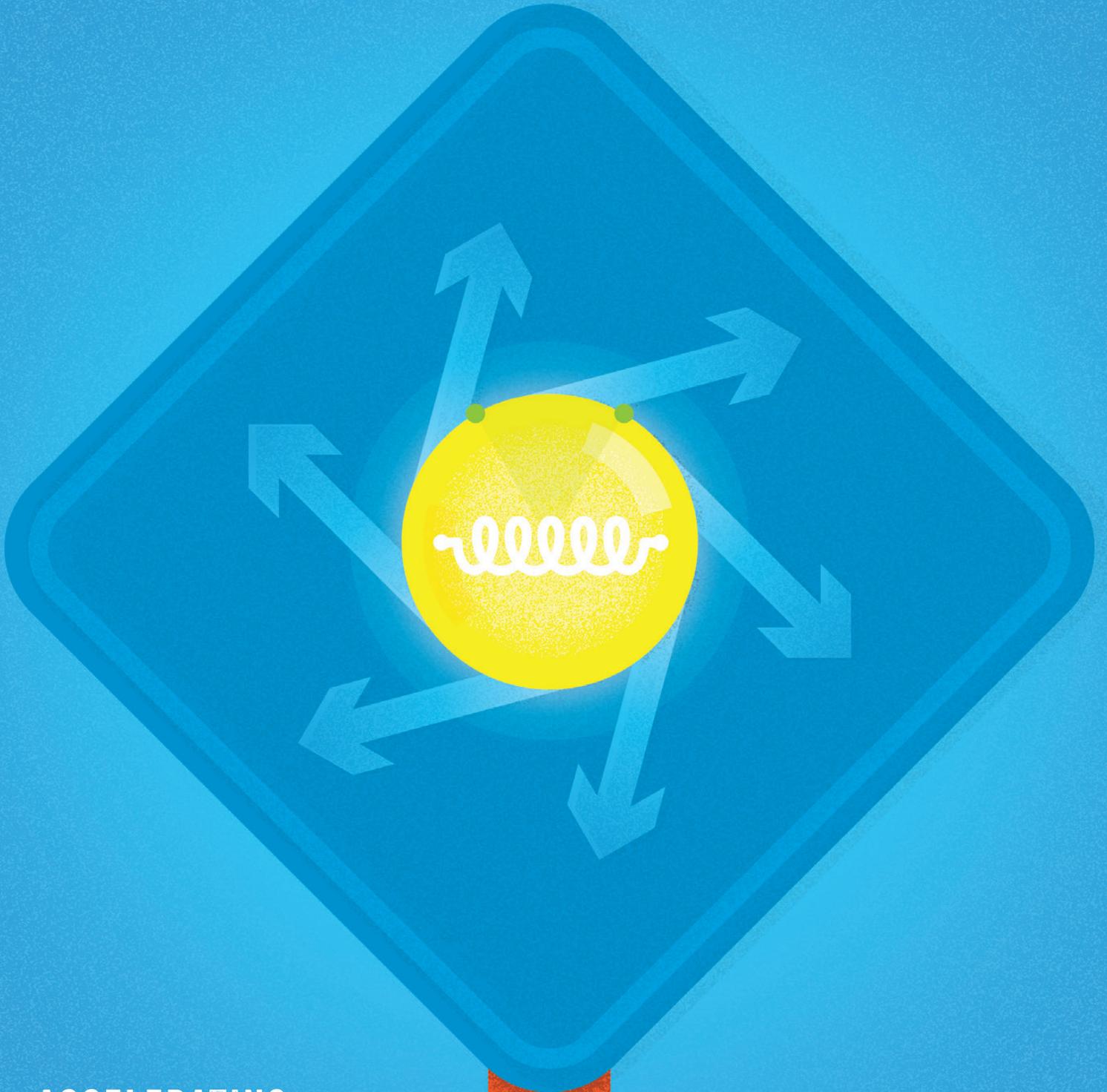
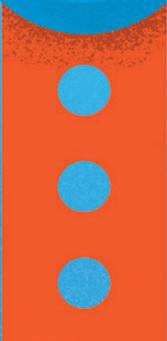


# UNM ENGINEERING



**ACCELERATING  
INNOVATION**

2013





# From the Dean

Greetings,

The School of Engineering at the University of New Mexico remains faithful to its mission by continuously reinventing itself, by redefining its aspirations, and by reaching out to its stakeholders and partners in academia, industry, and government. We are a dynamic school that seeks to engage the University, our state, and institutions across the globe in a conversation about the impact of engineering in the world we live in today. More importantly, we ponder ways for us to build a better world for tomorrow.

Our efforts are guided by a shared strategic vision, which our faculty is gradually shaping and refining. It is this vision that will allow us to leave our mark on the world and to be recognized as a school of distinction. Our strategic planning efforts are centered on four core concepts that are synergistic with the emerging aspirations of our University as a whole:

- **Economic development fueled by a powerful research enterprise.** UNM Engineering is uniquely positioned to contribute to economic development in the State of New Mexico. A large research enterprise with many nationally recognized projects, a culture of entrepreneurship among both faculty and students, and an excellent track record of technology commercialization make it possible for us to engage in the creation of new enterprises and in the expansion of the UNM economic development portfolio.
- **Lifecycle perspective on student success.** Our commitment to student success led us to formulate a comprehensive plan that starts by reaching out to high school students and ensures a quality educational experience all the way through graduate studies. Industry internships, early involvement in research, unique opportunities for multidisciplinary studies and research, and a modernization of our programs are some of the key elements of our strategy for ensuring student success while in our academic programs and later in life.

- **Comprehensive and multifaceted approach to internationalization.** For many an international experience is associated with spending a semester abroad. Our approach to engaging international partners is much richer and more nuanced. Traditional student exchanges are complemented by innovative dual degree programs which are likely to contribute both to enriching the experience of our students and to a significant expansion of the number of students likely to pursue graduate degrees. Finally, the addition of an economic development dimension to our international engagements distinguishes us from most other academic institutions in the nation.
- **Effective and impactful multi-tiered partnerships.** In a world of increasing complexity and interconnectivity, discipline boundaries are blurred and the problems we face today demand contributions from multiple disciplines and very diverse skill sets. Our approach to research and education reflects this view, and it is supported by explicit efforts to build partnerships across the University, with national laboratories in New Mexico and elsewhere, with innovative industrial enterprises, and with academic institutions in the United States and abroad. Our partnership in four prestigious NSF Engineering Research Centers is one illustrative example.

My sincere hope is that you will be part of this ambitious transformation. By being engaged with the school and by contributing your time, gifts, and ideas, we will be able to make these aspirations a reality.

Sincerely,

A handwritten signature in blue ink, reading "G. C. Roman". The signature is fluid and cursive.

**Gruia-Catalin Roman**

Dean, UNM School of Engineering

## On the Cover

The cover illustration visualizes the concept of “accelerating innovation” by combining road sign imagery with directional arrows in a tangential acceleration arrangement. In essence, innovation, as represented by the light bulb, is central and accelerates, spinning off new avenues of discovery for the UNM School of Engineering.



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## Points of Pride

### Dr. Stephanie Forrest Named Jefferson Science Fellow

The Jefferson Science Fellows Program in Washington, DC, has selected **Dr. Stephanie Forrest** as a 2013–2014 Fellow. Dr. Forrest is Regents Professor of Computer Science at the University of New Mexico and a member of the Santa Fe Institute External Faculty. Her interdisciplinary research studies adaptive systems and includes biological modeling, computer security, and software. At UNM, Forrest served as department chair for computer science from 2006 to 2011. The Jefferson Science Fellows Program is designed to further build capacity for science, technology, and engineering expertise within the U.S. Department of State and the U.S. Agency for International Development (USAID).

### Three Young Faculty Win Awards

The National Science Foundation (NSF) honored two of our faculty — **Meeko Oishi**, Assistant Professor in the Department of Electrical and Computer Engineering; and **Mark Stone**, Assistant Professor in Civil Engineering — with a prestigious Faculty Early Career Development Award. **Daniel Fezell**, Assistant Professor in the Department of Electrical and Computer Engineering, recently received a Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA).

### Mind Research Network Receives \$15M Award

The National Institutes of Health (NIH) awarded a \$15 million grant to **Vince Calhoun**, Executive Science Officer of The Mind Research Network and Distinguished Professor of Electrical and Computer Engineering at UNM. The grant will position New Mexico as one of the premier brain imaging sites while expanding research on psychosis and mood disorders.

## Accelerating Innovation

# 02

### Seeing 2020

#### Supporting A New Vision

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2013, Volume 9

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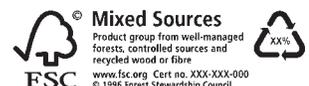
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**WHAT WILL THE SCHOOL OF ENGINEERING BE LIKE IN 2020? WE SEE A LARGER, MORE DIVERSE STUDENT BODY. MORE HIGH-IMPACT RESEARCH CENTERS AND PROJECTS. AND STRONGER PARTNERSHIPS WITH INDUSTRY AND NATIONAL LABORATORIES.**

And we see UNM Engineering emerging as a school of national and global distinction, recognized for its leadership and advancements in science, technology, engineering, and education.

This vision supports UNM2020, a campus wide initiative led by President Robert Frank. UNM2020 challenges the University community to reinvent itself and envision a new future. Dean Catalin Roman participated in helping shape the UNM2020 vision. "This was a watershed event that redefines the way UNM is perceived by the community and amplifies the University's impact on our state, economy, and culture," says Roman. "It's gratifying to see how UNM2020 embraces and reinforces our School's aspirations related to globalization, economic impact, and academic excellence."

**GOING GLOBAL**

UNM Engineering is emerging as a hub of activity driving research collaboration, laboratory sharing, student exchanges, internships, and economic development on a global scale. "UNM has the ambition to become international and our School laid the foundation for making this initiative successful," says Ramiro Jordan, Associate Dean for International Programs. "Under the leadership of Dean Roman, we are developing new programs designed to help UNM Engineering

increase its role in international education, research, and economic development." They include:

**Global Innovation Network for Entrepreneurship and Technology (GINET)** — envisioned to turn UNM Engineering into a hub for moving ideas out of worldwide laboratories and into the international marketplace.

**International Research Portfolio Expansion** — designed to promote international research collaborations by creating ways to share laboratory space, equipment, and expertise.

**Global Engineering Scholars Program** — proposed to encourage international student exchanges by allowing students from participating universities to earn a Bachelor's from their home institution and a Master's degree from UNM.



## DRIVING ECONOMIC GROWTH

UNM helps power economic development for New Mexico. With 26 start-ups to its credit, UNM Engineering is a key player in that effort. To boost economic development, the school plans to *double* that number by 2020. It starts with research. "We don't have start-ups, inventions, or technology transfer without research," says Plamen Atanassov, Associate Dean for Research. The focus will be on areas that will have a longer, deeper impact on economic growth.

The faculty and an entrepreneurial culture drive economic development because they connect research and technology transfer. They also influence the next generation of engineers. So the school plans to increase the faculty size and the number of multi-investigator research awards.

*"The UNM2020 vision has been created to guide us into the future. If we share a desired outcome and have invested in the design, we have a far better opportunity to make it a reality."*

**ROBERT G. FRANK**

*President, The University of New Mexico*

Combining research faculty and industry in "technology incubators" will also fuel economic development. The early success of the Configurable Space Microsystems Innovation & Applications Center (COSMIAC) is the blueprint. COSMIAC is a space venture incubator where faculty, government laboratories, and industry collaborate to advance aerospace engineering (see page 12).

## ACCELERATING ACADEMICS

Worldwide demand for skilled engineers is accelerating exponentially. To meet the demand and give students more opportunities, UNM Engineering made changes to improve and accelerate the academic experience. "We're working hard to make our students more successful in their academic efforts by rethinking our approach to pedagogy and advising," says Charles Fleddermann, Associate Dean for Academic Affairs.

This fall, UNM Engineering started accepting all freshmen directly into the school, rather than having some start in University College. "This new approach helps students quickly identify with our school and other engineering students. They can also access our outstanding advising, mentoring, and tutoring services immediately," says Fleddermann.

To help students stay on track with the engineering curriculum, the School plans that all freshmen enrolling from 2014 on will take Math for Engineers, a new lecture and lab covering all the math topics first-year students need to advance to sophomore level courses.

Other initiatives that will improve the student experience and success include increased participation in undergraduate research, more opportunities for industrial internships, and a new shared credit program. This program will allow students to earn a Bachelor's and Master's degree in five years by integrating studies between two degrees and by counting some coursework towards both.

"The School of Engineering sees UNM2020 as an opportunity to engage our faculty with the University community as a whole with the goal of building a shared future and helping UNM reach its true potential," concludes Dean Roman.

To learn more, please visit [unm2020.unm.edu](http://unm2020.unm.edu)

## UNM SCHOOL OF ENGINEERING-RELATED START-UP COMPANIES

**Alpine Biosciences, LLC:** New Mexico based company focused on targeted drug delivery for cancer therapy.

**Attochron, LLC:** California based company focused on advanced free-space optical communications. [www.attochron.com](http://www.attochron.com)

**Batterade, LLC:** Albuquerque, NM based start-up company focused on providing a solution to developing nations' cell phone charging issues. [www.batterade.com](http://www.batterade.com)

**Comet Solutions, Inc.:** Albuquerque, NM based start-up company focused on computational modeling toolkit, an object-oriented framework for engineering products. [www.cometsolutions.com](http://www.cometsolutions.com)

**Dynamic Photonics:** Albuquerque, NM based company developing ultra-fast optical receivers made from off-the-shelf components that substantially reduce costs. [www.dynamic-photonics.com](http://www.dynamic-photonics.com)

**Eta Diagnostics, Inc. (formerly Sandia Electro-Optic Corporation):** Albuquerque, NM based company focused on development, manufacturing and sales of optically enabled instrumentation for the life science and environmental sensing markets. [www.se-oc.com](http://www.se-oc.com)

**GLO USA:** Swedish company (with location in California) focused on nanoscale semiconductor manufacturing. [www.glo.se](http://www.glo.se)

**Human Recombinant Protein and Vaccine Initiative for Africa:** Iowa company focused on lateral flow strips.

**Lotus Leaf Coatings, Inc.:** Albuquerque, NM based start-up company developing superhydrophilic and superhydrophobic coatings for optics, micro-electronics, fluid dynamics, anti-fogging, sanitation, solar, HVAC, health and beauty, consumer products and other applications. [www.lotusleafcoatings.com](http://www.lotusleafcoatings.com)

**Magic Dragon Technologies, LLC:** California based company focused on next generation hardware security. [www.magicdragontech.com](http://www.magicdragontech.com)

**Nanocrystal International:** Albuquerque, NM based company developing defect-free, gallium-nitride nanowire semiconductors. [www.nanocrystal.com](http://www.nanocrystal.com)

**Neovita Biosystems, Inc.:** California based company focused on developing a new DNA sequencing device that will drop the cost of sequencing up to two orders of magnitude and require less than a single day. [www.neovitabio.com](http://www.neovitabio.com)

**Oligocide, Inc.:** Albuquerque, NM based company focused on development of robust, expansive, and novel antimicrobial materials platform. [www.oligocide.com](http://www.oligocide.com)

**On-Q-Ity:** Massachusetts based company focused on innovative diagnostics for treatment of cancer. [www.on-q-ity.com](http://www.on-q-ity.com)

**Pajarito Powder, LLC:** Albuquerque, NM based company focused on fuel cell catalysts. [www.pajaritopowder.com](http://www.pajaritopowder.com)

**Protomex Life Sciences (formerly P.D. Laboratories):** Albuquerque, NM based medical device company focused on technology to detect protein biomarkers developing low-cost biosensor. [www.protomexlifesciences.com](http://www.protomexlifesciences.com)

**Pressure Analysis:** Albuquerque, NM based company focused on pressure-sensing fabric for use in assisted-living and healthcare monitoring, as well as training of medical students on pressure sensitive operations.

**Synfolia, Inc.:** Albuquerque, NM based company developing tissue-scaffolding engineering solutions. [www.synfolia.com](http://www.synfolia.com)

Fluorescent microspheres aligned with an acoustic standing wave for optical analysis

Professor Steve Graves with Biomedical Engineering Graduate Program students Paul Durfee, Mekensey Buley, and Kirsten Cicotte



## Don't Go with the Flow – Improve It

### Steven Graves expands biomedical engineering research and education

Finding 50 things in a sea of one billion is no easy task. But **Steven Graves** is up to the challenge. If he succeeds, he could help change lives. Graves, associate director of the Center for Biomedical Engineering and associate professor of chemical and nuclear engineering, is developing new flow cytometers, instruments that measure the properties of single cells within a larger sample of billions of cells.

To do that, he's creating an affordable high-throughput flow cytometer that screens blood samples for rare cells, including circulating cancer tumor cells. These cells can be good indicators of therapeutic efficacy for some cancers.

Graves is creating highly parallel flow cytometers that can analyze hundreds to thousands of times more cells and solution than traditional instruments. "The more cells we can look at, the more information we can gather," says Graves. The result could be a more effective, less expensive way to analyze blood samples and he says that would be extremely useful. "In the American medical system, there is a real need to reduce the cost of medical diagnostics," he says.

Graves' approach is in part based on using sound waves to control cells in a flow cytometer, which concentrates particles so they can be analyzed longer and enables use of less expensive instrument components. He is also exploring several applications for the technology and flow cytometry in general, including studying proteases related to diseases including HIV, West-Nile, and cancer, as well as helping marine biologists measure plankton levels in seawater.

#### Educating Future Biomedical Engineers

Graves is also the director of the Biomedical Engineering Graduate Program. The BME program prepares MS or PhD students for successful careers in the growing field. The current program has 20-30 students and is actively seeking more interested students from any engineering discipline or those from other quantitative sciences.

"The UNM BME program offered me the opportunity to take courses directly related to my research and provided new avenues for collaborating with faculty," says

biomedical engineering doctoral student Christina Salas. "Biomedical research is inherently collaborative and this program lets students conduct research with engineers, scientists, physicians and other medical staff to help solve clinical problems with engineering solutions."

To meet the demand for biomedical engineering, the program is becoming more multidisciplinary and is trying to foster economic development in the state. Graves says, "Biomedical engineering is becoming more important to our country and humanity because it's about applying scientific and engineering principles to solutions that directly impact human health."

#### NOTABLES

- *Plenary Speaker for the International Society for Advancement of Cytometry – 2011*
- *Distinguished Patent Award for "Ultrasonic Analyte Concentration and Application in Flow Cytometry," Los Alamos National Laboratory*
- *Invited Speaker for the Gordon Research Conference on the Physics and Chemistry of Microfluidics – 2013*



## Paving the Way for Better Roads Ahead

### Rafiq Tarefder researches better materials for building roadways

Each mile of road in New Mexico costs between \$500,000 and \$1.5 million to build. Multiply those amounts by more than 27,800 lane miles of paved roadway in the state, and you start to get a sense of just how much the New Mexico Department of Transportation (NMDOT) spends on building and maintaining the state's highways and byways.

**Rafi Tarefder**, associate professor of civil engineering, is applying his expertise in pavement materials and design to change the roadway construction industry. His findings help government agencies, including NMDOT, build and maintain better roads — and save money in the process. “Based on the structural design of a road, one can save up to \$100,000 per mile,” explains Tarefder.

To conduct his research, Tarefder has developed four labs at UNM Engineering: the Advanced Pavement Testing Lab, the Materials Processing Lab, the Hydraulic-Pavement Lab, and the Asphalt Binders Lab, one of the few of its kind in the nation. Using state-of-the-art equipment and with research support from his

graduate and undergraduate research assistants, Tarefder is pursuing several research projects.

In one research project funded by a National Science Foundation CAREER award, Tarefder is trying to resolve a long-standing industry problem: how moisture damage occurs in asphalt and whether the damage happens between layers in the pavement or within binders in the material. Tarefder uses an atomic force microscope and nanoindenter to study adhesion and stiffness of the materials at a nanoscale level and then extrapolates those findings at the macro level. His research showed that moisture damage occurs in asphalt binders even with the presence of antistripping agents, additives that are used to reduce moisture damage in pavement. The research also demonstrated that lime is a better anti-stripping agent and is more effective in fighting against moisture compared to other agents, including chemical antistrips.

Tarefder is also researching ways to engineer better pavement. “In the past, NMDOT pavement design was

based on an empirical approach, relying on experience and equations developed from road test data of the ‘60s,” he says. “Now we use advanced mechanics, testing, and computation.”

Tarefder has been instrumental in calibrating and implementing the Mechanistic Empirical Pavement Design Guide (MEPDG), a national pavement design guide, in New Mexico. The MEPDG uses local materials information, traffic conditions, and climate data for efficient pavement design. But before the MEPDG could be implemented in New Mexico, it had to be customized with certain parameters specific to the state — including approved materials and failure criteria. Tarefder is leading that initiative, which will have a big impact on the state — and residents' wallets. “The calibrated MEPDG will save designers and taxpayers a lot of money.”

#### NOTABLES

- *UNM Regents' Lecturer Award, 2011*
- *UNM Engineering Junior Faculty Research Excellence Award, 2010*
- *NSF CAREER Award, 2007*



Melanie Moses and her students use "iAnts," robots controlled by iPhones, to experiment with distributed complex systems. The robots are programmed by genetic algorithms that adapt ant-inspired behaviors to complete a task as a group. With each experiment, the students learn something new that they can use to optimize the robots' group behavior in the next experiment.

# Unraveling the Mysteries of Complex Systems

Melanie Moses combines biology and computer science in innovative research

Could ant colonies hold the key to better computer security? And can computers decipher how our immune systems really work? **Melanie Moses** thinks so. As associate professor of computer science, Moses studies distributed complex systems and applies what she learns to make the world safer and healthier.

Her research is a unique integration of biology, computer science and engineering. Not only does Moses use tools and techniques from all of these disciplines, she asks questions motivated by each discipline.

Students in Moses' lab build robust and adaptable robot swarms based on behaviors that ants have evolved over millions of years of foraging. From carefully controlled experiments with their engineered systems, they gain detailed information about how each feature of ant behavior contributes to foraging success.

Moses and a graduate student are studying invasive Argentine ants on the Stanford University campus. These tiny ants have built massive colonies that are especially cooperative with

each other and dominate other ant species. By documenting the Argentinian ants' movement between nests in the colony, Moses hopes to learn what makes them so successful and then apply that learning to create robust, adaptive, and scalable computer networks.

Just as colony behavior emerges from complex interactions among ants, immune system function emerges from interactions among many different cells. Moses uses computational models to help researchers at the New Mexico Spatiotemporal Modeling Center (STMC) understand how immune cells move through the body to mount an immune response. "The goal is to understand how the cells quickly recognize and react to pathogens that enter the body," explains Moses. The computer models convert data about the cells' movements into valuable information for STMC researchers. They use that information to formulate and test new hypotheses that could lead to disease prevention and new treatment methods.

Moses is also part of a UNM research team creating a computer security system that mimics the individualized approach immune cells take to attacking pathogens. The idea is to have each computer repair itself after a malware attack rather than relying on instructions from a central command center. "That way one repair is different from another so the next virus that comes along will see two different machines. That makes it harder for the virus to spread," she explains.

## NOTABLES

- 2013 Co-director of the UNM Program in Interdisciplinary Biological and Biomedical Sciences
- 2013 UNM School of Engineering Junior Faculty Research Excellence Award
- 2012 UNM School of Engineering Research Excellence Award
- 2011 UNM Outstanding New Teacher of the Year
- 2010 UNM Faculty of Color Research Award

# PUF Goes the Hacker

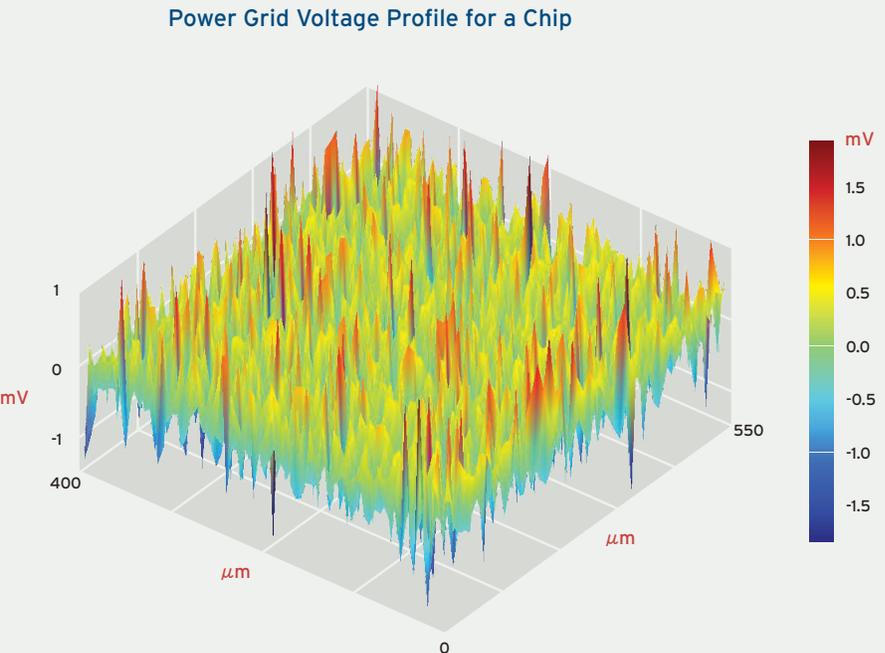
James Plusquellic's invention may revolutionize computer security

A "PUF." It sounds innocuous. But it could change how computer chips function and put hackers, counterfeiters, and thieves right out of business.

**James Plusquellic**, associate professor of electrical and computer engineering, has developed a new type of physical unclonable function (PUF), a process that measures the physical properties of a computer chip and, when queried about that measurement, generates a randomized response. PUF technology was developed over a decade ago, but Plusquellic has refined it and patented the result.



Plusquellic's PUF is a circuit built into a computer chip that measures process variations within the chip. Specifically, the PUF measures minute changes in the resistance of metal wires created by the imprecise fabrication process used to make the chip. Those variations are unique to each copy. "This PUF really takes security to a new level," says Plusquellic. "Think of it as the DNA of each chip." He says that his approach to measuring variations in metal resistance, which is very stable and predictable, is more reliable than



other processes that gauge changes in the more delicate transistors on a chip.

Plusquellic's PUF converts measurements of those resistance variations into a unique identifier – a string of ones and zeros – that provides the chip with a "fingerprint." That identifier, which cannot be cloned and never needs to be stored in memory or on disk because it's generated upon request, can be used as an encryption key or to distinguish a genuine chip from a counterfeit. The encryption keys created by the PUF could create an unhackable cell phone transaction with a bank, completely secure computer access to a top secret file, or protect the chips that control a computer-driven car.

Unlike other security devices that are applied by the manufacturer, the PUF's signature is secret. The manufacturer doesn't know it and

invasive efforts to steal it would destroy the chip. "This PUF gets everyone out of the loop. Nobody can sabotage or steal your information from a database because the PUF has a unique identifier that isn't recorded *anywhere*," explains Plusquellic.

After patenting the PUF with STC.UNM in 2010, Plusquellic launched a company to take it to market in 2013. The company, called Magic Dragon Technologies, already has a great deal of interest from major manufacturers and chip foundries. He says that's good news for everyone. "This PUF is going to give us a real leg up on the bad guys."

## NOTABLES

- IEEE Golden Core Award
- Co-founder International Workshop on Hardware-Oriented Security and Trust (HOST) Research Award



## UNM Students Participate in US DOE 2013 Solar Decathlon Challenge

On August 27, in Scottsdale, AZ, a joint interdisciplinary team of students and faculty from Arizona State University and the University of New Mexico celebrated the completion of the 860 sq. ft. SHADE house, one of twenty entries for the 2013 Solar Decathlon competition, sponsored by the U.S. Department of Energy. "SHADE" stands for Solar Homes Adapting for Desert Equilibrium. In planning the project, **Team ASUNM** – which formed its name from the acronyms of the two schools – chose materials and energy systems that are appropriate for the desert southwest.

The Solar Decathlon challenges collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winning house best blends affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency. The competition will be held October 2-12 in Irvine, CA.

During the two-year project, the team of 37 ASU and UNM students from the disciplines of architecture, engineering, construction, and communication focused on affordable photovoltaic solutions, taking advantage of the southwest's seemingly endless supply of solar energy. The house is smart-grid ready – with smart appliances and an optional electric vehicle



The interior of SHADE house features flexible space, allowing rooms to serve multiple purposes.

charger – and is equipped with home automation and control systems for greater energy savings.

After the competition, SHADE house will come to New Mexico for display at Mesa del Sol. For more details visit [www.asunm.org](http://www.asunm.org), or contact Professor Olga Lavrova at [olavrova@unm.edu](mailto:olavrova@unm.edu)

## Students Receive Awards and Fellowships

UNM Mechanical Engineering student **Alejandro Perez** has been awarded a fellowship considered to be among the world's best. The "la Caixa" scholarships from the leading savings bank in Spain are designed for students to continue a passion they've been pursuing for many years, earn a master's degree from a top university, and later contribute to the economic growth of their native country. After working four years as an aeronautical engineer in Spain, Perez came to UNM to pursue the LoboMotorSports program, a three-semester credited

course to learn racecar design and the business of automotive engineering.

**Mohammad Hossain's** paper entitled "Numerical Computation of Coupled Adhesive and Cohesive Damages in Asphalt Concrete," co-authored by Civil Engineering Professor **Rafi Tarefder**, received "The Best Paper Award of ICPT2013" at the Eighth International Conference on Road and Airfield Pavement Technology held July 14-18 in Taipei, Taiwan. Using laboratory testing and finite element modeling, they identified the causes and progression of moisture damage in asphalt concrete.

**Alan Kuntz**, a senior undergraduate student in Computer Science at UNM, has been awarded an Honorable Mention in the 2013 Computing Research Association Undergraduate Researchers Award. Kuntz was recognized for his work on computational methods for modeling antibody aggregation.

UNM Engineering student **M. Santiago Rojas-Carbonell** co-founded a company called Batterade, LLC, using a novel technology with the ability to charge cell phones in developing countries, where access to electricity is a problem and cell phone use is critical. The technology, developed by the Department of Chemical & Nuclear Engineering and CEET, is a new kind of paper-based bio fuel cell that uses an enzyme-based catalyst to generate electricity out of sugar.



# Taking STEPs to



STEP Project Director/PI Tariq Khraishi and STEP Coordinator Sue Buffington

It's not often that a freshman engineering student lands an internship at a national lab or tech start-up this early in their career. But a unique program at UNM Engineering is making internships possible for dozens of underclassmen each year. In the process, the program is inspiring the next generation of engineers.

The National Science Foundation (NSF) developed the Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP) to improve retention and graduation rates in STEM disciplines. In 2011, UNM Engineering received a \$2 million, five-year grant to start a STEP program.

Schools around the country took various approaches to the retention challenge. UNM Engineering chose to focus on students most prone to leaving the discipline – freshmen and sophomores. “The program gives these students a practical sense of what engineers do,” says Tariq Khraishi, professor of mechanical engineering and project director of the STEP program. “Internships can help students see the value of their studies and decide that they made the right choice and want to stay – and do well at UNM.”

Khraishi and his four co-principal investigators, in conjunction with Engineering Student Services, designed a program that mentors students during the academic year in preparation for 8-week summer internships. It's the first program in the school's history to provide

faculty mentoring for freshmen and sophomores newly admitted to the School's departments. Students also have the opportunity to attend conferences in their field after their internship.

Throughout the year, STEP students attend career workshops and meet in small groups, called “university families,” led by a faculty member who talks with the students about their chosen field, academic life, and research. Meanwhile, organizations offering internships and STEP students learn about each other and pair up in preparation for the summer.

Companies, government agencies, and even the national labs offer the internships. For their participation in the program, students receive a summer stipend funded by the NSF STEP grant. Students can also intern

## Organizations Participating in STEP

Army Corps of Engineers  
Array Technologies  
Fiore Industries  
HDR Engineering, Inc.  
IEC Electronics  
Laird Technologies  
Loadstorm  
Los Alamos National Labs

Marpac  
OSO BioPharmaceuticals  
PNM  
Sandia National Laboratories  
Sumitomo Electric  
TechFlow Scientific  
Trane/Hussmann Climate Solutions  
TriLumina



# Inspire Undergrads

“Our vision is to be an important piece of economic development in the State of New Mexico, matching more and more students with local organizations for jobs before and after graduation.”

TARIQ KHRAISHI



## Khraishi Acknowledged for Teaching Excellence

When Tariq Khraishi arrived at UNM Engineering in 2000, he had his sights set on doing more than his mechanical engineering research. He also planned to study the process of teaching and learning in order to make education more fulfilling for his students. To that end, he's consulted other faculty members, gathered student input, and attended pedagogical workshops to refine his teaching skills. "There is always room to learn more about technical topics and better techniques to reach students and improve their understanding," he says.

Khraishi also strives to show his students the bigger picture. "I work on helping students be well-rounded individuals who understand how their studies fit within the larger context of society," he says. "That makes them better citizens and will help us tackle problems around the world."

His dedication to student success has been recognized with two recent awards. Khraishi was honored with the 2013 School of Engineering Senior Faculty Teaching Award recognizing teaching excellence in the school. He also received the 2013 UNM Excellence in Faculty Advising Award for encouraging students to overcome challenges and helping them maximize their educational plans, career, and life goals.



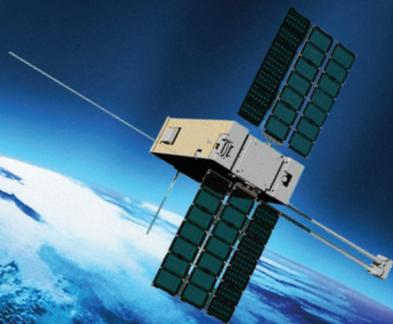
Justin Carmichael interned with Computer Science Assistant Professor Melanie Moses (see page 7), helping to implement an algorithm on the robots to see if it improved their performance over their old searching method. He says, "STEP was a great experience. I never thought I'd get to do robotics research as an undergrad, but STEP gave me this amazing opportunity."

## The Configurable Space Microsystems Innovation & Applications Center (COSMIAC)

COSMIAC is a five-year old center focused on the research and development of reconfigurable electronics and microsystems in aerospace and defense systems. The center was affiliated with the Electrical and Computer Engineering Department before becoming a UNM Engineering center in May 2013. ■ Recently, COSMIAC reached a new level of activity in its research and economic development initiatives. One of its inventions is being launched in a NASA rocket this Fall. Trailblazer is a small satellite containing three experiments that measure radiation in the ionosphere, the effectiveness of 3-D printing for miniaturized satellites, and the space “plug-n-play” architecture. ■ COSMIAC is also in the process of leasing space in its 11,000 sq. ft. building south of the main campus to the Air Force Research Lab (AFRL) and local aerospace companies. “It’s going to be the first of its kind facility at UNM where we can have academia working with a national research lab *and* industry. It’s a space venture incubator,” explains Christos Christodoulou, distinguished professor of electrical and computer engineering and director of COSMIAC. ■ Through an Educational Program Agreement with the AFRL, COSMIAC can use the national lab’s research facilities to “space qualify,” or test, inventions created by aerospace companies that are sending devices and equipment into space, but don’t have access to the facilities they need to test whether the equipment will work as planned outside Earth’s atmosphere.

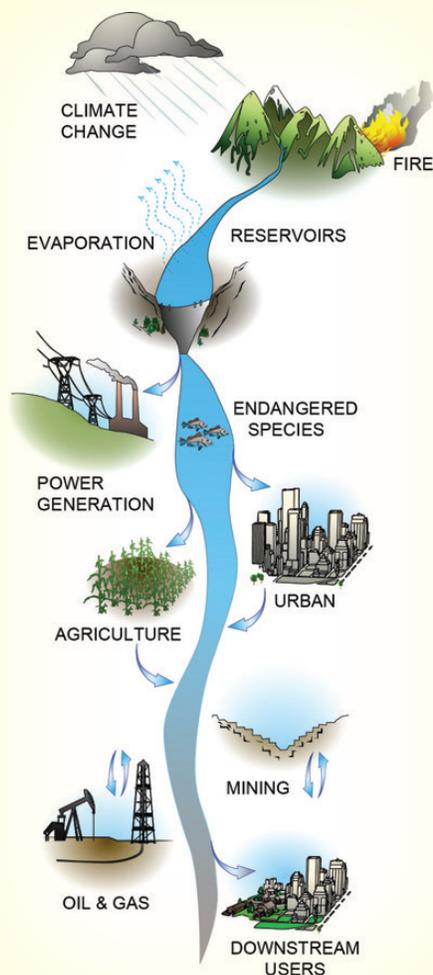
COSMIAC’s many projects include:

- Space Plug-and-Play Architecture – A rapid design framework for building satellites quickly
- Reconfigurable Radio Frequency (RF) Circuits – Configurable circuits for communication and tracking in space.



## Center for Water and the Environment

There is no resource more critical to the economic, social, and cultural viability of modern society than water. Wise water management requires researchers from diverse disciplines, and now engineers will be collaborating with biologists, chemists, economists, lawyers, and regional planners as part of UNM Engineering’s new Center for Water and the Environment, formed in May 2013. ■ The center was created to consolidate and maximize the water and environmental related research underway around campus. “Water is a very important issue and there are a lot of great people doing great things with water research at UNM,” explains Kerry Howe, associate professor of civil engineering and director of the center. “This center will allow them to make a greater impact with their work.” ■ The center will focus on two main issues: the lack of water resources in the Southwest’s arid environment and the relationship between water and energy. Findings from both endeavors could help solve water problems worldwide. ■ Howe’s next steps include building collaborations and pursuing joint research projects among UNM water researchers.



# Five for Bruce Thomson



Over the course of his 35-year career, **Dr. Bruce Thomson, P.E.**, Regents' Professor of Civil Engineering and Director of the Water Resources Program, has taught more than 1,500



students. Beyond educating and inspiring the next generation of civil engineers, Thomson has also helped shape the future of our

region by lending his environmental engineering and water resources expertise to important community organizations and as a technical resource to the media.

## NOTABLES

- 2013 *Engineer of the Year in the Public Sector Award* by the Albuquerque Chapter of the New Mexico Society of Professional Engineers
- 2010 *Earth Sciences Achievement Award*
- Albuquerque Metropolitan Arroyo Flood Control Authority Board member

### *What are you most proud of in your career?*

My students, definitely. Students I have worked with are now assuming leadership roles in environmental engineering and water resource management throughout the state and region.

### *What's one of your research highlights?*

The research I did on arsenic chemistry and treatment has received the most recognition. I worked with others to help develop methods of testing the effectiveness of using granular adsorbents for arsenic removal.

### *What's our biggest challenge regarding water resources?*

In New Mexico, we have some enormous water challenges. We need to figure out how to use water fairly, equitably, and wisely because there is not enough water to continue using it as we have in the past.

### *Why did you decide to get involved in the community?*

I've always felt that engineers ought to be involved in the public discussion because we have a quantitative way of looking at issues. When I became director of the Water Resources Program, I met more people in government and the community. Now I'm on the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) board with some terrific members. Nearly all of the issues we wrestle with have very significant technical components and that's where I hope that I can make a real contribution.

### *Why should students consider studying civil engineering?*

Civil and environmental engineers work directly with communities, on their critical infrastructure such as roads, water systems, buildings, bridges, and canals. There's a lot of satisfaction in seeing the immediate benefit to the community of your efforts and expertise.

## UNM Engineering Welcomes New Faculty

### Chemical and Nuclear Engineering

#### Jamie R. Gomez, *Lecturer III*

In 2013, Gomez received her PhD in Chemical Engineering from the College



of Engineering at Florida A&M University-Florida State University, where she was a research and teaching assistant. Her research

interests include material synthesis, characterization, and applications in electrochemical power sources including batteries and supercapacitors.

"Dr. Jamie Gomez brings considerable energy and new ideas to the chemical engineering program," says Timothy L. Ward, chair of chemical and nuclear engineering.

### Civil Engineering

#### Ricardo Gonzalez-Pinzon, *Assistant Professor*

Gonzalez-Pinzon received his PhD in Water Resources Engineering from Oregon State University in 2013. His professional interests include hydrologic transport, water quality modeling, and groundwater-surface water interactions.

"We expect Ricardo's experimental and modeling capabilities to significantly increase the impact of the department and school on the understanding of and solutions to water resources issues in the Southwest and beyond," says John Stormont, chair of civil engineering.

#### Jose M. Cerrato, *Assistant Professor*

Before coming to UNM, Cerrato was a postdoctoral research associate at Washington University in St. Louis from 2010 to 2013. His research involves molecular and macro-scale phenomena that affect the cycle



of metals and radionuclides in the environment. Cerrato received his PhD in Civil Engineering from Virginia Tech in 2010.

"Jose's research will add an important component to our environmental engineering program, and serve as a catalyst for multidisciplinary research," says John Stormont.

### Computer Science

#### Trilce Estrada, *Assistant Professor*

Prior to coming to UNM, Estrada was a postdoctoral research associate at the University of Delaware from 2012-2013. Her research includes high performance computing, computational biology, and



interdisciplinary computer science. Estrada received a PhD in Computer Science from the University of Delaware in 2012.

"Professor Estrada's interdisciplinary research will serve as a bridge between our High Performance Computing group and the scientific community at UNM," says Michalis Faloutsos, chair of computer science. "She is also committed to attracting and promoting the participation of women and under-represented minorities in computer science and engineering."

#### Abdullah A. Mueen, *Assistant Professor*

Mueen was a scientist at Microsoft Corporation before joining the UNM faculty. His research interests include data mining on unstructured data such as streaming and archived time series, videos,



and XMLs. Mueen received a PhD in Computer Science from the University of California, Riverside, in 2012.

"Professor Mueen is an expert in mining large, incomplete, and 'noisy' data and extracting patterns and anomalies," observes Michalis Faloutsos. "He is interested in interdisciplinary research and could be a catalyst for many scientific efforts that require intense data-analysis."

#### Brooke Chenoweth Creel, *Lecturer II*

Chenoweth Creel was a senior systems specialist at ARES Corporation in Albuquerque from 2008 to 2013. In 2002, she earned an MS in Computer Science from Indiana University where she was also a teaching assistant.



Faloutsos believes Creel's passion for teaching computer programming and computer science will have a positive impact on undergraduate students.

### Electrical and Computer Engineering

#### Jane Lehr, *Chair*

Lehr is an internationally respected researcher with a record of marked distinction and significant impact in the areas of pulsed power science and technology. She brings a commitment to education, extensive experience

in administration and leadership, and well-honed interpersonal skills. Lehr received her PhD in 1996 in Electrical Engineering from New York University-Polytechnic.

"I'm delighted to see Jane join the faculty and assume a position of leadership in



the School," says UNM Engineering Dean Catalin Roman. "She brings new ideas and a management style likely to change the culture in the department and to further enhance the spirit of collaboration that is a defining trait of our School," says Roman. "Her commitment to student success complements her passion for research and her desire to increase the visibility of an already excellent department."

Lehr comes to UNM from Sandia National Laboratories, where she has been a technical staff member since 2002. She spent the first ten years in the Pulsed Power Sciences Center and the last year in the Science, Technology and Engineering Integration Department using data driven strategic studies to support decision making in the enterprise.

Lehr is an IEEE Fellow and the recipient of the Air Force Basic Research Award and the IEEE Region 6 Award for Leadership of the Albuquerque Chapter.

**Manuel Martínez-Ramón, *Prince of Asturias Endowed Chair in Information Science and Related Technologies***

The Endowed Chair, which honors the heir to the Spanish throne, was established at the University of New Mexico in 2000 by Iberdrola, a Spanish electric utility company, with the support of the Ministry of Science

and Technology of Spain. The Chair is intended to serve as a catalyst for significant collaboration between Spain, Iberoamerica and the University of New Mexico. In addition, the appointment of the Chair is intended to foster ongoing and new collaborations involving Spain, and the support of graduate students from Spain.

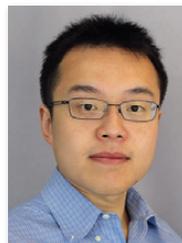
Martínez-Ramón received a PhD from the Universidad Carlos III de Madrid in 1999. According to Ramiro Jordan, Professor and Associate Dean for International Programs, Martínez-



Ramón's "research interests include machine learning with emphasis in its applications to engineering, in particular smart grids, brain imaging, computer aided decision, digital signal processing, antenna arrays and telecommunications."

**Zhen Peng, *Assistant Professor***

Peng comes to UNM from The Ohio



State University in Columbus, where he was a senior research associate in the ElectroScience Laboratory. His research includes computational science with a focus on computational electromagnetic and multi-physics analysis. Peng received a PhD in Electrical Engineering from the Chinese Academy of Sciences in Beijing, China, in 2008.

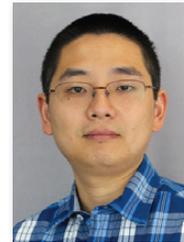
"Dr. Zhen Peng is a rising star in the Computational Electromagnetics community," comments Electrical and Computer Engineering Professor Edl Schamiloglu. "His research interests

cover computational electromagnetic and multi-physics analysis, with applications to electromagnetic compatibility and wireless communication systems."

**Yin Yang, *Assistant Professor***

Yang received his PhD in Computer Science from The University of Texas at Dallas in 2013. His research interests include computer graphics, physics-based simulation, and medical physics.

"His interdisciplinary background and expertise will complement ECE's



strengths in medical image and video analysis and UNM-wide initiatives in digital media and visualization," notes Marios Pattichis, professor, electrical and computer engineering.

**Mechanical Engineering**

**Mehran Tehrani, *Assistant Professor***

Tehrani is interested in researching



advanced materials for structural and energy applications, and numerical simulation at macro and nano scales. He received a PhD in Engineering

Science and Mathematics from Virginia Tech in 2012.

"His research expertise spans diverse fields such as nanomaterials, composites, and solid mechanics," says Chris Hall, chair of mechanical engineering. "His adeptness at both experimentation and computation will bring significant new strengths to the department's capabilities in the solid mechanics and materials group."

## Funding Formula SAE

For the average driver, a car is simply a mode of transportation whose value may lie in its cost or ability to perform. To an engineer, a car is a collection of carefully designed systems that are combined to optimize and balance cost and performance to meet customer requirements. The Formula SAE program at the University of New Mexico is a unique opportunity to teach systems engineering, or “putting it all together” – skills that are useful for engineers in every industry.



While the undergraduate mechanical engineering students who take part in the program and the *LOBOMotorSports* team are most excited about how the car places in one of seven annual Formula SAE car competitions, Professor John Russell, the program’s director, is more concerned about what the students learn through their involvement. To Russell, the value of the Formula SAE competition is in what it teaches students about systems engineering, project management, and teamwork.

“We run the program as if we were in industry,” he said. “These students could work for any industry and they’ll approach any project the same way they learn to do it here.”

For the record, the *LOBOMotorSports* team took 12th place overall out of 80 entries in this year’s Formula SAE competition in Lincoln, Neb., June 19-22. The cars are judged on their performance on the race course, as well as seven other measures of the entire design process, including car design, cost, acceleration, endurance, and the team’s marketing presentation. The UNM team met its goal of scoring fairly consistently over all categories.

The program is run as a three-semester mechanical engineering course that starts with the basics of how automobiles work and moves on to designing and building each system of a car, then putting all the systems together on time and on budget. The car is then tested and the drivers



trained before the *LOBOMotorSports* team takes the field to test the car against other teams from around the world.

Through the process, students learn the “soft” skills of communicating, working as a team, and how to balance cost vs. performance that apply to any engineering project in any industry. These are the skills that employers want to see in a new, just-out-of-school engineer.

## Funding Success

While many teams from other schools – especially competitors from Europe – have multimillion-dollar budgets from corporate sponsors, the UNM Formula SAE program runs on just \$60,000 per year. And while the competition is run on the premise that the team is designing a prototype car for a manufacturing firm, it does not start with a pile of cash on hand waiting to be spent, as an industrial design team would.

In reality, the team starts with a \$0 budget and must raise the money to build its car every year. This is accomplished through the generosity of Sandia National Laboratories, the Albuquerque Community Foundation, the UNM School of Engineering, the Department of Mechanical Engineering, the Associated Students of UNM, and other corporate and individual donors.

“If they gave a prize for place per dollars spent, I’d have no doubt we would win,” Russell says.

To help combat that uncertainty, the Mechanical Engineering Advisory Board has started an endowment campaign that will ensure the support of the UNM Formula SAE program and the *LOBOMotorSports* racing team far into the future. Mike Dexter (’75 BSME, ’76 MSME, ’11 MBA), a donor to the program and president of Bridgers & Paxton Consulting Engineers in Albuquerque, is leading this effort.

**To see the program first hand and learn how you can help, contact Mary Wolford, the UNM School of Engineering’s Senior Director of Development, at (505) 277-1088 or [Mary.Wolford@unmfund.org](mailto:Mary.Wolford@unmfund.org). Your gift will ensure engineering student involvement in Formula SAE competition through the *LOBOMotorSports* program for generations to come.**

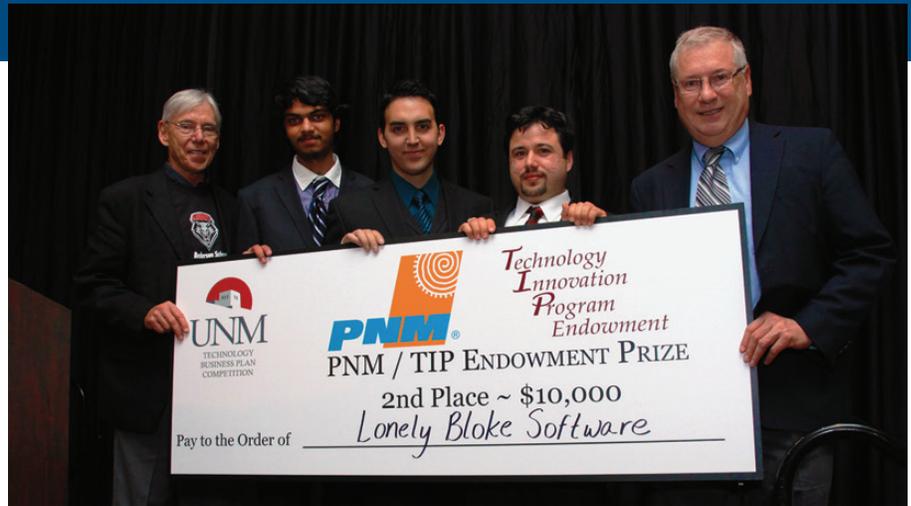
## Nurturing dreams, growing business

When UNM Computer Science Professor and Chair Michalis Faloutsos taught introduction to engineering at the University of California, Riverside, he used to ask how many of the freshmen intended to become entrepreneurs. About 30 percent said that was their goal, while another 30 percent indicated that they would be open to the possibility. Yet by the time those students graduated, many had gotten so caught up in school that they had forgotten that dream of entrepreneurship.

Faloutsos is working with UNM's Anderson School of Management Professor Sul Kassieh on a program that will keep that dream alive for engineering students and UNM students in all disciplines. "Life gets in the way," Faloutsos says. "To the degree that we can help maintain the dream of people who are entering as freshmen, we'll call that success."

Since 2008, the Anderson School and many local companies have sponsored the annual Technology Business Plan Competition. Funds raised go toward prize money for the winning teams, operational costs, and an awards ceremony the evening of the competition. The 2014 awards ceremony will be held on April 11.

The goal of the competition is to nurture the entrepreneurial spirit among UNM students and alumni. Over the course of the year-long competition, students work in teams to develop a business plan based on technological intellectual property and start a company based on that product. The technology products may be developed at UNM, or with partners Sandia National Laboratories and



Presenting the award to the 2012 Business Plan Competition are (left) Mike Rico of PNM and (right) Ray Radosevich of the Verge Fund to Lonely Bloke Software co-founders Hardik Bhate, Phillip Garcia, and Michael Darling.

Los Alamos National Laboratory, or anywhere else in New Mexico.

The competition has always been open to all students at UNM, and has been particularly appropriate for computer science and engineering students because of its emphasis on commercializing new technology. Faloutsos says it is important to empower interested students with information on how to start and run a business so that when their big idea hits they are ready to manage the new technology, not just develop it.

"At some point, many of our most successful students will become vice presidents or managers of firms," Faloutsos says. "The more they know about business, the more empowered they will be to assume those leadership roles."

The U.S. economy has thrived due to the large number of entrepreneurs who have started small businesses. These businesses create high-paying jobs and wealth, and are particularly important in helping to boost economic development in New Mexico.

Anderson School has developed a year-long course called The Lean Startup to support students in the competition as they start their businesses. Through

the course, students will learn to generate a business model, conduct market research, create a customer base, and build a viable business with all real-world pressures and demands of an early stage startup.

For more information on the competition and how to enter, visit the Technology Business Plan Competition website at <http://techbizplan.mgt.unm.edu/>.

**If you would like more information about how to sponsor this event, contact Pamela Weese, Director of Development, at [Pamela.Weese@unmfund.org](mailto:Pamela.Weese@unmfund.org) or at (505) 277-0230.**

### Retiring Faculty

Congratulations to the following School of Engineering faculty who retired during the 2013 academic year: Mechanical Engineering Associate Professor Nader Ebrahimi (29 years), Civil Engineering Professor Jerald L. Rounds (12 years), and Civil Engineering Professor Bruce M. Thomson (35 years). Thank you for your service!

## Smart Grid Expands

The University of New Mexico's Smart Grid just got smarter, thanks to a generous gift from Sacred Power Corporation.

The company donated parts and labor to install a new solar photovoltaic panel system on the roof of the Electrical and Computer Engineering building in April. The system is connected with the solar thermal system on the roof of the Mechanical Engineering building allowing both systems to be operated in unison, greatly reducing power consumption.

This project is an important first step in a plan to turn UNM's main campus into a Smart Campus, which will maximize the efficiency of its buildings and reduce energy use. Not only will this solar photovoltaic array generate power for the ECE building, its connection to a Smart Grid uses technology and intelligent distribution sources to enhance the entire system's ability to use renewable resources like solar power.

The system includes a digital controller that automatically adjusts system parameters such as flow rates, fan operation, and building temperature as demand for power changes throughout the day. That flexibility conserves energy and makes the building an excellent teaching tool. Electrical engineering students will eventually learn to use the system to run real-time tests of computer-generated energy consumption models.

With the demand for energy increasing along with the cost of producing it, electrical engineers have the important job of making energy delivery more efficient across the entire network. The Smart Grid's use in teaching engineering students how to do that in a hands-on way was exciting for Sacred Power President Dave Melton, ('86 BA), and a big reason he wanted to get involved. "Our plan was to give them real world experience, and to support the University," he said. "They got a chance to put into practice what they designed in their plans. You never forget an experience like that."



Sacred Power Odes Armijo Caster, COO (left)  
and CEO David S. Melton (right)

Under the guidance of Sacred Power technicians, UNM engineering students worked on every part of the solar installation, from the engineering design to flipping the switch. The 10 to 15 students on the power and energy academic track in electrical and computer engineering will work with faculty to operate the system for real time demand response and load management.

Melton, a member of Laguna Pueblo, and his wife, Adalaida ('88 BA, '93 MPA), learned about the Smart Grid project through their relationship with UNM Electrical and Computer Engineering Professor Olga Lavrova. Sacred Power is also working with her on a collaborative project with Arizona State that will be entered in the Solar Decathlon, which will be held in Irvine, Calif., in October. A key feature of the home is a photovoltaic shade structure provided by Sacred Power, which will shade the home while producing energy.