'm trying to get to is far up in the north and a little to the west, so it's these vague spatial ideas that we want to see if you can sketch into a mental map to align yourself with the real world.

"Somebody could describe their environment and say, 'I see a building on my right, and there's a parking lot behind me and to the left,' or 'I see a person walking toward the intersection'," Buck said. "Using their spatial knowledge, they could use this to build a sketch, a kind of mental map of what they envision their environment to be."

Buck's research began with a project called Text-to-Sketch, started in 2009 by a former engineering student with support from a National Geospatial Intelligence Agency grant that looked at whether a sketch of objects in the mind can be matched to real satellite imagery data, or conflation. A memetic algorithm — also called an evolutionary algorithm — is rooted in the theory of evolution. Instead of attempting to find one solution, Buck's algorithm starts by spawning a population of random solutions, which over time, evolve, cooperate and compete to find the best solutions to a given problem. In this case, finding mapped locations that most closely match descriptions provided in human language is the goal.

"You have the deterministic search method, and the evolutionary approach. This paper was ultimately the fusion of both using this graph search thing, which could be computationally expensive, but uses it locally as a way to refine the genetic algorithm," Keller said.



Graduate student Anthony Pace, center, is working with Assistant Professor Matthew Bernards, right, on a Nuclear Regulatory Faculty Development Grant project examining thorium as a nuclear fuel. The grant was procured by Professor Patrick Pinhero, at left. All are chemical engineers.

NRC faculty development grant funds thorium research

In response to the MU College of Engineering's expanding academic role in the field of nuclear science, chemical and nuclear engineering Professor Patrick Pinhero, applied for and was awarded a Nuclear Regulatory Commission (NRC) Faculty Development Program grant.

Recognizing a need for qualified faculty to train tomorrow's nuclear science workforce, the NRC makes grants for, among other things, the development of research in related areas. Funding targets junior, tenure-track faculty, and the award to MU will be used to fund research conducted by Matthew Bernards, assistant professor of chemical engineering and nuclear engineering, with Pinhero serving as a mentor.

Bernards' funded-research focus is an investigation into the development of a portable nuclear power generation system that would use thorium rather than uranium as a fuel.

"Dr. Bernards is a vibrant young engineer who is very ambitious," Pinhero said. "Though he is not a nuclear expert, he is a quick learner and is not constrained by institutional biases about thorium. I find this refreshing and therefore involved him in developing a novel engineering-based thorium research program focused on developing a design basis and working prototype."

There are many advantages to such a system including the fact that thorium is non-proliferative, Bernards said.

Bernards explained that the research project utilizes an accelerator-driven system. Thorium itself is not fissionable, but must be bombarded with neutrons to initialize the chain reaction that turns it into 233U, which is fissionable. A neutron generator will initiate the cascade or series of reactions responsible for thorium power generation. Such a device would therefore be operated with an on-off switch, further adding to its appeal.

A chemical engineering graduate student with a background in physics, Anthony Pace works with Bernards on the project. He said thorium nuclear power generation is safer because of the significantly reduced radioactive waste produced from the reaction in the form of minor actinide by-products — radioactive elements at the bottom of the periodic table.

"Thorium also has a long half life, so a thorium-powered device would run forever," Pace said. "Right now, we're looking at the amount of thorium we will need and characteristics of each daughter nuclide [isotope] produced in the burn-up," Pace said.

Research such as this is facilitated by the presence of the University of Missouri's research reactor (MURR). Until now, Bernards and Pace have been running computational simulations to produce characterizations of the process.

"The technology has many potential applications," Bernards said. "It would be a great alternative power source for disaster relief. You could drive it into a place like Joplin [a Missouri town devastated by a tornado in 2011] to provide power for recovery efforts. It could be used in unmanned vehicles and has both military and space applications."

MU researcher secures $1 million NSF grant to join 100G national research network

Gordon Springer connected the University of Missouri to its very first external computer network that was accessible to all university personnel in 1983. Now, the associate professor of computer science has secured a $1 million National Science Foundation grant to connect the Columbia campus to a 100-gigabit per second national research network.

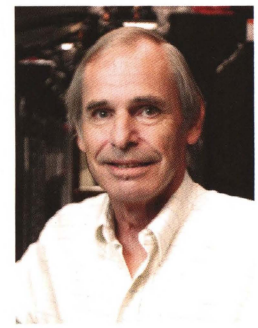
The 1983 BitNet worked at only 9,600 bits per second (bps), and the 1998 Internet2 network that Springer helped set up had the capacity of 45 million bps.

"The scale has increased enormously," Springer said. "Now the 4G cellular networks have that capability that we were so excited about for scientific research [in 1998]."

The $1 million grant will enable the University of Missouri to connect to a 100-gigabit per second national research network, which would enable researchers to transmit around five terabytes of data over the ultra high-speed network in less than a minute.

The growing importance of analyzing large amounts of data in disciplines like bioinformatics makes faster connections essential for research. Springer said the Life Sciences Center produces around five terabytes of data each week. With a 100 Gbps connection, that data could be sent and received in less than a minute.

The bulk of the NSF grant funds will be invested in the infrastructure to connect with the 100 Gbps optical recently installed by the Internet2 Consortium, of which Mizzou is a member. Springer said about $600,000 would be used for hardware, including a switch to connect to the Internet2 network. A connection will be created by connecting to the Internet2 Network in St. Louis and use university-owned fiber along Interstate 70 to connect to the 100G switch in Columbia and continue on to Kansas City to connect back up to the Internet2 network on the opposite side of the state.



Gordon Springer

The cable runs from Kansas City to St. Louis along I-70, and from those cities to connect with cities and universities in every corner of the country from Seattle to Boston and from San Diego to Miami.

Internet2 is a collaboration of research institutions focused on the technological needs of its members, particularly cyberinfrastructure. MU is one of 21 campus pilot sites for the Innovation Platform, which aims to connect researchers throughout the country by providing high bandwidth without the usual traffic.

"I'm interested in this whole idea of high performance computing in geographically distributed locations," Springer said.

The amount of data transferred across the network will make managing the volume and flow even more important. Springer said he wants to create a system so the network will be able to do that routinely.

"If everybody makes a telephone call at the same time, not everybody is going to get through," Springer said, likening the risks of researchers trying to send large packets of data at the same time to an overloaded cellular network. "We're trying to automate so we can dynamically adjust to changing loads."

Engineering Dean receives Texas Tech alumni award

In April, MU Engineering Dean James E. Thompson was recognized as one of the 2013 Edward E. Whitacre Jr. College of Engineering's Distinguished Engineers by his alma mater, Texas Tech University, for his engineering achievements in academia and his continued efforts to promote and inspire interest in engineering.

"Being recognized for my achievements and contributions to engineering by my alma mater is a great honor," Thompson said. "I substantially benefited from my TTU education and am grateful to the commitment and capabilities of the faculty of the Electrical Engineering Department."

A 1968, 1970 and 1974 alumnus of Texas Tech in electrical engineering, Thompson has served as the dean of MU Engineering since 1994. He is a registered professional engineer, a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and the former president of the IEEE Dielectrics and Electrical Insulation Society.

During Thompson's tenure at MU, the college's enrollment has more than doubled, retention and graduation rates continue to rise, and research expenditures have grown to approximately $35 million per year.

MU Engineering Dean Jim Thompson shares remarks after being presented an alumni award from his alma mater, Texas Tech University. Photo courtesy Micah Heatwole

Prior to joining the faculty at MU, Thompson served as the dean of engineering at the University of New Mexico.

He was elected an honorary doctor of the Institute of Electrophysics in Russia in 1992 and has authored more than 100 technical journal and presentation articles, as well as numerous chapters in technical books.

MU CELDi team earns third 'Success Story'

The College of Engineering's National Science Foundation-supported Center for Excellence in Logistics and Distribution (CELDi) — within the Department of Industrial and Manufacturing Systems — achieved its third "Success Story" for its work on a project for CELDi industry member The Boeing Co.

"We're looking at, as demand shifts, where to locate both part distribution and repair facilities," said James Noble, a professor of industrial engineering and MU CELDi's site director. "How would you set up the network to minimize costs?"

Noble and a student team devised a cost-efficient reverse logistics network involving Boeing's current distribution center and product maintenance repair facilities.

"Success Stories" feature exemplary projects among CELDi member-schools that achieve significant results that are then implemented by the industry partner.

This is Boeing's fourth year with MU's CELDi program and the second project the program has conducted for them.

"We are extremely pleased with the work that the Mizzou team has done on our project," said Nisha Shah, Boeing CELDi project manager and MU Engineering alumnus. "The CELDi experience has been mutually beneficial as students become exposed to real-life logistics problems, and Boeing receives insight into the latest research and analysis methods. The team has exemplified the power that can be harnessed when industry and academia work together to address a problem."

MU is one of six major research universities in the NSF-sponsored Industry/University Collaborative Research Center (I/UCRC).

Additional project partners have included Bayer CropScience, Leggett & Platt, Hallmark and Ameren.

Computer science senior Zach Winkler presents his team's winning entry in the Reynolds Journalism-sponsored 2013 Windows 8 mobile development competition at RJI's Tech Showcase event.

Team's smartphone app targets student safety

A new smartphone app, unveiled at the Reynolds Journalism Institute Tech Showcase in May, promises to give university students more assurance of a safe walk across campus.

Safe Trek was developed by Zach Beattie, Natalie Cheng and Zach Winkler, from MU's Trulaske College of Business, School of Journalism and Computer Science Department, respectively, for a 2013 Windows 8 mobile app development competition. The app took first place in the competition.

"It was pretty fun to work on," said Winkler, a senior computer science major and sole coder for the Safe Trek mobile app and companion web application. "We were just taking a lot of current technologies that are out there and then merging them together in sort of a new way."

The app works by allowing the user to activate a button on the smartphone's touch screen in any situation where they feel unsafe. The app responds with a small vibration and activates a GPS signal to map the user's movement. The user holds down the button until he or she feels safe enough to let go, and are then given ten seconds to enter a secret PIN. If the PIN is not entered, the phone connects to a local dispatch center where police can communicate with the user in-app, as well as track the phone's whereabouts in real time.

"Our idea is to get Mizzou on board with Safe Trek," said Winkler. "The fire chief is really excited about getting it implemented into their dispatch center [in Columbia], so that's pretty much guaranteed if we can get enough users to install it."

The app will be made available on the iOS and Android platforms as well, after its Windows 8 debut.

"I've done a lot of mobile application and web application development over the past four years," said Winkler. "I've been doing stuff like this for a long time, so Safe Trek was mostly pretty easy."

Winkler was also the lead developer for Project Scope, the winning entry in the 2012 RJI Student Competition. Safe Trek was Winkler's first project on the Windows 8 platform, but will be his last project as an MU student as he is headed to a job at California software company Intuit in August.

Researchers find small-sized solution has big potential for water treatment

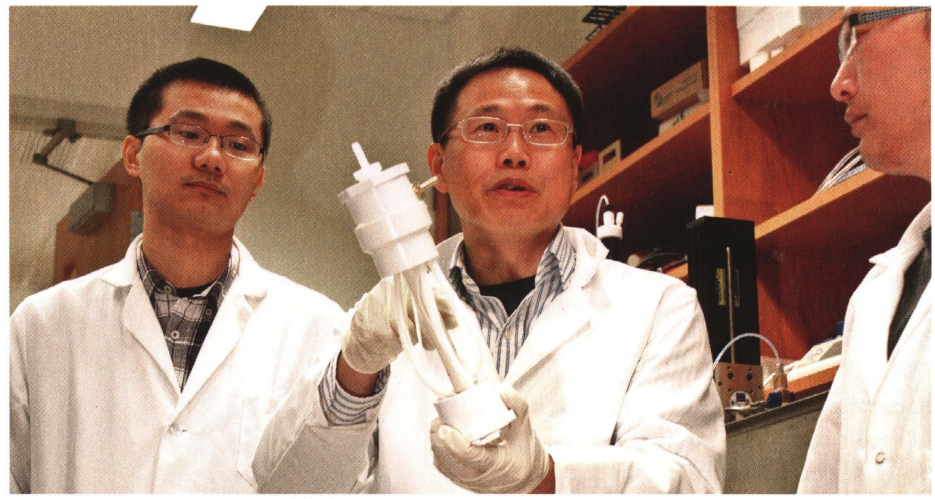
Researchers from both the Chemical and Civil and Environmental Engineering Departments in the University of Missouri College of Engineering have discovered that some very tiny materials — carbon nanotubes (CNT) — are an effective solution in water treatment.

Baolin Deng, department chairman of chemical engineering and C.W. LaPierre Professor of civil and environmental engineering, worked with Jun Yin, a doctoral civil engineering student, and visiting scholar Guocheng Zhu to develop a system of hollow-fiber membranes that utilize CNTs, as well as an application for the product in water treatment.

CNTs are carbon allotropes — variations of an element based on how the atoms are bonded together — structured in a cylindrical form hundreds of times longer than they are wide. Previous research examining the use of CNTs for water filtration, served as the catalyst for the MU researchers' work.

During the first year of the project, Yin said the team worked almost exclusively on creating the polymer and designing the system to make the membrane structures, which are approximately one millimeter in diameter, in lengths that can be customized. The membranes are hollow and have porous walls, similar to the pores in a sponge. The CNTs are introduced into the polymeric membrane structures.

"We can control, with the polymer and chemistry, the structure and size of the membrane pores," Deng said.



Baolin Deng, C.W. LaPierre Professor of civil and environmental engineering, holds a device used to hold polymer membranes in a water treatment research. With doctoral civil engineering student Jun Yin (left) and visiting scholar Guocheng Zhu, he developed a system to create hollow-fiber membranes that utilize carbon nanotubes for water treatment.

The research team found using membrane structures with CNTs could effectively filter contaminants from water. In their study, membranes are contained in narrow glass tubes through which pressurized water flows. The membrane is able to reject any contaminant larger than its pores. The CNTs found within the membrane structures create properties that significantly increase the efficiency of water flow and also help prevent a build-up of contaminants on the membrane surface that would obstruct water flow.

Deng said the project's methods could be used for treating different types of water — wastewater, greywater or drinking water — from a myriad of sources. He speculated the methods also could be used to treat brackish groundwater, potentially solving the global problem of a shortage of fresh water.

Deng's previous research found risks to the environment using "uncleaned" carbon nanotubes retaining trace amounts of metals left over from the manufacturing process. CNTs used in the water-treatment membrane structures are pre-treated with mixed acid solutions to remove these metals.

"If we find that the benefits outweigh the risks, we know this is something that we can take to a commercial level, but if we find the risks are too high, we may have to restrict how this technology is used."

MU student chapter of Engineers Without Borders implements water treatment project

Members of MU's student chapter of Engineers Without Borders traveled south to the small Central American town of Ciudad España, Honduras, over spring break to implement a project three years in the making.

The team launched an updated design in a wetland treatment cell for an existing wastewater treatment system in the mountainside village.

"A sand filter in the existing cell was clogged, preventing any drainage," project manager Adam Byrnes said. "The people there cut a hole next to the blockage, which created a flow concentration that killed plants meant to treat static water."

The result was wastewater draining too quickly into a river that serves as a primary water source. With the help of local residents, EWB students implemented a design that included a linear filter made with gravel and PVC pipes. They also planted more water filtering foliage — duckweed, cattails and water hyacinths on what was their fourth trip to the region.

The group made three assessment trips, one each year since 2010.

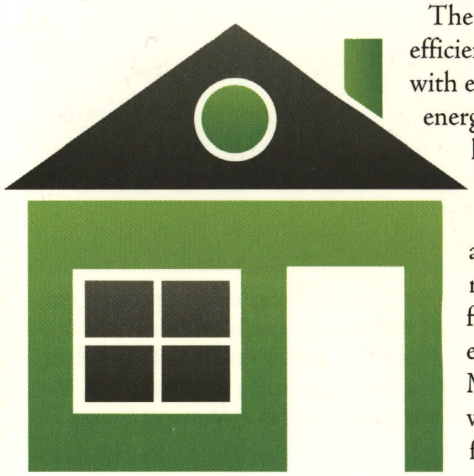
Members are already looking ahead to their next project, which Craig Wilkins, incoming chapter president, said probably will be in Panama.

Energy efficiency initiatives join forces under MU's Mizzou Advantage program

story by Jan Wiese-Fales • photo by Jennifer Hollis

Viewpoints vary widely on approaches this country could and should take to increase domestic energy production, yet few would debate that energy efficiency — the use of less energy to accomplish a given task — is a sensible place to begin. A goal of energy efficiency will result in conservation of resources and money that can be used to improve lives in a variety of additional ways. It also encourages both a closer look at current practices and increases the chances of innovative research to improve efficiency. Ultimately, a move toward energy efficiency will create jobs and result in reduced impact on the environment.

In addition to residential and industrial applications, there is keen interest in the topic of energy efficiency in the business sector as well as the construction industry. University of Missouri researchers have taken note and a number of independent efforts and programs have been initiated across campus to address various aspects of energy conservation. Schemes for these initiatives to join forces have been on a low simmer, but with the initiation of Mizzou Advantage — a campus program with an emphasis on interdisciplinary research in targeted areas, including sustainable energy — those plans have become reality. A consortium of six campus energy initiatives has come together as the Midwest Energy Efficiency Research Consortium (MEERC).



The six areas of energy efficiency impact include four with emphasis on areas of energy technology: lighting; high performance buildings; low energy heating and cooling; and energy solutions and research. Two additional foci take aim at major energy consumers in the Midwest: agriculture and water and wastewater facilities.

"No one has the components that we have on this campus in energy interdisciplinary relations," said Robert Reed, a research professor of civil and environmental engineering who will serve as MEERC director. "It provides us with the opportunity to cooperate with others and working together we are stronger."

Key collaborators in laying the groundwork for MEERC include Cerry Klein, professor of industrial engineering and facilitator of the Mizzou Advantage Sustainable Energy initiative, and Sanjeev Khanna, an MU mechanical engineering professor with a background in industrial and rural energy efficiency initiatives.

In its comprehensive approach to the broad topic of energy efficiency, MEERC has set some ambitious goals for itself. First and foremost, the group would like to educate those in public, private, academic, business and industry sectors about the various advantages and the value inherent in the practice of energy efficiency.

The center aims to build partnerships with other academic institutions, businesses and agencies in order to make academic courses and training programs available to those who can most benefit from them and then move forward to put the knowledge into play for students; design, construction and operations agencies; and business professionals.

"It's a needs-based, results-oriented approach," said Khanna, adding that such a program will be greatly beneficial to MU students.

"Our students will be involved in interdisciplinary training

and internships in practice of future professions in this industry," he said.

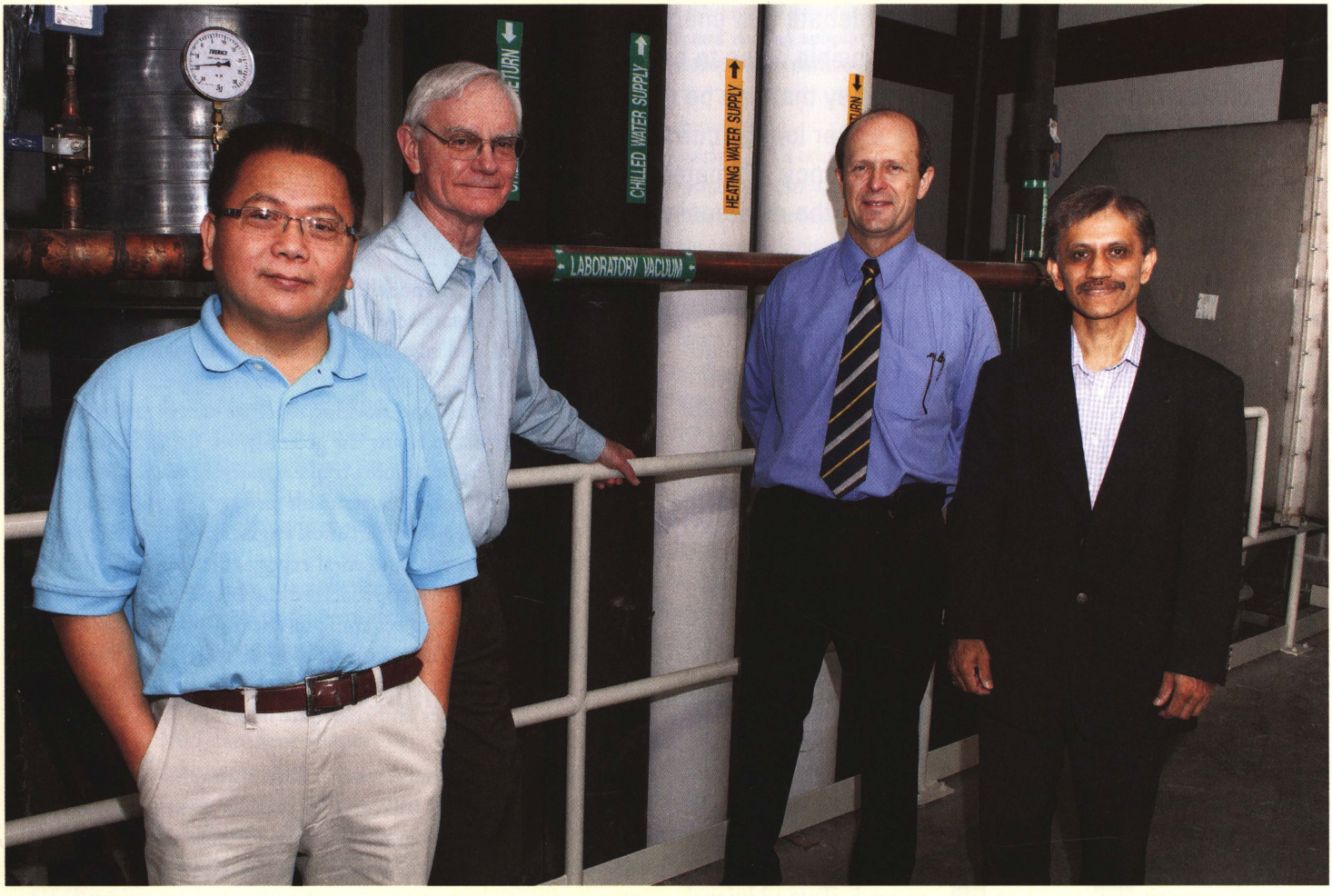
A related affiliation partnership with other MU colleges and programs will offer a graduate certificate in energy efficiency and also will provide a foundation for potential energy policy-setting guidance at the state or even the national level.

Energy research is a key component of the program. MEERC plans to build relationships with industry and government agencies to identify needs and follow through with research and development partnerships that will aid in putting new energy technologies developed by its centers into play.

Modeled on a successful program administered at the University of California-Davis, response to MU's initial efforts has been gratifying.

"We are getting an unbelievable response nationally, not just in mid-Missouri," said Reed, adding that a major international retailer with Missouri ties has expressed interest in working with MEERC in order to make various aspects of their business model more sustainable through local producer cooperatives and energy efficiency measures.

Associated Electric Cooperative, which serves 51 distribution cooperatives in Missouri, Iowa and Oklahoma, has voiced interest in partnering with MEERC through their municipal energy efficiency loan and grant program. The Missouri Public Utility Alliance, a not-for-profit service organization that represents municipally owned electric, natural gas, water, wastewater and broadband utilities, also is



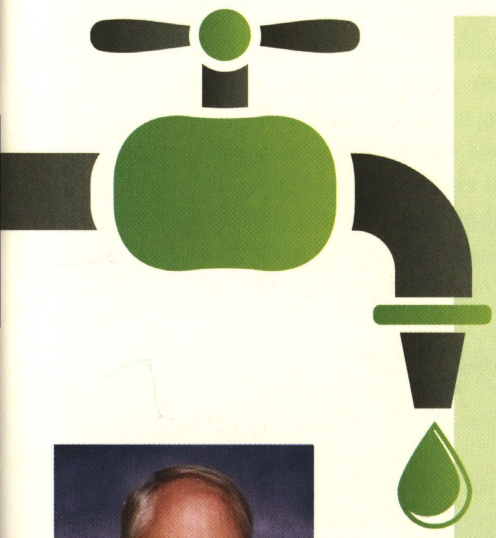
Engineering faculty members and industry partners from different disciplines have joined together to tackle six areas of energy efficiency under the umbrella of the Midwest Energy Efficiency Research Center (MEERC). Above, key players include, left to right, Shawn Xu, associate research professor in civil and environmental engineering; MEERC Director Robert Reed a research professor of civil and environmental engineering; Leon Schumacher, professor of agricultural systems management; and Sanjeev Khanna, LaPierre Professor in mechanical and aerospace engineering. At left are, top, Matt Belcher, president of Belcher Custom Homes and, bottom right, Richard Holmes, former senior advisor for industrial initiatives at Midwest Energy Efficiency Alliance of Chicago.

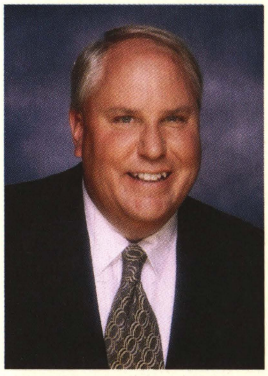
in discussion with MEERC about collaborations.

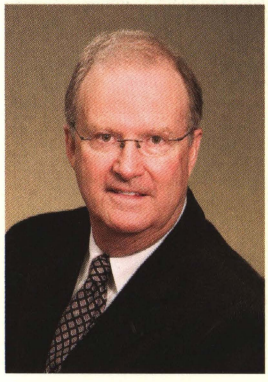
Additionally, a number of academic entities have weighed-in as MEERC partners, including Wichita State University. Faculty there has a keen interest in energy efficiency in healthcare settings, also an area of great potential on the MU campus and throughout the country.

Faculty working within two programs at University of Arkansas-Fayetteville have responded favorably to affiliations with MEERC: the poultry science program sees potential in the poultry facility geothermal work being conducted by Shawn Xu, MU civil engineering research associate professor. The U. of Ark.'s municipal sustainability program also is interested in collaboration.

"We are reaching out and bringing together all of the resources here at MU and those of outside organizations for the impact the energy efficiency industry needs," said Reed. "In chorus, we can offer a more holistic approach and a better result for all of our partners and the results they need for their various programs. It's like a department store approach: everything you need in one place."







The six MEERC consortium partner centers, their specializations and those leading the efforts for each are as follows:

The Agricultural Energy Efficiency Center will concentrate on production and value-added agricultural energy users. The development of innovative crop techniques to save water and energy, and best practices with high-efficiency mechanized equipment are also areas of interest. Leon Schumacher, professor of agricultural systems management, serves as director.

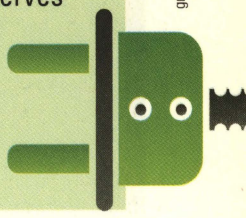
The Energy Solutions and Research Center will work to monitor and verify energy and water consumption and conservation. Work will involve product development and testing, creating technical content and market research for corporate firms. This center will synthesize research from the other five areas. Sanjeev Khanna, LaPierre Professor in mechanical and aerospace engineering and assistant director of the Missouri Industrial Assessment Center, serves as director.

The High Performance Buildings Center's specialty is energy efficiency and indoor air quality in homes and small commercial buildings. Work will include both new construction and those retrofitted with new technologies. Matt Belcher, president of Belcher Custom Homes serves as director.

The Lighting Research Center targets energy efficient lighting and the appropriateness of lighting as research targets. Richard Holmes, former senior advisor for industrial initiatives at Midwest Energy Efficiency Alliance of Chicago, serves as director.

The Low Energy Heating and Cooling Center will concentrate on research and development of efficient heating and cooling systems. Large-scale and solar-assisted heat pump technologies will be a primary focus. Shawn Xu, associate research professor in civil and environmental engineering, serves as director.

The Water and Wastewater Center intends to work to improve energy efficiency in water and wastewater utilities in small municipalities.



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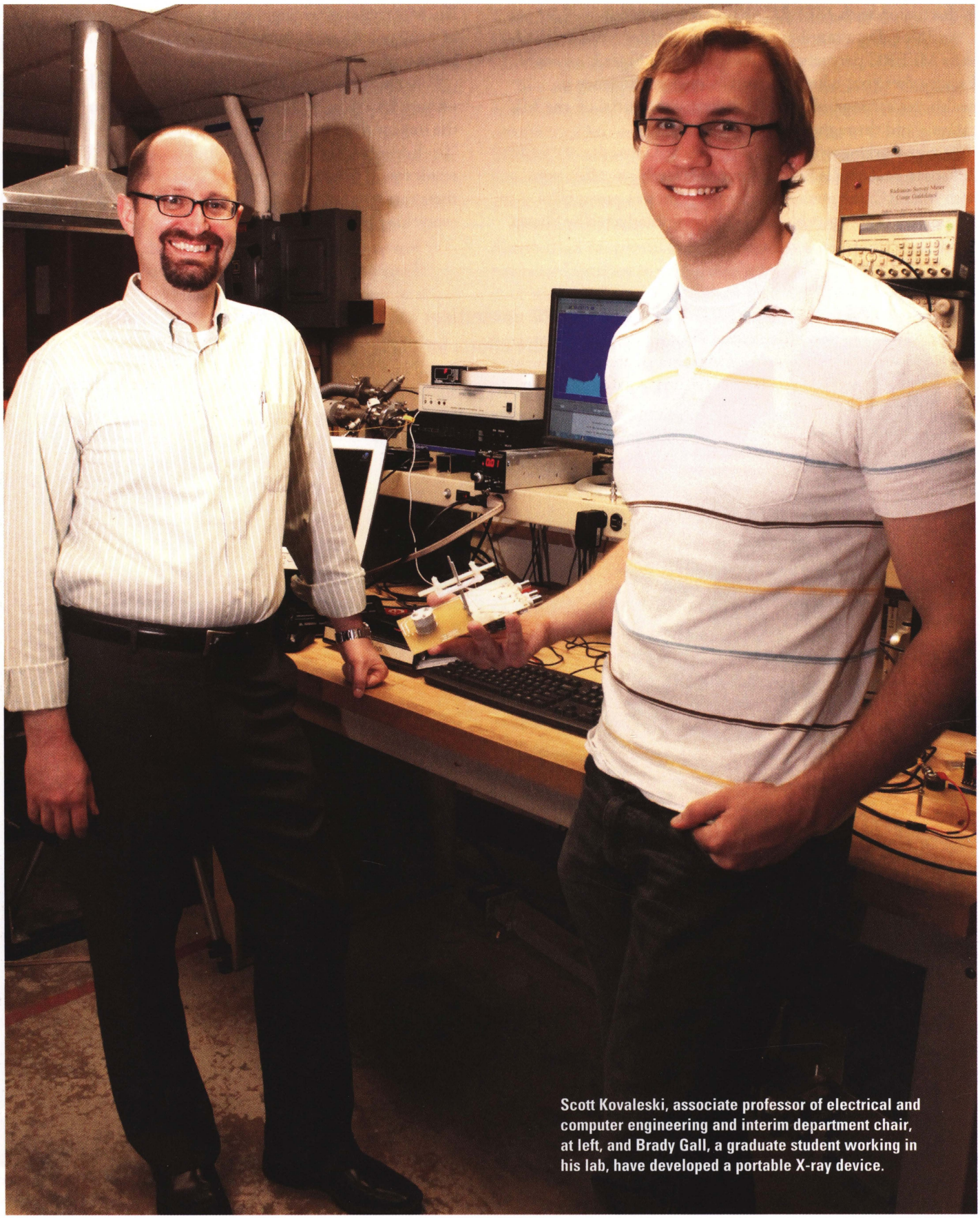


Scott Kovaleski, associate professor of electrical and computer engineering and interim department chair, at left, and Brady Gall, a graduate student working in his lab, have developed a portable X-ray device.

Portable X-ray device has exciting potential

story by Jan Wiese-Fales • photos by Katie Bell

French physicist and Nobel laureate Henri Becquerel's accidental discovery of radioactivity in 1896 occurred as he worked to uncover the secrets of X-rays. One hundred and seventeen years later, serendipity and X-rays again joined forces for an unexpected consequence and an exciting discovery in the lab of Scott Kovaleski, an MU associate professor of electrical and computer engineering and interim department chair.

One of Kovaleski's research emphases is the development of space propulsion thrusters. As he and his team conducted experiments toward the development of an ion thruster, they realized the output energy — in the form of an electron beam — produced X-rays. The researchers immediately recognized the potential of their discovery to produce an inexpensive, portable X-ray system that would also have other advantages such as limiting dosage of radiation via previously impossible configurations.

"Rather than having the film in your mouth and the X-ray source exposing your head for dental X-rays, for instance, such a device would shoot outward, limiting your exposure," Kovaleski said.

The device operates using what is known as the piezoelectric effect: non-conducting crystals that are subjected to mechanical stress — in this case exposing a man-made crystalline ceramic material, lithium niobate ($LiNbO_3$), to a low-voltage electrical signal — store energy in a vibrating mechanical wave that can be extracted and accelerated as a high-voltage electron beam.

The AC electrical energy used in the experiments cause the crystal to vibrate and "ring" like a bell. "You can hear it chirping," Kovaleski said of the chewing gum-sized crystal.

"Piezoelectricity is used in a lot of neon signs, LCD monitors, laptops and AC/DC converters," said Brady Gall, an electrical engineering graduate student working with Kovaleski. "They produce at most, 300 volts."

But, Gall said, repeated experiments have produced 120,000 volts with statistical certainty.

"All the simulations said that it was possible, but no one got it. We were the first to try it," Gall said.

The researchers said there was nothing "magic" about the project. It has taken three years of tinkering, testing and new configurations to get them to this point, and they continue to work to optimize the output of the crystal. They estimate it will be three to five years before an actual portable X-ray prototype is developed.

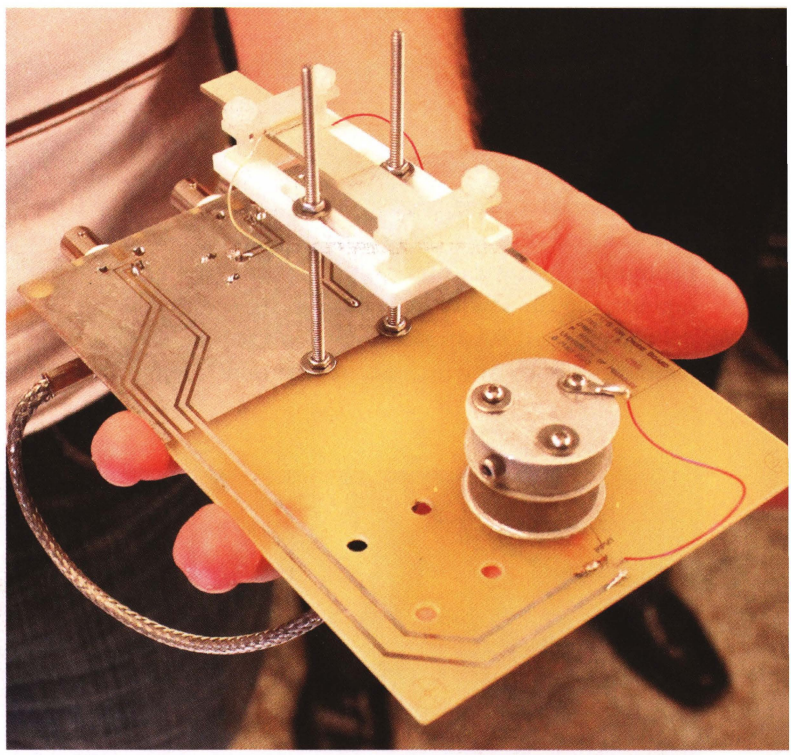
"Currently, most X-ray machines are huge and require tremendous amounts of electricity. A cell-phone-sized device could improve medical services in remote and impoverished regions and reduce health care expenses," Kovaleski said of the device's potential. "And it can run on batteries."

He said that in addition to being a used as a low-cost scanner to detect contraband and playing a role in other security devices, the technology has implications for everything from space exploration to its use in oil drilling.

It also has potential to replace dangerous radioisotopes in a variety of applications.

"Our device is perfectly harmless until energized, and even then it causes relatively low exposure to radiation," Kovaleski said. "It has never before been possible to develop radioisotope devices with an on-off switch.

"More applications will develop over time," he said. "The potential for innovation is very exciting."



Brady Gall, electrical and computer engineering graduate student, holds the prototype for a portable X-ray device developed in the lab of Associate Professor Scott Kovaleski.

Researcher's aim is to produce polymer-free custom-made bone

story by Jan Wiese-Fales • photo by Katie Bell

"Hundreds of scientists are working to understand the binding interactions of bone tissues, but not one can replicate the mechanical properties of bone without a polymer," said Matthew Bernards, a University of Missouri chemical engineering assistant professor, who has made this particular biomaterials puzzle the cornerstone of his research program. His ultimate goal is to create custom-made bone.

Bernards explained that bone is composed of two materials: collagen, a structural protein, and hydroxyapatite, the mineral structural element. He and chemical engineering graduate student Kevin Zurick are conducting a systematic study of the major non-collagenous proteins found in bones and teeth for their abilities to bind collagen and hydroxyapatite.

"Proteins have been shown to facilitate bone formation, so we are looking at which of the small integrin-binding ligand, N-linked glycoproteins (SIBLING) is most conducive," said Zurick.

The pair identified three SIBLING proteins they felt had merit as they are the most prevalent non-collagenous proteins in bones and teeth. The testing process involves quantifying the ability of each to form minerals on collagen-coated substrates and to induce collagen fibril formation, both of which occur naturally during reparative processes within the body

"If we can successfully replicate these reactions, we could recreate the mechanical properties of bone in a biomimetic fashion," Bernards said.

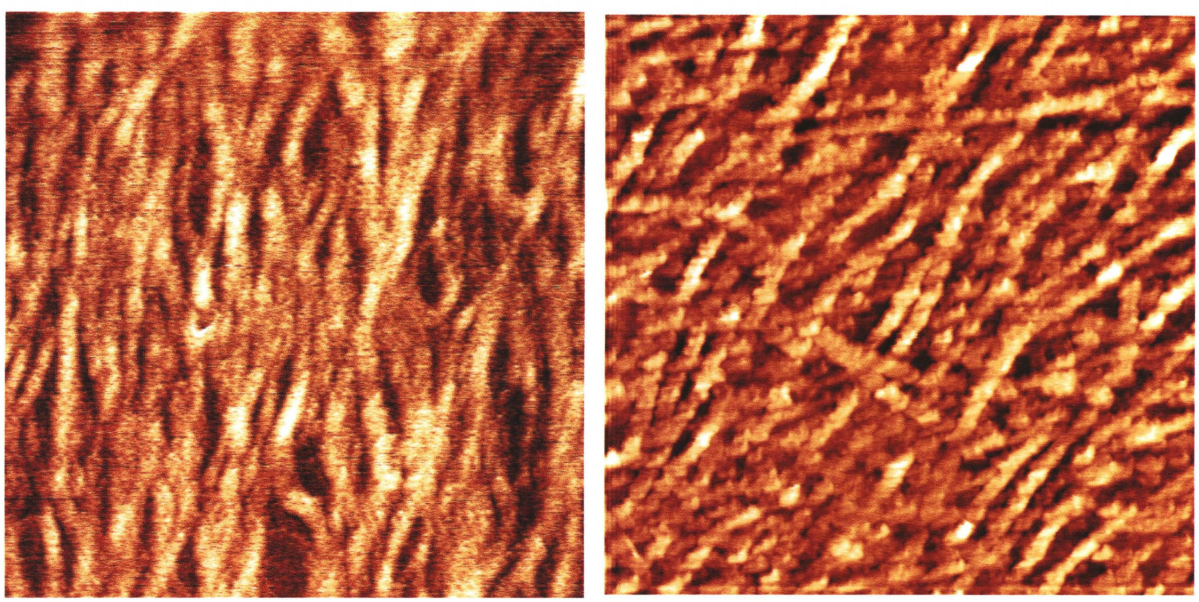
Zurick sees the potential to produce biocompatible bone tissue in a "big block" that could be cut to precisely replace damaged bone.

"The scaffold, or medium, must have qualities of what you intend to replicate. Cells will grow into it based on physical and chemical cues and differentiate accordingly because the native binding was replicated. And the immune response would be negligible," he said. "You could take an X-ray and not be able to tell it had been replaced."

Bernards said he believes that he and Zurick have identified the most promising of the mineral inducers, and they continue to work on identifying the best fibril inducer.

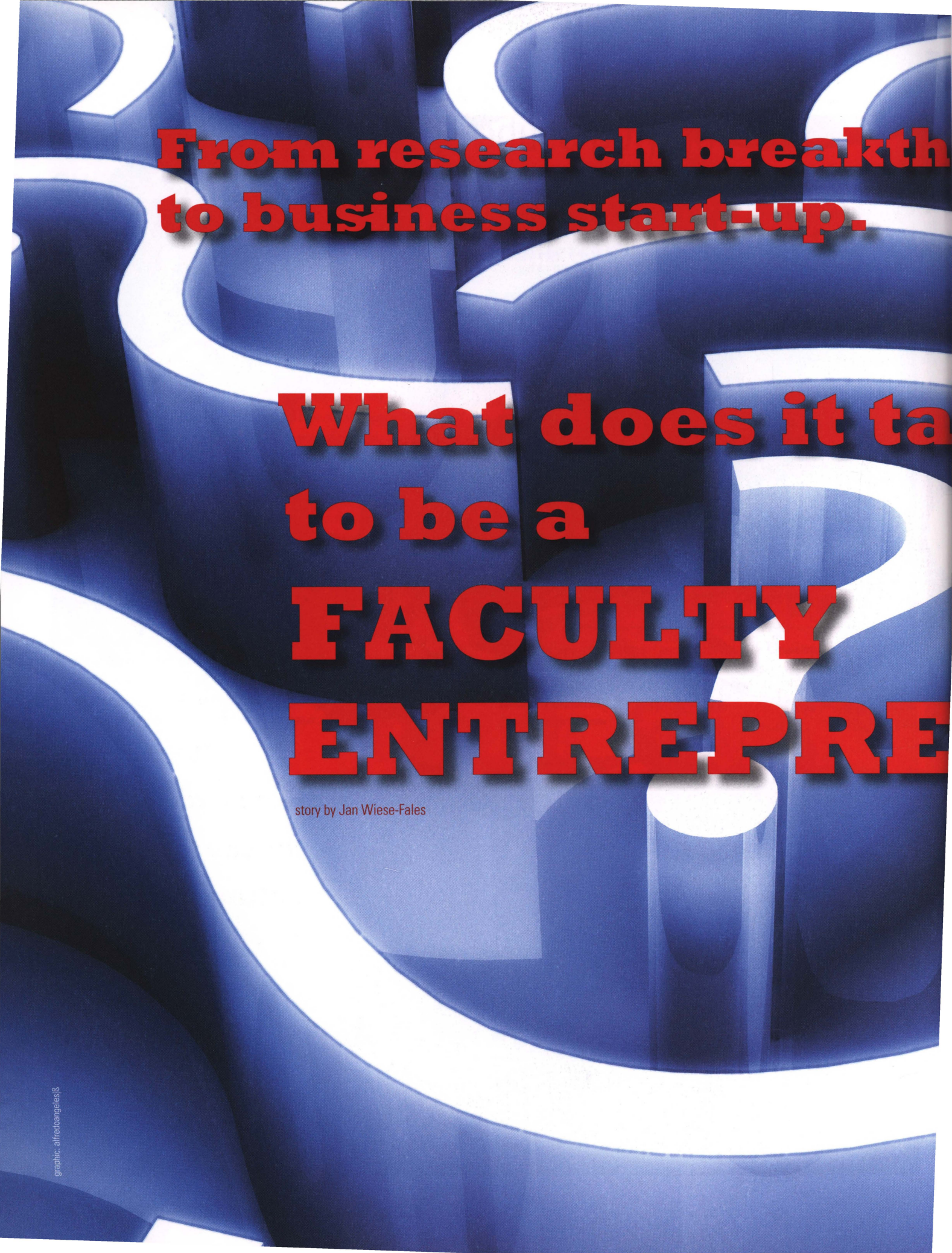
"Hopefully, it's the same one," Zurick said.

Zurick is one of the department's Holtsmith Graduate Student Scholarship recipients. He has been working with Bernards for four years in part thanks to a gift from chemical engineering alumnus Robert Holtsmith and wife, Dorcas, in support of the department's graduate program.



At left, pre-treated collagen. At right, mineralized collagen after five hours of immersion in a mineralization solution with the researchers' most promising mineralizing protein. Photos were taken with an atomic force microscope.

Matthew Bernards, assistant professor of chemical engineering, foreground, and graduate student Kevin Zurick, look over the results from testing the two are doing to recreate the mechanical properties of bone without using synthetic materials.



story by Jan Wiese-Fales

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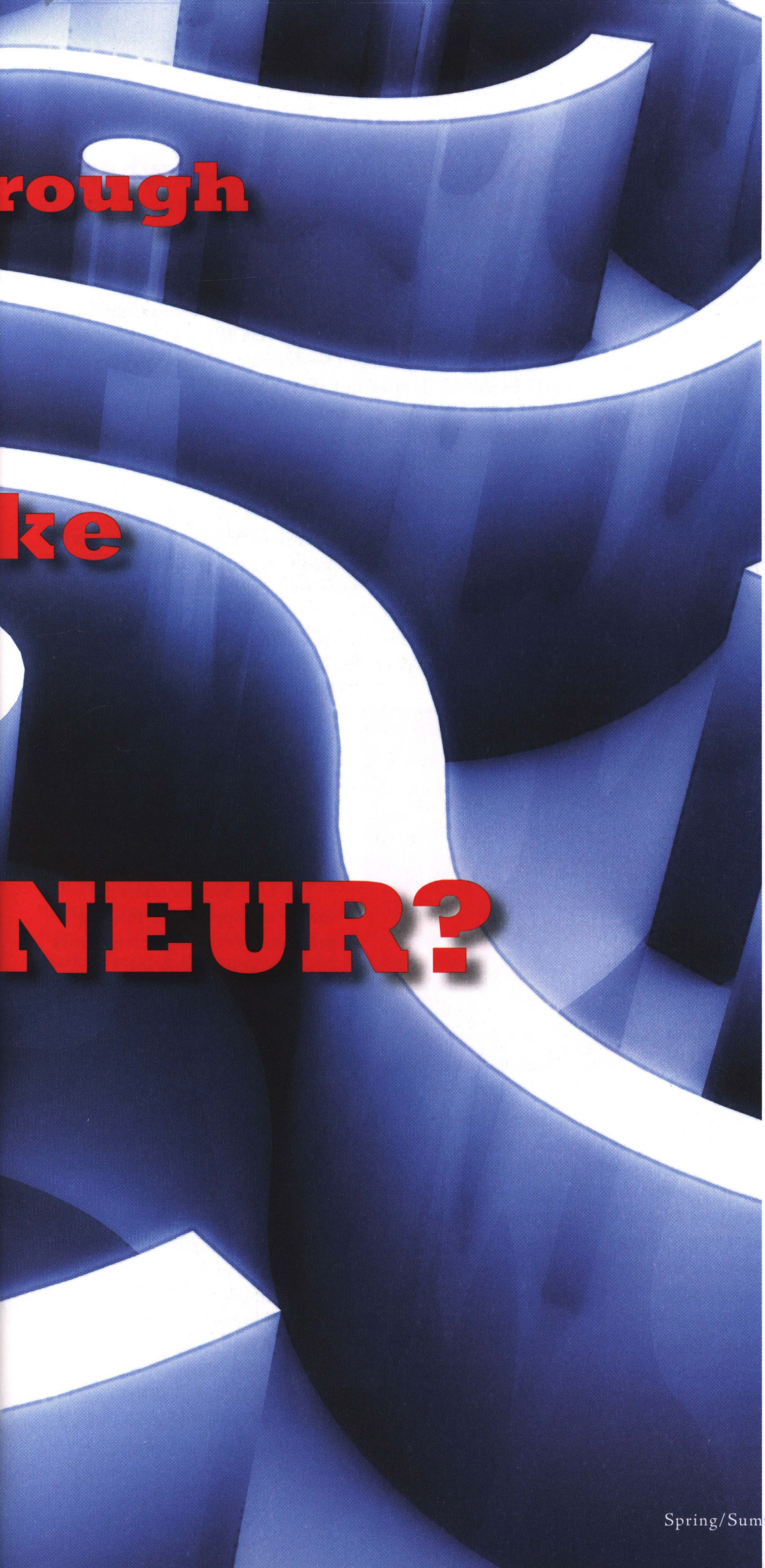


In the popular Star Wars film "The Empire Strikes Back," the wizened green Jedi master Yoda's words of wisdom to his protégé Luke Skywalker could be the mantra for successful entrepreneurs: "Try not. Do or do not. There is no try."

Several on the University of Missouri College of Engineering faculty are "doing," having launched businesses based on their research breakthroughs. What follows is an examination of how faculty launch start-up ventures and a look at a handful of some of engineering's adventurous risk-takers' efforts, in various stages of development.

How does it work?

When an MU researcher comes to a point when he or she believes an innovation arising from their research is patentable, they file an intellectual property disclosure. Such a disclosure kicks off a review by MU's Office of Technology Management and Industry Relations (OTMIR), which includes an assessment of the patentability and the marketability before a decision is made to file a provisional patent application. According to Wayne McDaniel, OTMIR associate director, 75 to 100 inventions are disclosed each year at MU, and about 60 percent lead to provisional patents. These temporary patent applications serve as placeholders for one year.

By policy, inventions by faculty at the university are assigned to and become the property of the university. Before the university invests between $10,000 and $30,000 or more for a utility patent application, a business case must be made to justify this investment. Is the invention novel, non-obvious and useful? Can it be differentiated from something that already exists? Does it take current technology to the next step? Is there a market? Can it be commercialized?

McDaniel and colleague Brett Maland, senior licensing and business development associate with OTMIR, serve as the intellectual property-licensing unit (IPLU) in the College of Engineering. They are responsible for making a recommendation to Chris Fender, director of OTMIR, who makes the final file or don't-file decision.

Once a patent application is filed, commercialization can take one of two paths. Either the IPLU works with the researcher to identify established companies that want to license the technology from the university, or the researcher can license it from MU to develop his or her own company. McDaniel and Maland are responsible for most of engineering's "tech transfer" negotiations and contracts.

Is the invention novel, non-obvious and useful? Can it be differentiated from something that already exists? Does it take current technology to the next step? Is there a market? Can it be commercialized?

What does it take and where do you get it?

"We start working with researchers when they are just thinking about ideas," said Paul Bateson, technology commercialization counselor with the University Center for Innovation and Entrepreneurship (UCIE), a Missouri Small Business and Technology Development Center that is part of MU Extension, located in Lafferre Hall. "They find us after they make a disclosure, often with a referral from OTMIR."

Bateson and Jim Gann, the center's director of technology business development, work directly with entrepreneurial clients through concept, development and commercialization phases. Bateson explained that clients must juggle the technological, marketing and business development stages of their venture, giving each equal weight as they proceed.

The inherent risks in entrepreneurial endeavors are not for the faint of heart. No matter how fabulous the technology, unless there is funding capital — and usually lots of it — there is a definite possibility that the venture will go nowhere fast. A time investment at least equal to an additional full-time job also comes with the territory.

Funding can come from a variety of sources. Independently wealthy entrepreneurs — or those with generous families — are ahead of the game.

The UM System offers a variety of support and funding programs — through competitive application processes — including Faculty Innovation Awards, a Fastrack program, an Interdisciplinary Intercampus Program and the Enterprise Investment Program (EIP), among others (umsystem.edu/fundingopps).

A couple of federal grant programs are available for small innovative technology businesses like those launched by MU Engineering faculty. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are administered under the umbrella of the federal Small Business Administration. UCIE provides application assistance. Projects under both grant programs proceed through three stages with federal grant support available for the first two – proof of concept and commercialization R&D. The grantee company must fund the final stage in taking products to market. The SBIR program is aimed at "qualified small business concerns," and STTR is for "small businesses in partnership with nonprofit research institutions."

The primary source of available investment capital to seed early stage start-up companies is angel investors. Angel investing is a term used to describe private financial support from wealthy individuals or organized angel groups who are investing their own money.

Centennial Investors is an angel investor network in Columbia, Mo., located at the MU Life Science Business Incubator at Monsanto place. The group was formed to "meet the early capital needs of university and private sector entrepreneurs." Such a group is able to take advantage of the opportunity to join with others of the same ilk to invest in early-stage companies. In addition to infusing start-ups with needed funding, angels offer fledgling companies mentoring support and validation of business concepts.

Missouri Innovation Center (MIC) manages the Life Science Business Incubator and the business incubation program, a non-profit organization that has been helping start-up companies in mid-Missouri since 1984. Although a legally separate entity, MIC has had an affiliation agreement with the university for almost 30 years. This public-private partnership brings private sector perspectives and expertise to the business of starting and nurturing companies. More than 13 engineering-related companies call the business incubator home.

"The incubator is about much more than rental space," said Jake Halliday, president and CEO of MIC, who referred to it as "a complete ecosystem of resources that young companies need for full-cycle technology commercialization."

"We offer a variety of services for our resident companies," said Halliday. "Centennial Investors is right here as a source of investment capital and a small army of MBA candidates from the [MU] Trulaske College of Business supports market research and analysis of the competitive landscape for resident clients. Legal externs are provided by the MU School of Law and two law firms from Kansas City provide pro bono office hours on-site."

Halliday said that affiliate mentors in diagnostics and medical devices travel from Kansas City and St. Louis to coach incubator companies and an FDA regulatory specialist and a grant writer are also available for consultation. Plus, MIC's counselors provide ongoing coaching for the startups, and OTMIR, which is headquartered at the incubator, hosts workshops and events of interest to faculty entrepreneurs.

Another eventual infusion of development and operations funding are venture capital investments, generally made by a group of wealthy investors or financial institutions once it is clear the technology is advancing toward commercialization. These cold cash investments often come with "warm body" investments — people with technical and managerial expertise. Venture capitalists take a more active role in company decisions and also receive a portion of the company's equity.

A sampling of those who are "doing"

More than 20 engineering faculty members have taken the entrepreneurial plunge in an attempt to commercialize what is essentially their life's work. The fact that their success may result in tidy financial gains is sometimes less an incentive for such risk-taking behavior than their desire for their invention to have the benefit to society they have envisioned.

The following five start-up profiles are intended to give a flavor of the truly impressive research that originates from the diverse and talented scientists who work and teach at the University of Missouri's College of Engineering that may eventually benefit you or someone you know.

ProactiveSense

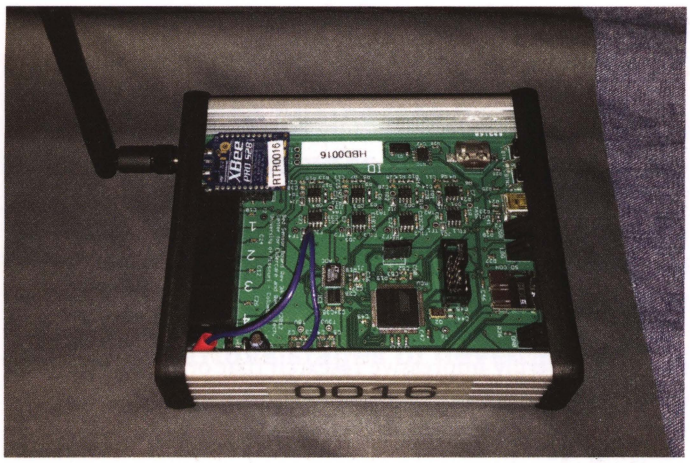
Entrepreneurs: Marge Skubic, professor with joint appointments in electrical and computer engineering and computer science, and collaborator, MU Curators' Professor Marilyn Rantz, Helen E. Nahm Chair at the MU Sinclair School of Nursing

Innovations/products: Aging-in-place sensor technologies, an electronic health record (EHR) for long-term care and care coordination

Company structure: Principals are George Chronis, Skubic's first graduate student, and Katy Musterman, Sinclair School of Nursing's manager of nursing services. Skubic and Rantz have small equity partnerships in the business. The newest of any profiled here, ProactiveSense just "came together" in late May.

Background: Since 2002, the pair of researchers has pursued their vision of developing technologies and care management strategies to allow people to extend their independence into old age. They have done so with a vibrant and extensive interdisciplinary research program at TigerPlace, an active retirement community developed by Americare in affiliation with Sinclair School of Nursing.

The sensors the team has innovated are aimed at non-invasive monitoring of human behaviors that may signal declining health and even emergency situations.



This bed sensor is one of the components of "aging in place" sensors developed by electrical and computer engineering Professor Marge Skubic aimed at non-invasive monitoring of human behaviors that may signal declining health and even emergency situations.

Doing: "We were looking for a path where we could introduce this work into a commercial marketplace to people who can use it," said Skubic. "It became obvious we wouldn't be able to proceed with scaled-up research without a commercial partner."

But, Skubic added, they could not find the right fit, so they approached Chronis to help launch a business to do so and he agreed.

"Marilyn and I had been very firm about not starting a company ourselves," Skubic said, explaining the model they have chosen. "We wanted to avoid a conflict of interest that would taint our research. But we talked with the MU compliance officers and they assured us that a potential conflict of interest could be addressed."

Skubic said Musterman, who also has her MBA, is the expert on the venture's clinical data support system for early intervention, and Chronis, responsible for developing the EHR/care management software, are the perfect fit.

And, she added, Chronis has had some experience with entrepreneurship as he is running two companies of his own: his family's Greek olive oil business, Olea Estates, a five-generation venture that he brought back into commercial success, and CyberSense.US, which specializes in information technology solutions with a target audience of academia.

Starting your own company takes perseverance," Chronis said on the day he readied ProactiveSense's pitch to Centennial Investors.

Chronis said he planned to tell investors about the opportunity in the marketplace, the company's abilities and advantages and their plan to commercialize their products.

"Everything else being equal, our competitors do not have what we have," Chronis said.

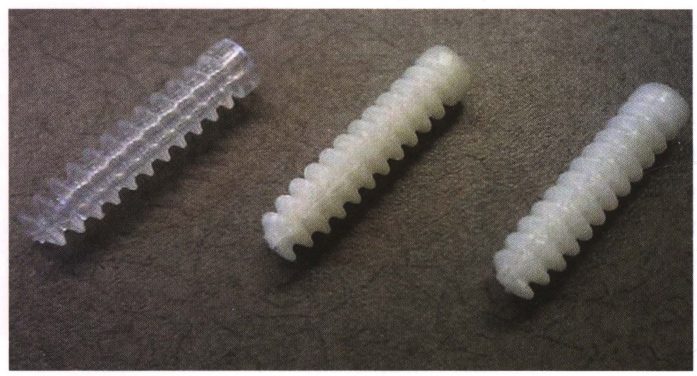
Nanova, Inc.

Entrepreneurs: Hao Li and Qingsong Yu, associate professors of mechanical and aerospace engineering

Innovations/products: Medical devices for orthopedics, dentistry and cardiovascular applications

Company structure: Li is company president, and holds a doctorate in chemical engineering. Co-founders Yu, who also holds a doctorate in chemical engineering, Meng Chen, with a doctorate in electrical engineering, and Kenneth Lambert, an orthopedic physician, are the company's VPs.

Background: Li has been investigating biological nanocomposites since 2005, and received a National Science Foundation CAREER Award in 2009 to study "Fabrication of surface-modified hydroxyapatite nanofibers and their composites." One result, bioadsorbable bone screws, will be one of the company's commercialized products. A plasma dental brush that cleans and disinfects cavities in teeth to increase the bond of fillings is also close to hitting the market, with many other innovations simmering on the back burner.



These bone screws are one of the products developed by mechanical and aerospace engineering Associate Professor Hao Li, who is using nanofabrication techniques to discover novel nanofillers and nanocomposites for orthopedic and other applications.

Doing: Li and Yu announced in late March that the China-based venture capital firm SummitView Capital and other investors will pump $7 million into Nanova, creating a joint venture with the engineering researchers on their orthopedic implants and dental consumables.

"We presented our work to a lot of venture capital companies; but venture capital appears to be a small world," Li said. "Getting the money is difficult, but may not be

the most important and difficult thing. Finding the right partner is. It's similar to a marriage. We have declined funding from others because the resources they had to contribute were not the right fit. We know ourselves. I don't have experience in areas like management and marketing, and have no manufacturing expertise," he added, elucidating some of the areas in which SummitView will support Nanova.

Li said he has dreamed of developing and commercializing a novel device that can improve people's lives since he was a student, not solely for financial gain, but for the impact he can make on the world.

"Although profit is important, that is not the driving force for our team. We would like to make our devices available in underdeveloped countries for low costs," he said.

Of moving innovations forward to commercialization, Li said researchers should step back and treat the technology like it's someone else's and not get too personally involved.

"Companies have to take risks and take the full responsibility, right or wrong. How much can you sustain failure before you succeed? It takes persistence to get things done."

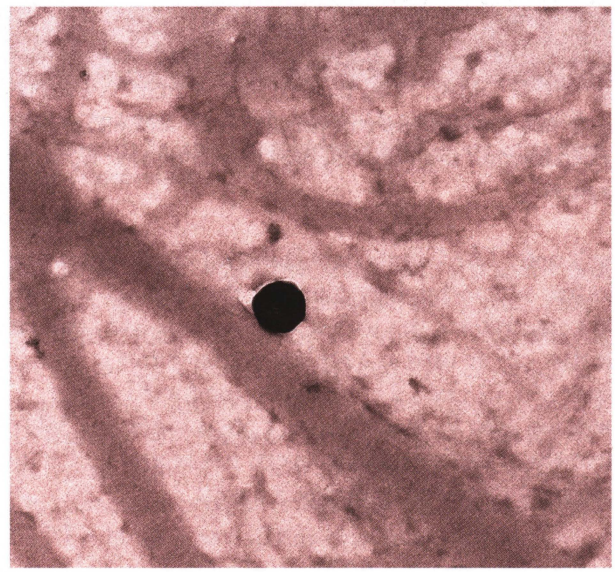
EternoGen

Entrepreneurs: Sheila and David Grant, a bioengineering professor and a senior research design engineer, respectively

Innovations/products: A medical biotech company, EternoGen's first product is a cosmetic dermal filler — or tissue scaffolding — that is a combination of collagen and gold nanoparticles.

Company structure: Sheila and Dave Grant are co-founders. Sheila serves as chief technology officer and David is director of analytical development. Global dermal filler expert and entrepreneur Anna Tenstam Lunvall is chairman of the board and chief commercialization officer. Luis Jimenez is chief executive officer; Dale DeVore, a leading commercialization expert in dermal fillers, serves as chief scientific officer; Ron Bassuner a successful biotech researcher, is chief operations officer, and Rebecca Rone serves as director of preclinical development.

Background: Sheila Grant performed the original research. She then teamed with MU's Biodesign Program in 2008, when Rone was a fellow with the program, to launch the dermal application. In addition to use in skin correction procedures, soft tissue fillers have implications for a variety of additional human connective tissue applications. EternoGen's dermal filler represents a longer-lasting, better dermal solution than those currently available, offering superior regenerative, anti-inflammatory, antimicrobial and antioxidant properties. "I've been working on EternoGen since 2009, my first baby steps into a start-up," Sheila Grant said.



This transmission electron microscopy image shows a nanoparticle conjugated to a collagen fibril. Research by biological engineering Professor Sheila Grant shows the presence of nanoparticles in the dermal filler gives it properties that make it superior to what's currently on the market.

Doing: Grant said the extremely positive response she received after a presentation about her research at a dermal conference in Europe first clued her to the product's commercial viability.

The dermal filler research originally was proffered as one of the six biomedical projects used in a MU business school graduate course taught by Halliday, who said the course teaches "how to launch a high-growth venture and get it financed." Graduate students in the class form six simulated start-ups around faculty inventions, write full business plans and make a pitch to a panel of investors in competition for a cash award.

MBA student Luis Jimenez won the class competition with a plan for EternoGen and the plan — along with Jimenez — made the transition into the real world.

Missouri Technology Corporation, a state-supported technology investment program, MU's EIP and Centennial

Investors have financially embraced Grant's start-up initiative, which is based at the business incubator.

Animal studies are currently being conducted and there are plans to first launch the product in Europe because, as Grant noted, the European Medicines Agency (EMA) — their regulatory agency — works faster than our Federal Drug Administration (FDA).

"We have at least ten doctors lined up, each with patients who are willing to participate in trials," Grant said of their European strategy.

"As a company, EternoGen has gone a long way because of the team we have put together — the right people to get this going." Grant added. "You have to believe in it. We think it's going to make a difference in people's lives and you can't get more satisfaction than developing something that makes a difference."

Editor's note: The Grants have launched another company, Nanocine, a biotechnology company that plans to license Grant's research success with a nanomaterial and acellular tissue that can be used as a replacement anterior cruciate ligament (ACL) graft. The research, conducted in cooperation with Richard White, a physician in the MU department of Orthopaedic Surgery, has received a Coulter Transitional Partnership Program award.

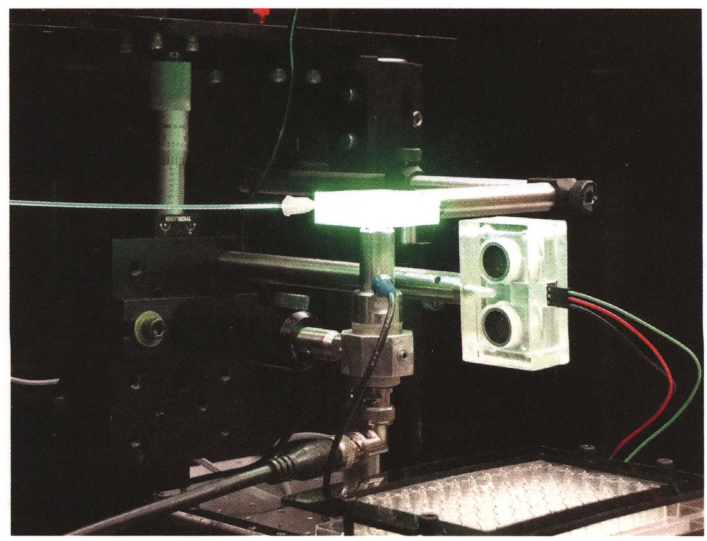
Viator Technologies Inc.

Entrepreneur: John Viator, professor of biological engineering

Innovations/products: Photoacoustic detection of circulating melanoma cells

Company structure: Viator serves as president and chief scientific officer. Co-founder Martin Sanders, a physician who has extensive biological research and business development experience, is executive chairman. Cofounders Richard Maisto, an investment professional, is the company director, and Bash Derti, with background in financial consulting and investment, is chief financial officer and vice president of finance. Sharon Lew, whose background includes international start-up experience, is chief commercialization office and vice president of operations.

Background: MU's positive climate of interdisciplinary research offered Viator the opportunity to work with MU physician and surgeon Paul Dale to identify the potential in the cancer detection technologies he began developing in 2006. The device Viator has innovated, which is about the size of a small photocopier — can detect the presence of metastatic melanoma cells in a patient's blood sample. Its compact size, relatively low price, ease of use and the fact that it also offers earlier detection to available technologies make it a groundbreaking technology.



Biological engineering professor John Viator has developed a laser-induced photoacoustic method to detect melanoma cancer cells in blood samples.

Doing: Viator said he put his biophotonic research program together after countless seminars, brainstorming and lots of talk with doctors and clinicians.

"To truly master something and have high impact, it must be fairly well defined and you have to have collaborators," Viator added.

Viator said regulatory hurdles place commercialization of the technology at least five years out.

"It will take at least two years of clinical lab testing to make sure it can report a number [of cancer cells in a sample] that is lower than that for diagnosis," he said of the required testing. "But we may be at a point at the end of next year where we will be able to sell devices for use in research such as drug testing as the regulation hurdles are lower."

Also finding a home at the business incubator, Viator Technologies has received funding from a variety of sources on campus and off, including funds from private investors.

Viator also is using biophotonics to develop technologies that will help physicians evaluate and treat burns, and plans to expand his photoacoustic cancer detection research to

additional cancers.

"It's my hope that I will be a small part in a grand effort to make cancer as irrelevant as polio. Kids may need to look it up on Wikipedia. Someday, on the list of 917 things to be afraid of, cancer will be 916," Viator said.

NANOS Technologies, LLC

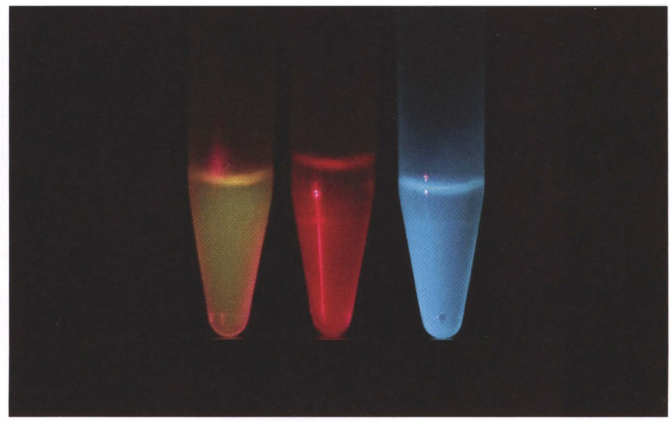
Entrepreneurs: Shubhra and Keshab Gangopadhyay, LaPierre Chair of electrical and computer engineering with joint appointments in bioengineering and physics, and professor and research professor of electrical and computer engineering, respectively

Innovations/products: Nanocoating for aircraft window repair, as well as a food safety and bioterrorism detection test

Company structure: Keshab serves as founder, president and chairman, and Shubhra is chief scientific officer. Gus Pappas is chief executive officer, Andrew Kennedy serves as chief medical advisor, and Angel Wu is director of international business development.

Background: The Gangopadhyay Research Group has made its home in the College of Engineering since 2003, engaging in a broad spectrum of nanomaterials research. The aircraft window-coating technology, which began as a collaborative project with The Boeing Company, will reduce the need to replace scratched windows on planes, saving thousands of dollars. The food pathogen project began as a military force protection grant from the Leonard Wood Institute. It uses nanomaterials to cause a change in fluorescence with a change in concentration of toxins, in this case, botulinum. The detection device being developed is portable and test results are available within an hour, much more quickly than current technologies.

Find more about these and other engineering faculty member's research at:
engineering.missouri.edu/research/researchers-a-z
Click the faculty/researcher's name and a new screen will open with research foci and links to news features about their research and achievements.



A change in fluorescence of dye-doped nanoparticles — synthesized in Professor Shubhra Gangopadhyay's lab — are being used for sensor development.

Doing: "We first worked on transistors and in the mid-1990s, they shrank to nanometers," Shubhra said of her research introduction to nanoscale projects. "Working with them bottom-up — nanoparticles and rods in solutions — changed my entire research program, which exploded after I came to MU because there is such a collaborative environment here."

The nanocoatings research has benefited from both SBIR and STTR funding in addition to private support.

"We have worked with Wayne and Brett to set up a business plan," said Keshab of the window nanocoating venture. "We have the exclusive license for this technology and may have a company [to produce the coating] here in Missouri within six months to a year."

The Gangopadhyays continue to scale up the toxin detection research and are working with a couple of other companies that are interested in the technology.

"Our license for this technology is exclusive," said Keshab. "What is more realistic or pragmatic is to make it a joint venture with one partner providing the IP and the other side, the capital."

He said they have worked on a partnership proposal with Epic Medical Concepts & Innovations (EMCI), a Kansas City-based company that exists to help companies like NANOS Technologies commercialize their innovations.

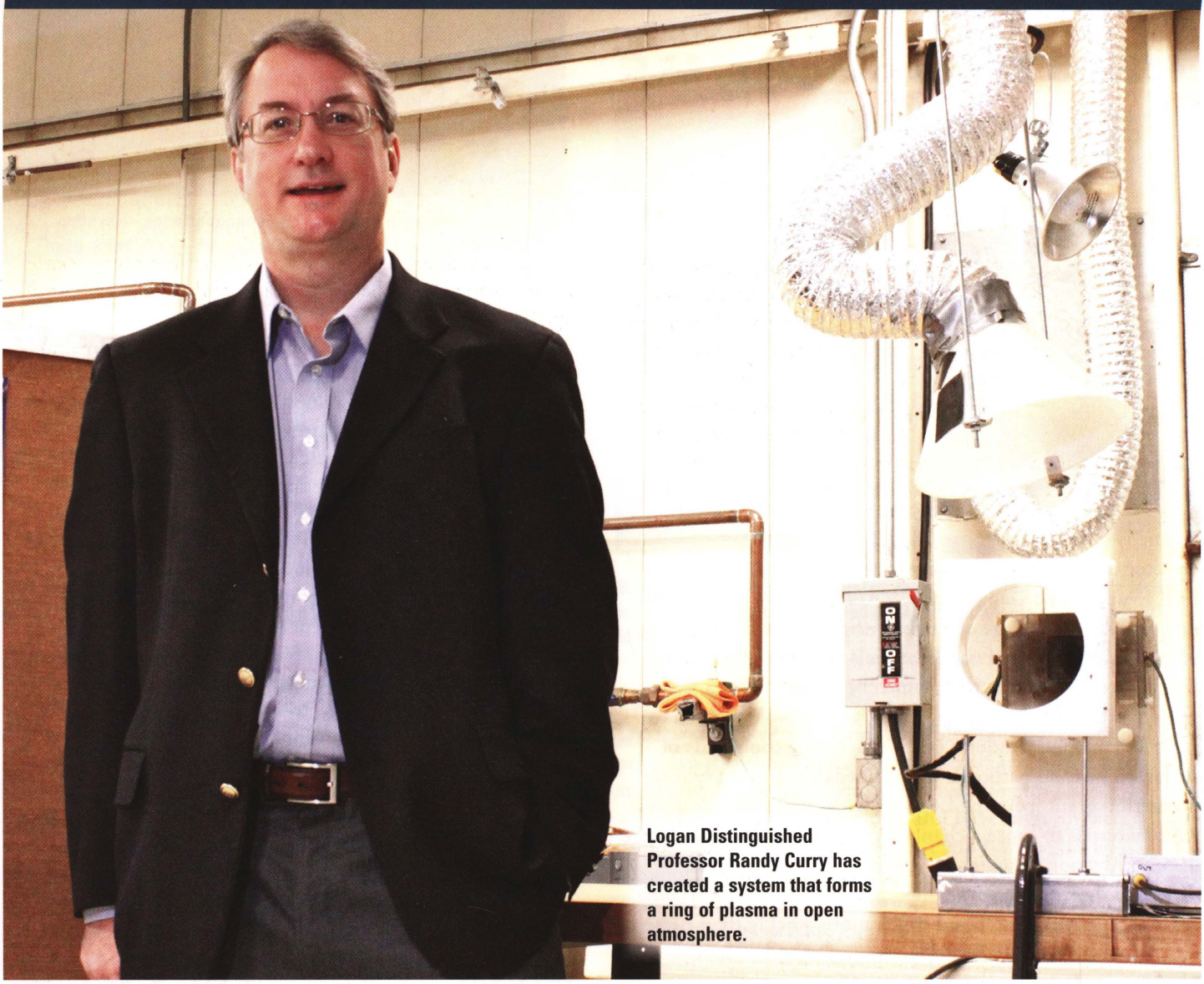
"The Kansas Bioscience Authority may partner with us to produce necessary nanoparticles," Keshab said.

NANOS Technologies also is based in the business incubator.

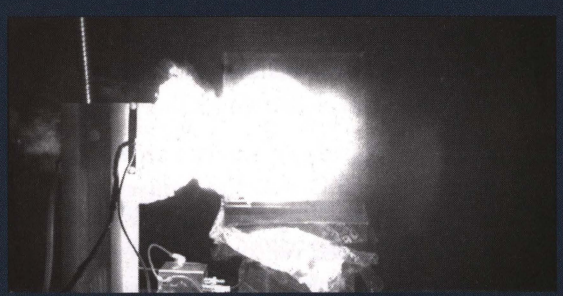
Editor's note: The Gangopadhyay's have a second start-up, NEMS/MEMS Works, LLC, that has licensed the research group's nanoenergetic materials project for defense industry applications. The well-funded venture has received financial support from a number of public and private sources. It too makes its home in the business incubator.

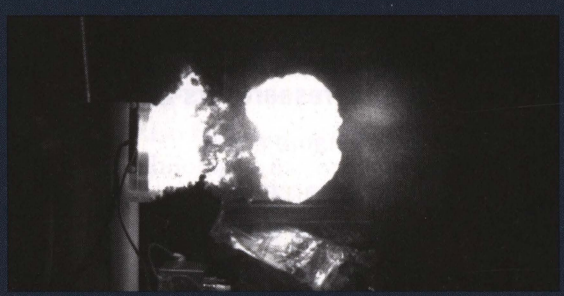
Plasma 'ring' sets the stage for further research

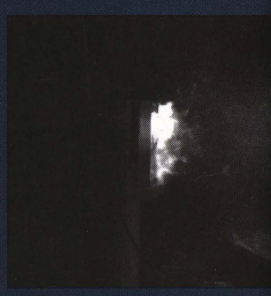
story by Jennifer Hollis • photos Katie Bell



Logan Distinguished Professor Randy Curry has created a system that forms a ring of plasma in open atmosphere.







In the 1980s, a novelty product that introduced people to a basic form of plasma technology soared in popularity. The plasma globe utilized a mixture of gases that discharged plasma filaments in a glass globe. The touch of a finger provided a large receptor producing a place for energy to flow and a brilliant, little self-contained light show.

In the larger picture of space, reactions in the sun create energy-emitting plasma, also known as the fourth state of matter, and back on earth, potential applications of plasma technology have resulted, most popularly, in flat-screen televisions. Devising plasma technologies that can further benefit consumers is a topic of research in research labs around the world.

Until now high-density plasmas have only been generated in controlled environments, but researchers in the University of Missouri College of Engineering's Electrical and Computer Engineering Department have devised a system that creates a toroidal- (or ring-) shaped plasma emission. But unlike previous research, this plasma generates in open atmosphere.

"Scientists have investigated the generation of long-lived plasma in open air without a vacuum or outside magnetic field for years, but have failed previously to produce a self -sustaining plasma," Randy Curry, Logan Distinguished Professor of Electrical Engineering, said.

Curry's team in the Center for Physical and Power Electronics has been working on open-air plasmas for the last few years. Funded by the Office of Naval Research, the plasma rings projected from Curry's system don't emit radiation and do not present a danger to humans who might be exposed to them.

The system uses pulsed-power energy made from a DC power supply that charges capacitors and discharges the energy quickly. It explodes a copper wire that is housed behind a biased-metal, mesh screen — or accelerator grid — held between two pieces of Plexiglas. The wire is vaporized, and the resulting plasma results in a self-propagating ring of plasma lasting "tens of milliseconds."

"We've been able to develop an approach that forms a stable plasma ring in open atmospheric conditions," Curry said.

The ring-shaped blast of plasma projects up to 24 inches. Curry said the open-air occurrence is revolutionary and made possible because a self-magnetic field that is present.

The discovery came as a surprise after Curry suggested to Adam Lodes, a former graduate student, that he make a number of key modifications to the system.

"It was serendipitous," Curry said. "He came in here and said, 'I don't quite know what I have here."

Upon inspection, Curry verified the results of a toroidal-shaped plasma, which was later confirmed by a leading plasma researcher from Princeton University.

Curry added this research is part of the most basic science of plasmas, and that theoretically, a larger machine would create a larger ring that could potentially travel a much longer distance. Further funding, he stressed, is important because it could lead to a smaller device that would create an output equal to a larger machine.

"We were funded by the ONR on a basic science research program to research plasmas," he said.

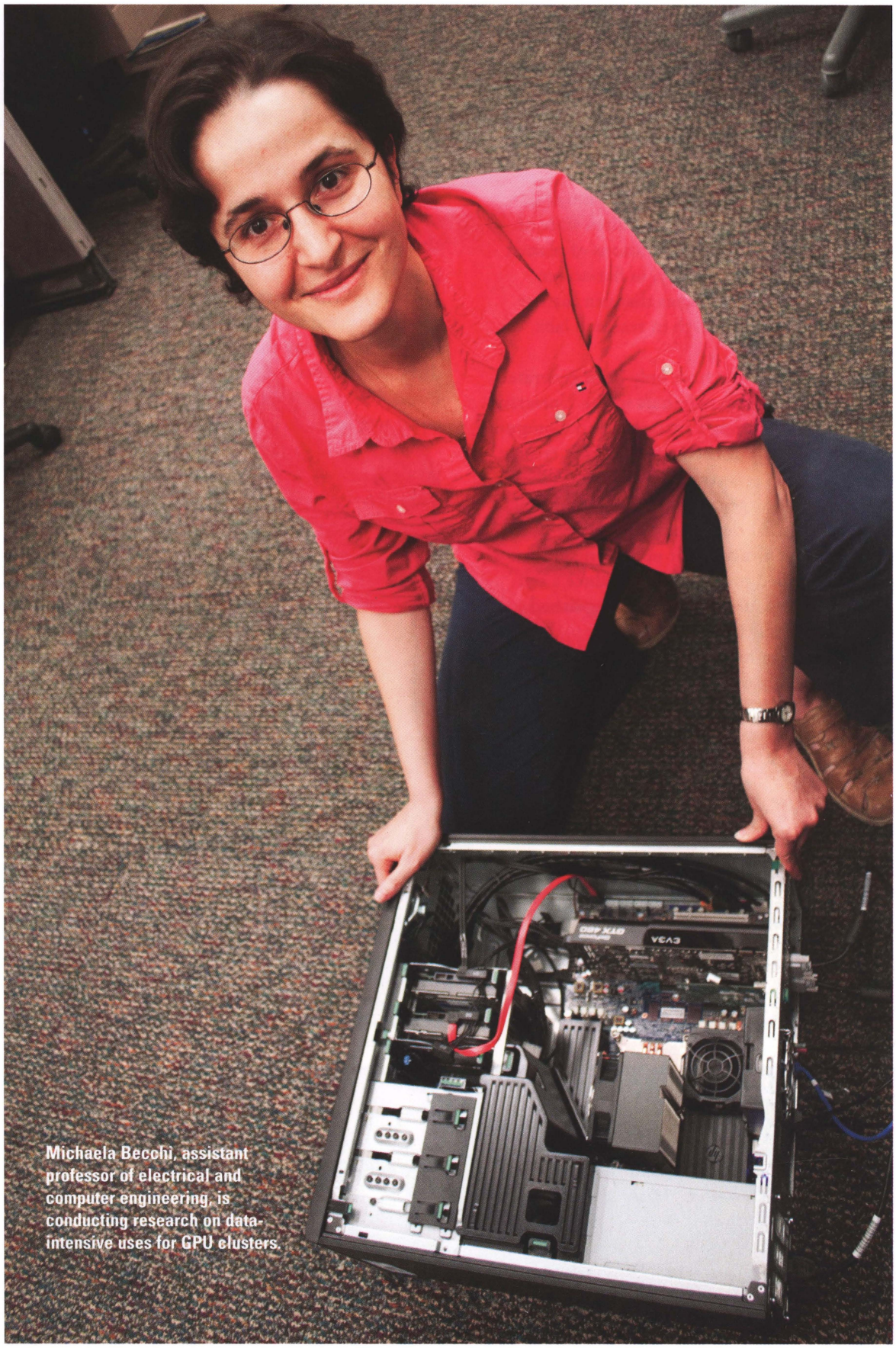
"In the future, we will investigate the use of this plasma for the generation and storage of energy," he said.

It may be three-to-five years before this technology could be used to significantly advance power and energy storage, Curry said. Until then, he stressed the need for funding of this kind of research.

"We have a world-class team here, and without that funding, that team will evaporate," Curry said. "Without that funding, I don't see us competing."

At right, electrical engineering Professor Randy Curry's open air plasma system capable of producing a stable plasma ring.

Below, a series of images demonstrating the generation of a plasma ring in open atmospheric conditions.



Michaela Becchi, assistant professor of electrical and computer engineering, is conducting research on data-intensive uses for GPU clusters.

Researcher drives interest in cutting-edge field of parallel computing

story by Marie French • photos by Jennifer Hollis and Marie French

High-powered graphics in video games like Skyrim, Bioshock and the Grand Theft Auto franchise depend on specialized processors that perform multiple separate functions side-by-side. These graphics processing units, or GPUs, perform the heavy lifting of rapidly building images for display in fast-paced, visually oriented games.

But that's only one use for these processors — researchers have extended their abilities to perform general computing just like the CPU in your desktop computer. With this shift, researchers have found them to be more efficient at processing large amounts of data than traditional computer processing units or CPUs.

Their massive hardware parallelism makes GPUs uniquely suited to many data-intensive scientific applications. They have proven to be particularly useful for bioinformatics applications as the amount of DNA, RNA and protein sequence data available continues to increase exponentially. Michaela Becchi, an assistant professor of electrical and computer engineering at the University of Missouri, received nearly $500,000 from the National Science Foundation for research on data-intensive uses for GPU clusters.

Big Data? Meet Big Computing.

The cutting edge of increased computing speed

Until a couple of decades ago, computer architects focused on achieving higher computing capabilities by building more powerful and sophisticated single-core general purpose processors. These types of units performed complex calculations in a single stream. They were fast, but researchers always wanted something faster.

The focus was on increasing the clock rate of the CPU, or the frequency at which it can run. The limitations of materials and heat, however, slowed efforts in that direction.

These old techniques are no longer feasible because of the increasing power consumption and the huge gap in speed between processors and memory. As the result of paradigm shift, scientists and engineers stopped building larger and larger processors. Instead, they began to integrate many small and simple cores within the same chip. This is the so-called many-core architecture.

"Evolution came to the point where increasing the clock rate was not feasible, so evolution to multi-core and many-core machines was kind of inevitable," Becchi said. "A few years ago people started using GPUs for other scientific applications."

In addition to graphics applications, Becchi said GPUs began to be harnessed for complicated processes like those in computational finance, weather prediction and pattern recognition. The architecture of GPUs, with hundreds of cores rather than the single or few cores available on general purpose CPUs, means such multiple computations can be done in parallel, providing an advantage in the field of high-performance computing.

Da Li is pursing his doctorate in computer engineering and works in Becchi's lab. He compared the advantage of GPUs over CPUs to that of 1,000 smaller men over four big, strong men. The combined power of thousands of the less sophisticated cores in the GPU translates into higher computation capacity than the fewer cores in the more powerful CPU.

"It depends on what problem you're trying to solve," Li said. The GPU's architecture is better for throughput-oriented problems, as the multiple cores allow the processor to execute several billions of small programs at once.

"Considering the applications for big data and high-performance computing, what people care is not getting a response immediately," Li said. "On the contrary, the ultimate goal is to process a large amount of data with some time constraints."

The GPU structure is better for these types of throughput-oriented problems, as the multiple cores allow the processor to execute several billions of small programs at once.

Some companies have already recognized the potential of the GPU. In 2010, Amazon launched a new cloud service with GPU clusters. Hardware companies also have been investing in developing many-core architecture (Intel's Xeon Phi Coprocessor) and making it more programmable for researchers and programmers.

Since GPUs benefit from a different design philosophy, they have become a star in the high performance computing community. Titan, which is the fastest supercomputer in the world according to the Top 500 list, relies on thousands of cutting-edge GPUs.

Harnessing speed for new research applications

Becchi has already shared her background in computer engineering to assist professors in other disciplines with the challenge of analyzing terabytes of data. She is one of the core faculty at the University of Missouri Informatics Institute (MUII), which is dedicated to creating interdisciplinary efforts to tackle the problems of information processing.

"Today there is a lot of emphasis on big data as there's more and more data available in biology," Becchi said. "Bioinformatics applications need to perform a lot of searches and comparisons among big data sets."

Kittisak Sajjapongse, a doctoral student whose research is focused on distributed computing, said the ability to process these large data sets will help researchers in many fields.

"We want to be able to provide a framework to scientists which runs on a cluster with GPUs because the GPU is cost effective," Sajjapongse said. "So we want to reduce cost and at the same time we can also speed up research for scientists."

A paper published in February 2012, co-authored by Becchi, Dmitry Korkin, Chi-Ren Shyu and other College of Engineering researchers, presented the results of a new tool to analyze protein structures built on the power of GPUs. To demonstrate the superior performance of the multi-core GPUs, the researchers compared the speed of the new program running on a GPU card to existing solutions on CPUs.

The results are telling: the new program completed its analysis between 36 and 65 times faster than existing programs relying on the computing power of traditional CPUs.

The program, ppsAlign, is freely available to researchers interested in trying it. Although designed mainly for protein structure alignment — comparing the structures of proteins in order to discern their relationship or possible functions — the software could be repurposed to compare other biological data such as DNA or RNA sequences.

Becchi also has worked on applications for bioinformatics with her husband, Gavin Conant, assistant professor of animal sciences and a colleague at MUII. She said he had more than 30,000 DNA sequences he wanted to analyze — 450 million individual comparisons, a process that would have taken months with a CPU-based program.

"I wondered, 'Why don't we use the GPU to accelerate this computation?'" Becchi said.

Similar applications for varied bioinformatics purposes existed, but nothing that was applicable to Conant's data. One of the challenges in harnessing GPUs for applications like DNA sequence comparisons, said Becchi, is the difference in structure that requires a complete rewrite of the algorithm.

"You cannot just take a serial algorithm and tweak it here and there," she said. Instead, the programmer has to identify where it can benefit from using the parallel structure of GPUs."

Their joint work led to a paper presented at the IEEE International Conference on Application-specific Systems, Architectures and Processors at George Washington University in Ashburn, Va., in June 2013. The work was co-authored by Li, Sajjapongse, Becchi, Conant and Huan Truong, an informatics doctoral student advised by Conant.

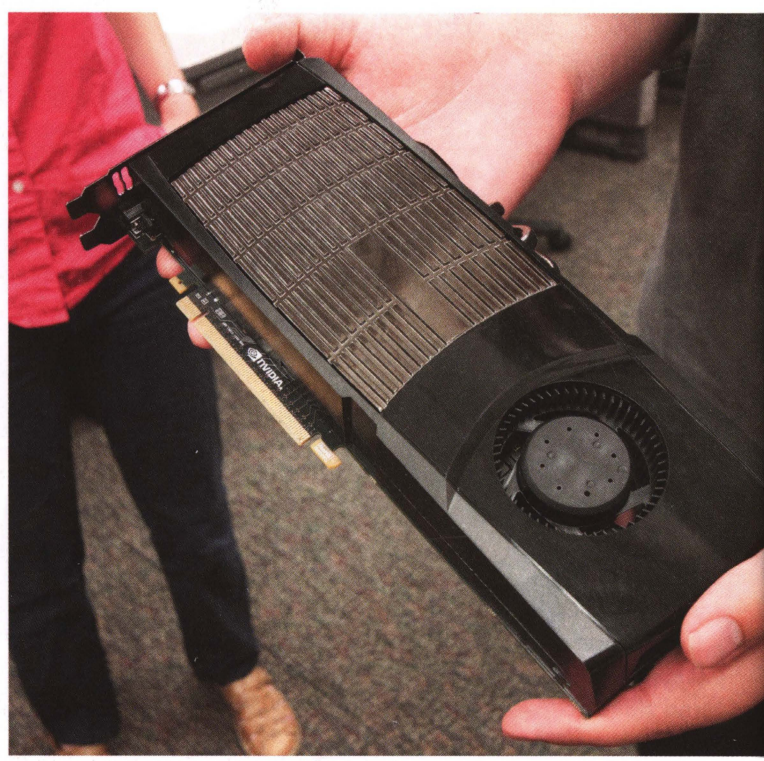
Beyond applications — laying the groundwork

While creating applications such as ppsAlign that use the unique structure of the GPU is a more applied research area, it is not what most intrigues Becchi. Her core research focus is more on the abstract — investigating how clusters of machines equipped with GPUs can be effectively used to maximize application performance and power efficiency, for example.

"They are projects that are not specific to a particular application problem," Becchi said.

Rather, she wants to build a framework to utilize GPUs in clusters for high-speed computing, the focus of her NSF grant. The goal of that research project is to create a software package that will be able to use multiple nodes with both GPUs and CPUs to increase the computational power available to the user, all while providing a seamless interface on the front end.

Becchi's background is in computer engineering, with a focus on the architecture of computer systems. She received both her doctorate and masters degrees in computer



engineering from Washington University in St. Louis and then worked as a researcher in the systems architecture department at NEC Laboratories.

She said she's brought that architectural and structure-focused view with her to Mizzou, expertise that strengthens MU's program.

Developing a strong GPU program at MU

Becchi currently works with two doctoral students and three master's students in her lab, as well as some undergraduate students.

Li came to Mizzou because of a previous connection with Becchi and his interest in an area of irregular applications for GPUs, graph algorithms. He has had two papers on the topic published in his first two years as a doctoral student and another is in the works.

"I applied here because I knew about Dr. Becchi's research and I know she's really nice," Li said. "She gave me lots of hands-on help in my first year." This summer Li will be interning at the NEC Research Lab in Princeton, N.J.

Becchi has worked hard to attract outside funding and interest in her research area. In February, NVIDIA named MU as a CUDA Research Center. CUDA is a parallel computing platform and programming model for GPUs. The company is leading the field in developing extremely powerful GPUs, and the designation came with a gift of the newest hardware, which she hopes will increase interest in the field.

"Basically if there is new hardware we can have access," Becchi said. "If we have questions about the GPUs we have a privileged way to get the information."

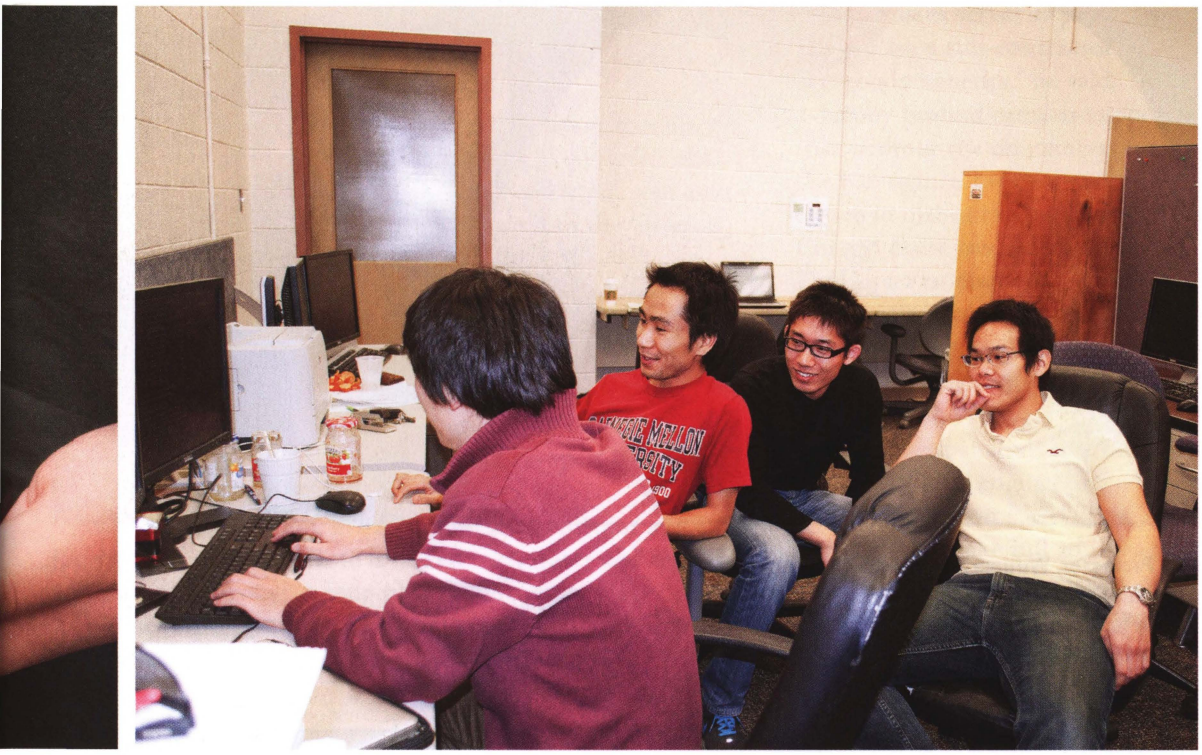
Sajjapongse, who got his master's of science from MU in 2010, said he stayed on to work with Becchi, as her research interests overlapped with his. His focus has been on making groups of GPUs and CPUs work together to increase the computing power of a system and not let any component go to waste. He already has created a framework for that purpose, and has been working with computers in both Lafferre Hall and Engineering Building West, which has created some challenges.

"If we just integrate them in a naïve way, the slow computers over in Engineering Building West would slow down the faster servers in Lafferre," Sajjapongse said.

This summer, Sajjapongse will be interning at AMD, a semiconductor company that develops computer processors. Becchi said GPU computing is a particularly high-demand, rapidly growing field and that Sajjapongse's work in this field helped him secure the internship.

Becchi added that she hopes more students will become interested in the field by working at her lab and hearing about her research at Mizzou. Starting with repurposing algorithms to work on the parallel structure of GPUs, students can quickly learn the principles of parallel computing structures.

"They learn to deal with algorithms and computer architecture at the same time. They work at the intersection of two worlds," Becchi said. "They learn how the architecture and design of the computer influences the algorithm."



Far left, a close-up of one of the NVIDIA Graphic Processing Units (GPU) Assistant Professor Michela Becchi is innovatively using to process large amounts of data.

At left, students work together in Becchi's lab. Left to right are doctoral student Da Li, at the keyboard, Huan Truong, an MU Informatics doctoral student, Xiang Wang, a master's student, and Kittisak Sajjapongse also a doctoral student. Li and Sajjapongse are collaborating on a research project using GPUs in cluster and cloud environments.

Biological engineering Associate Professor, William "Bill" Jacoby, foreground, and the graduate students who work in his Carbon Recycling Center are collaborating with researchers at Duke University to develop a process to dispose of human waste using supercritical water oxidation. From left to right are Nick Wilkinson, Malithi Wickramathilaka and Reza Espanani.

Supercritical water oxidation to be used to treat sewage in Third World Countries

story and photo by Jan Wiese-Fales

University of Missouri Professor William "Bill" Jacoby's Carbon Recycling Center has been examining the use of supercritical water to process biomass and other wastes. A collaborative project, the research is led by Marc Deshusses, professor of environmental engineering at Duke University, who turned to Jacoby's lab when he was looking for a suitable collaborator for his Bill and Melinda Gates Foundation-funded project, "Neighborhood-Scale Treatment of Fecal Sludge by Supercritical Water Oxidation."

"We had published five or six papers on supercritical water gasification," said Jacoby, who holds joint appointments in biological and chemical engineering at MU. "Marc was searching for technical help in a similar area, and he came across our published work."

The project is part of the Gates Foundation's water, sanitation, and hygiene strategy, which, among other things, aims to develop new technologies for sanitation in countries where no wastewater treatment facilities exist. Developed technologies need to be effective in communities with limited water supply and no existing sanitation infrastructure.

In addition to providing their supercritical water oxidation expertise, the MU arm of the research project is tasked with design, fabrication, and operation of a process development unit to determine design parameters for a larger prototype unit, which will be built at Duke.

Nick Wilkinson, a graduate research assistant working in Jacoby's lab, explained that in Third World countries that lack sewer infrastructures, waste can be collected from ablution blocks [public toilets] and transported to the location of the oxidation reactor.

"Oxidation simply means burning. We are burning the waste in the presence of oxygen — similar to burning wood on a campfire," said Wilkinson. "But we perform the reaction in a high-temperature, high-pressure reactor using supercritical water as a process fluid. Using supercritical water gives the technology a number of competitive advantages."

Reza Espanani, also a graduate research assistant in Jacoby's lab, said the waste is mixed with water and oxygen and pumped through a long plug flow reactor.

"Under supercritical conditions, sewage sludge will combust, releasing energy as heat," said Espanani.

As a result of this released heat, the reactor reaches a temperature of over 1,100 degrees Fahrenheit. Some of this heat can be recycled back into the process, making the system self-sustaining — capable of operating without external heat input.

"After cooling, what comes out of the reactor is carbon dioxide vapor, salts and clean water," said Wilkinson. "The water should be potable, but also will have other uses in developing communities for things like laundry or showering."

The pair agreed that a real benefit of the system is that some of the heat produced from the reaction could be potentially be used for electricity or heat in the local community.

The research group is experimenting to gain as much information about the process as possible and to overcome some of the challenges associated with supercritical water oxidation technology.

"On the surface, the technology seems complicated for a Third World setting," Jacoby said. "And the out-of-the-box approach is challenging," he added, saying he is confident his team can reasonably solve the problems presented in this research.

"Deshusses serves as primary investigator for the project and we are a sub-contractor. If we improve the process, everybody benefits," he said.

Jacoby praised campus support for his research. He said that without the on-campus funding he received from both the bioengineering program and the Mizzou Advantage initiative in one of the program's five asset areas, Sustainable Energy, there would have been no research results for Deshusses to discover.

The research also has provided his lab assistants with great experience and credentials to continue their graduate degrees. Wilkinson earned his master's from MU in May and is headed for the University of Minnesota to work toward his doctorate. Espanani is continuing his work toward a doctorate in biological engineering with Jacoby's group.

"At the Carbon Recycling Center, we realize that we must learn to take full advantage of our renewable carbon resources. I've made believers out of my students and this research did what it was supposed to do," Jacoby said of the students' graduate school aspirations.

Class Notes

Share your news with fellow alumni. Please email news about your accomplishments to Mizzou Engineer Editor Jan Wiese-Fales, at wiesefalesj@missouri.edu

1960s

Glen A. Barton, BS CiE '61, DHL '04, of Peoria, Ill., received the 2012 SAE Subir Chowdhury Medal of Quality Leadership at the SAE 2012 Commercial Vehicle Engineering Congress in Rosemont, Ill. The Chowdhury medal honors innovators of the mobility industry who have made an impact in mobility engineering, design and manufacturing. Barton is retired from Caterpillar, Inc., where he served as chairman from 1999-2004. He joined Caterpillar in 1961 as a college graduate trainee.

1970s

Larry Frevert, BS CiE '70, of Kansas City, Mo., was hired as a senior consultant with Trekk Design Group, LLC, in Kansas City. Frevert most recently retired from HDR Engineering, Inc., as the director of the National Public Works Program. He is a member of the Civil and Environmental Engineering Department's Academy of Distinguished Alumni, received a 2009 Missouri Honor Award and was the 2002 Citation of Merit honoree.

Len Rodman, BS CiE '71, MS '78, of Olathe, Kan., will retire as chairman, president and CEO of Black & Veatch at the end of 2013. Fellow MU Engineering alumnus Steve Edwards (see next column) will assume his position after Rodman's retirement. Rodman has worked for Black & Veatch for 42 years. He also sits on the board of directors of the Federal Reserve Bank of Kansas City.

Thomas C. Young, MS CiE '72, of Potsdam, N.Y., was honored for his 36-year career with Clarkson University in Potsdam and named provost emeritus at the university's 120th commencement. Young began teaching at Clarkson University in 1977, serving as chairman of the Department of Civil and Environmental Engineering from 1999-2004, associate dean of the Coulter School of Engineering in 2005 and provost and chief academic officer from 2005-2012. He earned his bachelor's degree in zoology/fisheries biology and a master's degree in civil and environmental engineering from MU and his doctorate in limnology from Michigan State University.

Ray Hutsel, BS CiE '76, MS '78, of St. Louis, joined Paric Corporation as a senior project manager. He previously was senior project manager for the Presbyterian Manors of Mid-America project in Wichita, Kan.

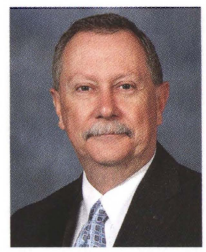
Steven L. Edwards, BS EE '78, of Parkville, Mo., will take over as chairman, president and CEO of Black & Veatch in 2014, following the retirement of current CEO Len Rodman (see above). Edwards has worked for the company since 1978 and currently serves as its chief operating officer. Previously, he was Black & Veatch's executive vice president.

Terry L. Maddox, BS EE '78, of Bakersfield, Calif., was named plant manager of Mount Poso Cogeneration Company, LLC. Maddox has more than 30 years of experience in the electric power generation business. He previously served as business manager for the Indianapolis Power & Light Company Generation Fleet Asset Management Group. Mount Poso is a 50/50 partnership between Macpherson Energy Company of Santa Monica, California and DTE Energy Services, Inc. (DTEES) of Ann Arbor, Mich., with DTEES designated as the operating partner. It was recently converted from a coal-fired power plant to 100 percent biomass.

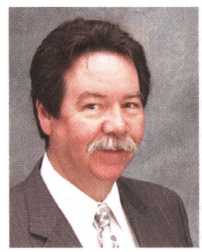
1980s

Bob Youness, MS '80, of Lenexa, Kan., was hired as a senior engineer with the civil services division at Ulteig's Bismarck office. He was previously owner and project manager of Land Partners One LLC, in Kansas. Youness holds an associate's degree in civil engineering from Bismarck State College and a bachelor's degree in civil engineering from North Dakota State University.

Dave Nichols, BS CiE '82, of Jefferson City, was named director of the Missouri Department of Transportation. He served as interim director since March 21, taking over from fellow MU Engineering alumnus Kevin Keith, who departed on a medical leave of absence. Nichols has worked for MoDOT for more than 29 years, serving in leadership positions including chief engineer, director of program delivery and as district engineer for MoDOT's Northwest District in St. Joseph.



Steven Roberts, BS EE '82, of Leawood, Kan., was elected to the Kansas State Board of Education, District 2, and assumed office in January. In addition to his MU Engineering degree, Roberts also earned a Master of Education from Grand Canyon University in 2007. Roberts built a math tutoring business as "Mr. X, Mentor of Mathematics" and taught in public, private and parochial schools. He also teaches via math tutoring videos on the Internet. Roberts is a licensed teacher in Arizona, Kansas and Missouri.



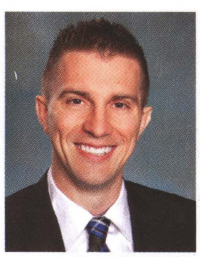
Ed Hassinger, BS CiE '83, of Ballwin, Mo., was named the Missouri Department of Transportation's chief engineer. Hassinger has worked for MoDOT in a variety of roles and was most recently the St. Louis district engineer. In St. Louis, he oversaw more than $1 billion worth of projects, including several improvements to Interstate 64. He fills a position that has been vacant since March.

1990s

Sen. Martin T. Heinrich, BS ME '95, of Albuquerque, N.M., was elected to the U.S. Senate in the November 2012 general election. He previously served as the U.S. Representative from New Mexico's 1st district. As a member of the House, Heinrich served on the Committee on Armed Services and the Committee on Natural Resources, on which he still serves. He also currently serves on the Select Committee on Intelligence and the Joint Economic Committee.

2000s

Benjamin Tietgen, BS CS '02, of Phoenix, Ariz., joined the law firm Quarles & Brady LLP as an attorney in the Intellectual Property Group. He previously worked at Etherton Law Group, LLC, in Tempe, Ariz. Tietgen received his law degree from Arizona State University College of Law.



Engineering alumnus Jerry Jost was the recipient of MUEAO's 2013 Citation of Merit award.

Jost honored by alumni organization

Jerry L. Jost, BS ChE '70, founder and president of Jost Chemical Company, was presented with the MU Engineering Alumni Association's Citation of Merit Award at a luncheon in his honor on March 16.

"This award is not just about me," Jost said in his acceptance speech. "I stood on the shoulders of some very great people to get where I am today."

Jost's St. Louis-based company manufactures high-purity specialty chemicals for the pharmaceutical, nutritional, food and specialty markets. Launched in 1985, the now-international company has enjoyed an average annual growth rate of 25 percent. Today, Jost Chemical Co. has over 240,000 feet of manufacturing space, as well a sales office in Belgium and warehousing space in both Belgium and California.

The successful entrepreneur said his start-up chemical business required extreme time, energy and cash flow.

"You need to saw off the limb that you went out on so that you aren't tempted to climb back down," he added.

The Small Business Administration for Eastern Missouri named Jost the 2010 Business Person of the Year.

Jost has been generous with his time and talents, serving on the MU Chemical Engineering Department's Industrial Advisory Board since 2007.

STAY IN TOUCH WITH WHAT'S GONG ON WITH MIZZOU ENGINEERING!

If you receive this magazine, but not the MU College of Engineering's e-newsletter — published August through May — email us at umcengrdev@missouri.edu to update your email.

Derek Vap, BS CiE '06, MS '07, of Kansas City, was awarded Young Engineer of the Year for the Western Chapter of the Missouri Society of Professional Engineers in February at the 62nd annual luncheon for Engineers Week in Kansas City. Vap is an engineer for HNTB, a Kansas City-based infrastructure solutions firm, where he has worked since 2008. He is a registered professional engineer and serves on the board of directors for the Western Chapter of MSPE.

Deaths

1950s

Edwin H. Morris, BS EE '50, died Oct. 8, 2012. He was born Oct. 31, 1926.

Walter "Tom" Buchanan, BS CiE '55, MS CiE '57, Ph.D. ED '84, of Columbia, died Feb. 12, 2013. He was born Oct. 27, 1932, in Moberly. After graduation, he served as a captain in the U.S. Army Corps of Engineers. Buchanan's career took him to New York and Iowa before returning to Missouri to work for the University of Missouri Extension in St. Joseph, were he stayed for 24 years, earning a Meritorious Service Award from the MU Extension Association in 1970. He finished his career with the University of Illinois Extension. He also was involved in the St. Joseph Rotary Club and the Moila Shrine Temple in St. Joseph. He is survived by his wife, Pat, and three daughters.

Roy Lawrence Reed Jr., BS EE '57, of Bath, Maine, died Dec. 10, 2012. He was born May 14, 1934, in St. Louis. Reed grew up in Columbia and joined the U.S. Air Force in 1956. He moved northeast later that year, where he remained the rest of his life. He worked briefly as an electrical engineer for DuPont before working for the Bath Iron Works from 1965-1990, retiring as vice president of marketing. He is survived by a son and a daughter.

Donald L. Hiatte, BS CiE '58, of New Bloomfield, Mo., died March 21, 2013. He was born Dec. 4, 1932, in Marion, Mo. Hiatte worked for the Missouri Department for Transportation for more than 30 years, including four as the Northwest District Chief Engineer, and retired in 1989. Following graduation from MU, he served with the U.S. Army and the occupying forces in Germany during the Korean War and, after discharge, served more than 30 years with the U.S. Army Reserve and the Missouri National Guard, rising to the rank of colonel. He also was a lifelong member of the MU Alumni Association, as well as involved with many professional and service organizations. He was also active at First Baptist Church in Jefferson City. He is survived by his wife, Barbara, a son and two daughters.

1960s

Basil C. Fassoulis, BS ME '63, of Athens, Greece, died March 21, 2013. He was born July 7, 1939.

1970s

Hsien Tang Hwang, MS Nuc '79, died Nov. 25, 2012. He was born Aug. 25, 1953, in Taiwan.

Wilson lecturer inspires women engineering students to 'get it right'

"Successful engineers build a successful society," Heather Hunt told those gathered for the MU Society of Women Engineer's 2013 Ada Wilson Lecture. Held just prior to SWE's annual Green Tea, the lecture honors engineering's first female graduate.

Hunt, an MU assistant professor of biological engineering, was selected to deliver this year's lecture, which she started out with a quote from Herbert Hoover: "To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope."

"What you do matters. You cannot pass the buck to someone else," she said. "If you get it wrong, people will die."

Hunt made her point with footage from the Space Shuttle Challenger disaster, pointing out that it was televised into every home in America.

Hunt then switched gears and showed videos of extreme testing of nuclear waste containment drums, including one being hit by a train.

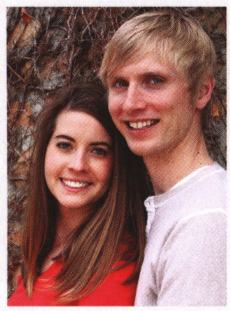
"This is what happens when we do it right," she said. "We work in teams so mistakes aren't set in stone. What you do is important."

Hunt finished her presentation with a quote from Isaac Asimov: "Science can amuse and fascinate us all, but it is engineering that changes the world."

Heather Hunt, assistant professor of biological engineering, delivered the Society of Women Engineer's 2013 Ada Wilson Lecture.

Engagements

Matthias Young, BS ChE '10, of Pleasant Hill, Mo., and Shannon Felker, BS CEE '11, of Jackson, Mo., will be married in September. Young is pursing his doctorate in chemical engineering at the University of Colorado-Boulder. Felker is a traffic engineer in Jefferson County, Colo. They will be married in Jackson, Mo.

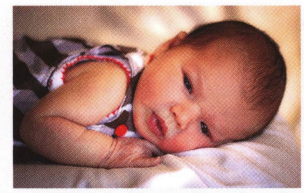


Weddings

Danielle Smith, BS ChE '03, of Bartlesville, Okla., married Ryan Fitzpatrick on Oct. 13, 2013, in Springfield, Mo. Both are currently associate engineers for Phillips 66 R&D in Bartlesville. The couple met as graduate students in the Chemical Engineering Department at the University of Texas at Austin, where both obtained their doctorates in chemical engineering in 2009.

Births

Steven Schilke, BS CEE '02, of Algonquin, Ill., and his wife Deb, welcomed a son, Erich Thomas Vader Schilke, on Nov. 14, 2012. The baby weighed six pounds, nine ounces and was 19.5 inches long.



Jason Gruender, BS EE '03, of Columbia, Mo., and his wife Bridget, BS AF&NR '02, MS MED '07, MD '13, welcomed a daughter, Lydia Daisy Gruender, on July 23, 2012. Jason is a project manager for Meyer Electric Company in Jefferson City. Bridget recently earned her doctorate from MU.

JOIN!

Alumni unite in support of Mizzou Engineering

Members of the MU College of Engineering's alumni organization (MUEAO) meet twice each year to hear updates on their alma mater and also to plan for activities and events in support of the college.

One of the primary functions of MUEAO is to identify candidates for Mizzou Engineering's annual **Citation of Merit Award**. The award honors one alumnus or alumna who has made noteworthy contributions to the engineering profession and/or the College of Engineering. This year's award went to founder and president of Jost Chemical Company, Jerry Jost ChE '70 (Story on page 29).

MUEAO also provides funding support for student and alumni activities. The group traditionally sponsors the popular **"Casino Night"** festivities for students, held as part of the culminating event of Engineers' Week, the St. Pat's Ball. This year, MUEAO members Ray Cook, BS ChE '77, and wife Cindy Cook, BS CiE '77, generously provided funding support for the evening of student fun. Alumni board members David Junk, BS CiE'78 and John Conway, BS CiE '71, MPA '86, served as dealers.

The group also sponsors the college's **Family Day Barbecue,** a fall event for students and their parents, welcoming and introducing them to campus. They additionally provide funding support for a variety of engineering student organizations.

"Awards are made based on the number of requests we receive, the amount available for that fiscal year, the degree of impact our support will have and how it will benefit students," said Conway, MUEAO's current president.

On Fri., Sept. 6, the engineering alumni group will sponsor its **19th golf tournament and silent auction.** The tourney takes place the weekend of the home football game with the University of Toledo and is MUEAO's primary fundraising event. For more information, please contact Monica Collins at 573-884-3426 or collinsmw@missouri.edu.

If you are interested in keeping in touch with your alma mater and providing support to the College of Engineering by joining and participating in MUEAO, you can do so electronically by visiting the website at engineering.missouri.edu/alumni.

Three MU Engineering Alumni receive Missouri Honor Awards

In March 2013, three College of Engineering alumni were recognized for their professional accomplishments, commitment and ideals with Missouri Honor Awards for Distinguished Service, the college's highest honor. A complete list of all of recipients can be found at engineering.missouri.edu/alumni/moha

Ray Kowalik, BS CiE '85, with daughter, Sabrina, at left, and wife, Jill, at right.

Raymond J. Kowalik

Raymond J. "Ray" Kowalik is president of Energy Global Practice for Burns & McDonnell, a full-service engineering, architecture, construction, environment and consulting solutions firm headquartered in Kansas City, Mo. As such, Ray is responsible for the entire business line as it relates to power generation anywhere in the world.

After graduating from the University of Missouri with a bachelor's degree in civil engineering in 1985, Ray earned his master's degree from MU in 1999.

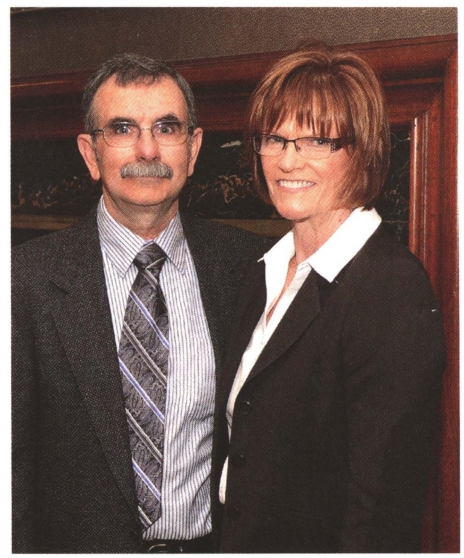
In 1987, Ray launched his career with Burns & McDonnell as a structural engineer in the Energy Division where he worked on a variety of projects including combustion turbines and powerhouse structures. He was promoted to project manager in 1994, eventually transitioning into the position of design-build project manager. In 2001, he was named vice president, became general manager of the Energy Division in 2004 and finally, division president in 2007. He also has served on the company's board of directors since 2009.

Ray exemplifies Burns & McDonnell's overarching principle of giving back, leading by example.

Since 2002, Ray has served on the MU Dean's Engineering Advisory Council and has been a member of the Missouri 100 for the last three years. He is a sustaining member of the Shamrock Society and also is a member of the MU Alumni Association and a contributor to the Tiger Scholarship Fund.

Ray is a registered professional engineer in Missouri, Indiana and Alabama. He is a member of the American Society of Civil Engineers.

Ray and his wife, Jill, live in Lee's Summit, Mo. The couple has one daughter, Sabrina, who currently is an engineering student at MU.



Vicki Panhuise MS NE '76, PhD '78, with husband, John Panhuise III

Vicki E. Panhuise

Vicki E. Panhuise is president of Airborne Systems Group (ASG), a division of HDT Global, responsible for the design and production of high-performance parachutes for international aerospace and military markets.

After graduating from Wells College in Aurora, N.Y., in 1974 with a degree in mathematics, Vicki earned her master's and doctorate degrees in nuclear engineering from the University of Missouri in 1976 and 1978, respectively. She was awarded an MBA from the University of Arizona in 1999.

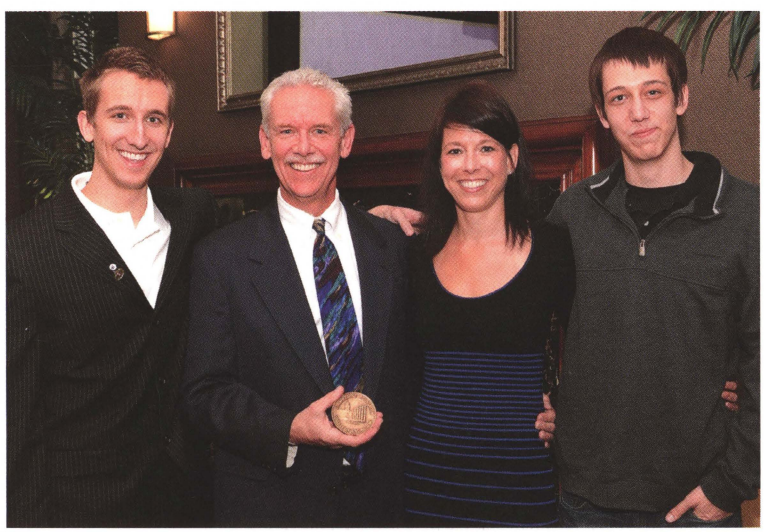
Prior to accepting a position with ASG, Vicki served as president and owner of VePoint Consulting Group, providing change management, program management execution, and merger and acquisition consulting services.

Vicki retired from Honeywell Aerospace in January 2011 as vice president of the Military Aircraft/U.S. Defense Customers Strategic Business. During her 30-plus year career with Honeywell, she worked in a number of capacities, serving as a materials engineer, lab manager and as director of engineering and technology.

In 2008, she was appointed by the governor of Arizona to serve as the chairman of the Arizona Aerospace & Defense Commission and in 2010, to also serve on the Arizona Commerce Authority (ACA) board of directors. She served as ACA's aerospace and defense industry advisor during 2012.

The Society of Women Engineers (SWE) presented Vicki with an Upward Mobility Award in 2004. She served as the inaugural Ada Wilson guest lecturer for MU Engineering's student chapter of SWE in 2007.

Vicki lives with her husband, John A. Panhuise III, in Scottsdale, Ariz. John received his master's degree in nuclear engineering from MU in 1976.



Gregg Scheller BS MAE '79 with wife, Donna, and sons, Michael, at left, and Steven

Gregg D. Scheller

Gregg D. Scheller serves as founder and chairman of Katalyst Surgical, LLC, a company that designs and produces products for ophthalmic surgery, and Kogent Surgical, LLC, which deals in neurosurgery. Both companies are located in Chesterfield, Mo.

Gregg received his bachelor's degree in mechanical engineering from the University of Missouri in 1979 and was a member of both Tau Beta Pi and Pi Tau Sigma.

A serial entrepreneur, Gregg started two medical instrument companies prior to his most recent ventures. He is an inventor listed on more than 90 U.S. patents.

Gregg's second company, Synergetics, Inc., was started in his garage in 1992. The start-up grew by an average 41 percent annually, and in 2005, the company merged with Valley Forge Scientific Corp. to become Synergetics USA, Inc. When he left, the company had 400 employees in 85 countries with $50 million in annual revenues.

Scheller next served as the MU College of Engineering's director of entrepreneurship and industry partnerships and co-directed the university's biodesign program advising student-inventors on how to succeed as entrepreneurs. He currently serves as the program's chairman of the board. He serves on the Dean's Engineering Advisory Council.

Gregg has received numerous awards, including being named the Ernst & Young Midwest Life Sciences Entrepreneur of the Year in 2007.

Gregg and his wife, Donna, live in Wildwood, Mo. Donna received her bachelor's degree from MU in business administration in 1986. The couple has two sons. Michael earned a bachelor's degree in mechanical engineering from MU in 2011, and is pursuing his master's, and Steven is an undergraduate in mechanical engineering.

IMSE alumnus successfully champions and implements 'lean' operations throughout his career

David Engelkemeyer BS IMSE '73 and his wife, Susan, pose with their family on the beach near Boston, Mass. From the left to right are daughter-in-law, Erin Engelkemeyer, holding their granddaughter, Grace Engelkemeyer, son, Jason Engelkemeyer, son-in-law Brad Chalifoux and daughter Kristy Chalifoux. Not pictured is Liam Chalifoux who joined the family on April 1, 2013.

David Engelkemeyer grew up in Hermann, Mo., where he was both class president and president of his high school's student body. The son of factory workers, the 1973 graduate from the Department of Industrial and Manufacturing Systems Engineering said that even as a youngster, he thought about some sort of a career that would make his parent's way of life better.

Because he had an aptitude for science and math, Engelkemeyer's school guidance counselor pointed him toward an engineering career. He said he considered going to school in Rolla, but while on the MU campus to take his SATs, he walked around the College of Engineering where then-dean, William R. Kimel, invited him into his office to talk.

"I knew I liked the business side of things. The dean pointed me in the direction of industrial engineering, which turned out to be exactly the right thing for me," said Engelkemeyer, who currently serves as vice president of operations and supply chain for Welch Foods Inc., headquartered in Concord, Mass.

"My college experience included my summer job selling books [door-to-door] for The Southwestern Company," Engelkemeyer said.

During the three summers he worked for them, he was one of the top sales producers out of the nearly 8000 college students they employed. Over time, he picked up increased leadership responsibilities. By his final summer, he was supervising 15 student sales managers and their teams. This direct selling experience helped him hone important skills that have contributed to his successful career.

"In addition to core engineering studies skills, it is every bit as important to find opportunities to build communication, leadership and team-based social skills" Engelkemeyer said. "Students should choose their electives wisely, get involved and pursue meaningful work experiences."

Engelkemeyer took a job with Procter and Gamble after graduating in 1973, and said the initial management development training he received was worth another college degree. When he left the company in 1994, he had twenty years of increasing responsibility under his belt. For the next six years, climbed the ranks of Avery Dennison Worldwide Office Products, starting as a site manager for the Paper Products Division where he led one of the most challenging and successful turnarounds in the company history. By 2000, he was group director for the company's office products plant operations and supply chain functions.

His next position was with a Boston-based start-up retail service company where he acquired invaluable exposure to the entrepreneurial and private equity world working as senior and then executive vice president of operations.

From 2004 until he went to work for Welch Foods in 2007, he served as vice president of worldwide operations for Banta Corporation, a printing and supply chain management firm — now part of R.R. Donnelley — where he was responsible for 40 plants across three continents.

Throughout his career, Engelkemeyer has taken an active role in introducing and championing Lean Thinking, an operational philosophy that targets the elimination of practices that do not add value to products for the end user. His strategic plans have annually saved his companies tens of millions of dollars.

"It's basically just identifying ways to take waste out of the system with a customer focus," Engelkemeyer said. "The skill set of looking at processes this way and making them more efficient is an important one to develop."

The work he has accomplished utilizing those skills has been gratifying, based on the satisfaction he has derived from his engineering career, including his past six years with Welch Foods, a national co-op owned by 1,100 grape-growers.

"We're the marketing arm for their crop," Engelkemeyer said. "Being owned by your largest supplier puts a very interesting twist on managing your supply chain," he added, and said that this job has put all of the skills he has developed in his previous positions into play.

"I have a broad, influential and rewarding role at Welch's," Engelkemeyer said. As a member of the senior leadership team, I not only share in helping to develop the company's vision and strategy to achieve it, but from a functional perspective, I'm continually challenged with finding new opportunities for taking out cost to help drive innovation, growth and customer satisfaction.

Engelkemeyer met his wife, Susan (West) Engelkemeyer, when he was a student at MU and she a student at Stephens College. Susan also has had an exciting and rewarding career. She currently serves as president of Nichols College, a business college in Dudley, Mass.

The couple's home base is a fully restored, 120-year-old oceanfront Victorian house near Boston, Mass. Their two adult children, Jason and Kristy, and their families — including two grandchildren — live nearby. Engelkemeyer said that keeping up with the house has become a weekend hobby.

"I enjoy living on the ocean in the Boston area and spending time here with my family and friends," he said.

Mizzou
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Engineering Advancement Office
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Columbia, MO 65211-2200

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Mizzou Engineering Calendar

JULY 2013

14 Engineering Summer Camp week one begins

21 Engineering Summer Camp week two begins

AUGUST 2013

16 FIG Panel Discussion and BBQ

SEPTEMBER 2013

6 MU Engineering 19th Annual Alumni Golf Tournament
Columbia Country Club
1 p.m. to 7 p.m.

7 MU Engineering Alumni Organization Board Meeting

14 Freshman Float Trip

17 Engineering Career Fair
Hearnes Center Concourse
10 a.m. to 3:30 p.m.

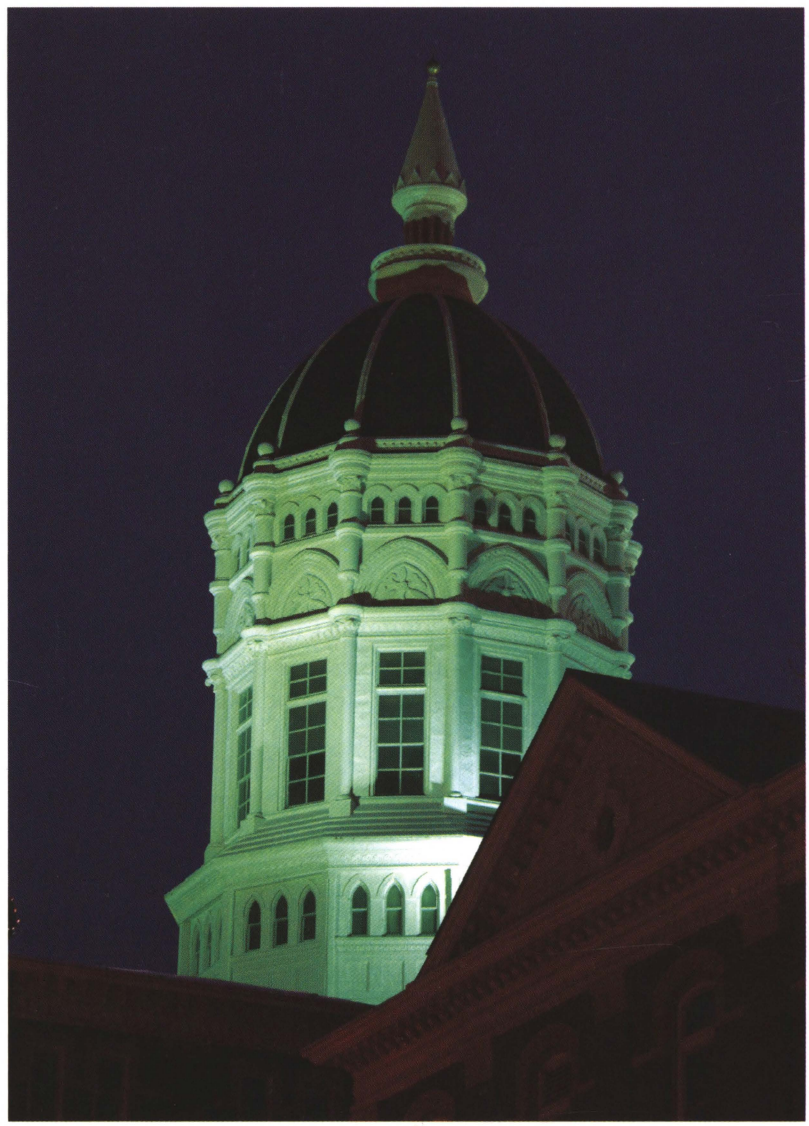
28 Parent's Weekend

OCTOBER 2013

18 Dean's Engineering Advisory Council (DEAC) Meeting

NOVEMBER 2013

14 Engineering Scholarship Dinner
MU Memorial Union, Stotler Lounge
6 p.m. to 8:30 p.m.



A now-annual sight on campus, for a week in March, MU's Jesse Hall dome is bathed in green light in honor of Engineers Week. Photo by Katie Bell