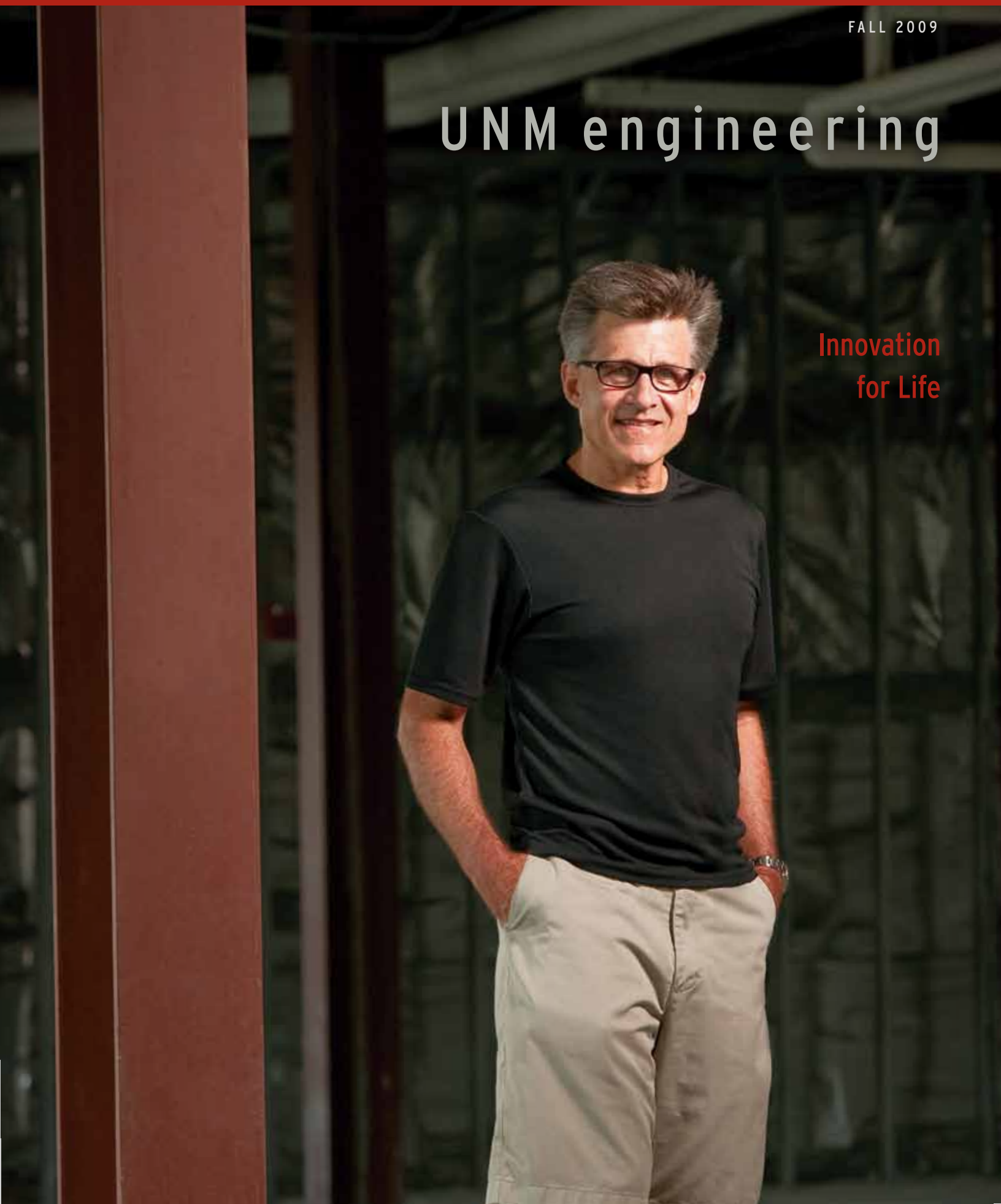
THE UNIVERSITY OF NEW MEXICO SCHOOL OF ENGINEERING

FALL 2009

UNM engineering

Innovation for Life



From the Dean

It is an honor to serve the School of Engineering as interim dean. I started my career here in 1988 as an assistant professor and over the years have been fortunate to have interacted with thousands of enthusiastic students and developed life-long relationships with my graduate students. From laboratory-based experimental mechanics to managing large interagency R&D projects on space-based optics, the interdisciplinary nature of engineering research has been the most invigorating experience of my academic life.

The theme of our fall magazine, "Innovation for Life," captures our aspirations to create solutions for the many challenges facing society. In this issue, you'll read about enhancing life through new medical diagnostics and treatment, harnessing the power of molecules to keep us safe or to monitor our health, and using computer graphics to improve the way we convey visual information.

The theme also embodies our vision to educate students to be able to innovate in response to global challenges. To do this, our graduates must have a firm grasp of technology, be engaged with society, think long-term, and have an international perspective. Featured in this issue is a collaboration with Harvard that creates these opportunities for multi-faceted education and research, with the additional component of outreach.

Students must also be able to work with a diverse, global team. At UNM, research and diversity come together: the university has the distinction of being the only university in the nation designated as 'Carnegie Very High Research' as well as 'Hispanic Serving'. In addition, UNM is a major state university in the middle of a dynamic metropolitan area with about 840,000 people and a diverse high-tech economy. Our students can take advantage of numerous career opportunities in the industry and R&D labs while still pursuing their undergraduate degrees. With over 100 faculty engaged in teaching and research, almost all our full-time graduate students are supported by research projects, which also provide funding and training to a large number of undergraduate students.

This issue features faculty, student, and alumni discoveries and successes in research ranging from developing new complex materials with novel, controllable properties to the intersecting areas of energy, the environment, and transportation.

We're proud of our accomplishments and excited about our future. And this fall, we will embark on a search for a permanent dean of the School of Engineering with a vision that I believe will be inspirational yet pragmatic.

With best regards,

Arup K. Maji

Interim Dean, UNM School of Engineering

Points of Pride

■ Chemical and Nuclear Engineering Professor **Abhaya Datye** and Chemistry Associate Professor **Deborah Evans** were awarded a highly competitive grant from the Department of Education Graduate Assistance in Areas of National Need (GAANN) program. This program, to be implemented through the Nanoscience and Microsystems Graduate Program, will provide need-based fellowships to train students to solve complex problems utilizing multidisciplinary skill sets.

■ Civil Engineering Assistant Professor **Rafi Tarefder** has secured grants in excess of $1M from state and national agencies to study various aspects of pavement design and longevity. The focus of his work is on the development of "perpetual pavement," which would extend the life of a pavement to 50 years and result in enormous cost savings.

■ Distinguished Professor of Computer Science **Deepak Kapur** will collaborate with four institutions in a $1.2 million NSF grant to develop a computer program to find vulnerabilities in cryptographic protocols that protect flow of information on the internet—from financial transactions to e-voting as some examples. Kapur will work with Clarkson University, SUNY Albany, University of Illinois at Urbana-Champaign, and the Naval Research Laboratory.

■ As a successful participant of Electrical and Computer Engineering's Expand Your Engineering Skills summer internship program, **Abhik K. Das** (from IIT Kanpur) assisted Professor **Majeed Hayat** and his graduate student **Peng Sun** in 2007 on a research project that has led to a paper scheduled for publication in the September issue of IEEE Transactions on Communications. The paper is titled "Bit Error Rates for Ultrafast APD Based Optical Receivers: Exact and Large-Deviation-Based Asymptotic Approaches."

■ In Spring 2009, the **Mechanical Engineering Department** graduated a record number of 37 undergraduate students, of which 13 were minority and 7 women. In addition, there were 13 MS and 4 PhD graduate students, of which 7 were minority and 5 were women.

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Managing Editor
Tamara Williams

Writing
Megan Fleming Writing & Creative Services and Tamara Williams, UNM

Design
Brian Hurshman, Sparkplug Studio

Photography
Eric Swanson (front and back cover, inside front cover, 3, 5, 7, 8, 9, 16)
Chris Corrie (10, 11, 13, 17)

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School of Engineering, Centennial Engineering Center, Room 3071, MSC01 1140, 1 University of New Mexico, Albuquerque, NM 87131-0001. 505-277-5521 **www.soe.unm.edu**

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I'm interested in building biotic-abiotic materials, where we incorporate biological components into inorganic materials.

C. JEFFREY BRINKER

New Lab for Nano-Bio Breakthroughs

Groundbreaking Research and New Facility Boost UNM Nano-Bio Research

In 1990, C. Jeffrey Brinker wrote a seminal book on sol-gel processing, a means of making inorganic materials molecule-by-molecule in a beaker, much like organic polymers. Today, sol-gel processing methods are used in everything from makeup to tires, and Brinker is internationally known for his work in advanced materials.

Now a Distinguished and Regent's Professor of Chemical and Nuclear Engineering, a member of the National Academy of Engineering, and one of only two Fellows at Sandia National Laboratory, Jeff Brinker continues to explore new frontiers in nanoscience and bioengineering research. Soon he and other UNM researchers will take another leap forward by establishing a new nano-bio incubation space and lab on UNM's campus, and new worlds of technological innovations could result.

Biologically Inspired

Currently Brinker is applying his expertise in nanostructured materials to research projects inspired by biology in several labs on and off campus. "I'm interested in building biotic-abiotic materials, where we incorporate biological components into inorganic materials," says Brinker. The most dramatic demonstration of that is how he incorporates a living cell into a non-living environment in order to preserve the cell's viability in extreme conditions—like hot, arid locations—for months or even years.

Brinker began this research six years ago as a means to create a self-contained, self-sustaining cell-based sensor that could operate covertly riding on the back of an insect. "We discovered that living cells could direct the formation of unique nanostructures that prevented drying and stress development," explains Brinker. Now Brinker and a team of researchers are turning this around to understand how the cell-built nanostructure can influence cellular behavior.

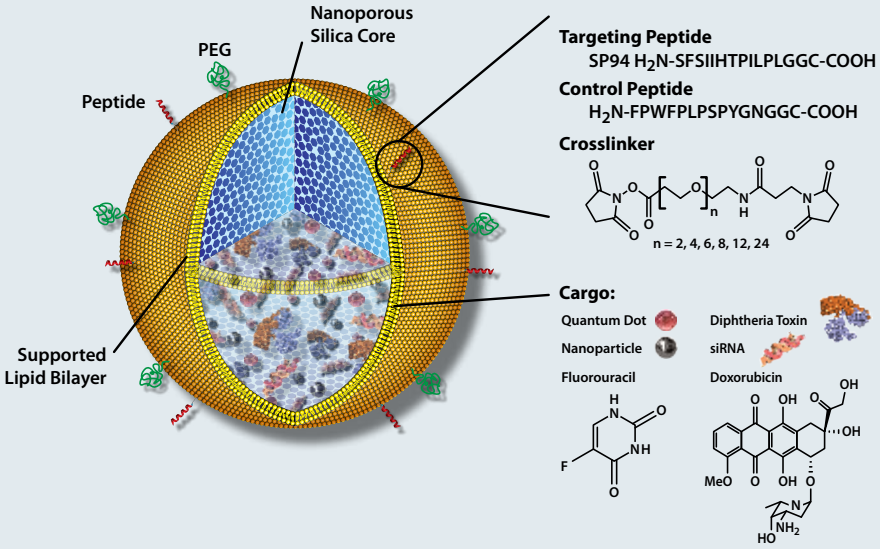
Brinker and his team were the first to chemically and physically isolate a living cell in an inorganic microenvironment. To achieve that goal, they developed a method to incorporate individual cells along with lipids (the fatty molecules making up cell membranes) within nanostructured glass beads made by a variation of sol-gel processing. The microenvironment is naturally hydrophilic, which helps to keep the cell alive. "If you make a structure with small, extremely uniform pores, water will actually condense into those pores even at very low humidity," explains Brinker. Now the team is using the materials and technology to find new and better ways to study cells.

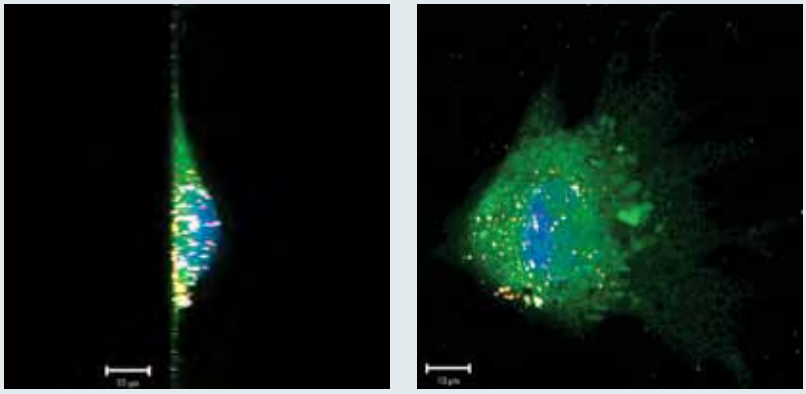
Innovation in Isolation

In the process of developing these microenvironments, Brinker and his team discovered that isolating cells in a sol-gel matrix changes the way cells interact with their environment. Cells are natural sensors, sensing hormone-like molecules emitted by themselves and other cells, and changing their genetic programming to adapt to their environment. Brinker's matrix gives researchers a way to keep cells alive in an isolated environment and to see what happens when they can't interact with other cells. "No one had looked at what happens when you take one of these cells, put it in a small enough environment, and see if these hormone-like molecules accumulate," explains Brinker. "We've proven that the cells can turn on this genetic programming even when they're isolated." That finding has important medical implications, especially in

Professor of Chemical and Nuclear Engineering Jeff Brinker (center) in the new nano-bio incubation space and lab with (left to right) Eric Carnes, lecturer and researcher in the Chemical and Nuclear Engineering Department; Graham Timmins, associate professor in the College of Pharmacy; David Peabody, virologist and professor of molecular genetics and microbiology; and Carlee Ashley, ChNE research assistant.

Protocells are cell-like nanoparticles composed of a porous silica core and a fluid lipid bilayer shell. Targeting peptides incorporated in the bilayer enable multivalent binding to and internalization within cancer cells. The high surface area silica core serves as a reservoir for drugs, therapeutics, and imaging agents that through various 'escape' strategies are delivered to the cytoplasm or organelles.





Confocal fluorescence microscopy image showing targeted protocells (bright white spots) taken up by a cancer hepatocarcinoma cell. Left image is a cross-sectional reconstruction and right image is a plan view. Green = cytosol, blue = nucleus, red = Texas Red-labeled lipid, white = Alexa Fluor 647-labeled silica. Many silica protocells are observed within the cell cytosol and the nucleus.

the study of cancer cells, which can be isolated from the main tumor and remain dormant for a long time, only to transform into a metastatic cancer later on.

Brinker and his team are using these microenvironments to study disease dormancy and drug resistance in humans and to develop more effective drug targeting strategies. Currently, many cancer drugs work in the two-dimensional environment of a Petri dish, but when the drugs are injected into a three-dimensional arena like the human body, they don't work. Brinker's microenvironments give researchers a way to study a drug's effect on an isolated in vitro cell, in essence a way to study cell dormancy in the body. Brinker will be publishing his interesting findings later this year.

A Promising Prototype

In another research project, Brinker and a team of engineering graduate students and School of Medicine researchers are developing a drug delivery agent using a new material called a "protocell." This cell replica has a porous silica core that can be loaded with a therapeutic drug and surrounded by a lipid bilayer. On the lipid bilayer, Brinker 'floats' various peptides, short chains of amino acids that are the building blocks of proteins. The fluid lipid allows the peptides to move around and gather at the point of interaction with another cell, which creates a binding effect through multivalency, the simultaneous interaction between two or more entities that governs biological interactions between them. Multivalency can effect selective targeting to a diseased cell, but it can also induce an immune response that clears beneficial drugs out of the body. Brinker's drug delivery protocell might overcome that problem. "Because the peptides are in a fluid surface and can move around, just a few are required to effect targeted delivery. The remainder of the surface contains lipids and other components that help to make it more immune resistant."

Brinker also has informal research collaborations with a variety of engineers, scientists, and graduate students from other departments and organizations. "All of this research has emerged out of thin air. We have a fragile network of researchers right now," says Brinker. "When we have a space where we can bring people together in a physical setting, we can create a lot more in the way of intellectual content and technology."

A New Space to Collaborate

Brinker's plans for a new nano-bio incubation space and lab in the Centennial Engineering Center will help researchers realize the goals of advancing technological innovations and improving New Mexico's economic development. In March, UNM received $2 million from the state legislature to build and equip the new facility.

The incubation space is anticipated to attract funding from investors to help researchers solve the conundrum of how to pursue new research directions when funding agents often require substantial amounts of preliminary data. This could also help projects move through the challenging process of technology transfer, where research is beyond federal funding but not quite ready for private sector investment. Brinker is working on augmenting funds from the state with grant money and private contributions. He also hopes to enhance the lab by moving facilities currently at Sandia National Laboratories to the new space.

Brinker says that technologic developments from the incubation space could increase the number of technological innovations and the number of nano-bio startups. "If we can bring all these capabilities together, it would be very impressive. Then we can imagine companies springing up around these ideas and that would be a great thing for New Mexico." ✦

Transforming Graphics for All

Pradeep Sen's research on computer graphics, visualization, and gaming

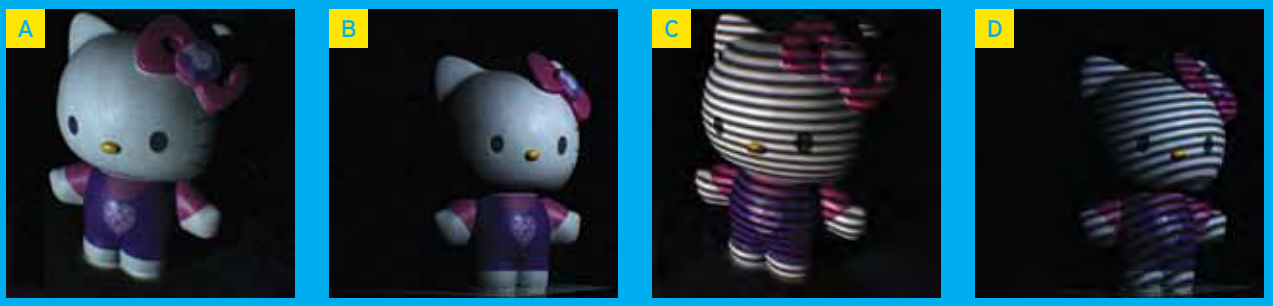
Soon the spectacular special effects of blockbuster movies won't be just the province of George Lucas or the wizards at Pixar. *You'll* be able to create them, too. And the exquisite lighting, stunning sharpness, and perfect composition of an Ansel Adams photograph will be at your fingertips.

These concepts are part of Pradeep Sen's vision for the future of filmmaking, photography, and more. Sen, assistant professor of electrical and computer engineering, is working with a team of students to advance computational photography, real-time rendering, and the visualization of complex data to develop more efficient, effective ways to capture and experience our vision of the world.

Professional Photos for Everyone

Sen and his students are harnessing the power of online digital photography databases to help ordinary people take better pictures. Imagine a photograph of a child against a drab background and a separate picture of a beautiful landscape. What if you could blend the two into one eye-catching new photo? Or suppose you want to take a photograph of a famous landmark but crowds ruin the scene. A tool that could erase the crowd and fill in the holes accurately would be handy.

Current technologies help make those changes, but they're not easy to use and the results aren't seamless. That's where Sen's research comes in. His team is developing algorithms that leverage online photo databases to correct lighting and find information to fill the empty spaces in photos where objects have been erased. Professionals use similar tools; Sen plans to make them available to everyone. "What could you do if you had a magic camera? We want to empower everyone with automated tools to help them produce professional results," he says. The final software would have applications beyond photography, including enhancing medical imaging, complex data analysis, and architectural rendering. →



Sen works in computational photography, an emerging field within computer graphics where digital images, new camera technologies, and massive computation are integrated to produce new kinds of images. He notes that the computational photography approach is fundamentally different from traditional image processing tools that modify photographs using pixel information. "Instead of looking only at the information contained within the pixels of a single image and modifying them, we look at the system as a whole," he explains. "We take into account the camera, the lighting, online image databases, and more so we can leverage all of that data to generate the best picture possible."

Shedding New Light on Relighting

In other research, Sen and his team studied the physics of light to address the challenge of image-based relighting. Changing the lighting of a scene, or relighting, is needed when images and footage are captured under different lighting conditions than the final desired product. Relighting involves acquiring the reflectance function, the function that measures the way the light strikes an object and how it is transformed by the scene into outgoing light. The entire process is a time consuming, data intensive effort.

Sen addressed the relighting challenge with his research on a new kind of imaging technique called dual photography. The process harnesses Helmoltz Reciprocity, the physical law that states light pathways are the same regardless of the direction the light is flowing, to accelerate acquiring the reflectance function. Sen demonstrated that the flow of light emitted from a projector is symmetric in both directions and could be reversed, effectively transforming the projector into a virtual camera. " Dual photography allows us to use a projector to both emit and capture light," says Sen. "It's a much more efficient way to capture the data than a system based on multiple projectors and one camera."

In his latest research, Sen is accelerating the acquisition of the reflectance function even further. He is applying ideas from compressed sensing, which uses new algorithms to compress the information in a signal so that it can be captured more efficiently. Sen's approach requires only a small set of simple black-and-white patterns to do the same task that initially required complex illumination patterns and sophisticated processing. The simplicity of this approach makes it more practical for industrial applications, including use in a real movie studio. "We've taken ideas from physics and applied mathematics to create a novel framework that accelerates light transport acquisition. It could be a new way to solve many graphics problems," explains Sen.

Visualizing New Opportunities

Sen is also helping the next generation of engineers develop diverse graphics and visualization skills. Since joining UNM in 2006, Sen has expanded the graphics curriculum and helped start the Interdisciplinary Film and Digital Media Program, a joint undergraduate program offered by the School of Engineering and the College of Fine Arts. Now in its second year, the IFDM offers core classes and electives that give students a breadth of technical and creative skills, which they can apply to innovative digital technologies in the real world.

← Sen's work significantly accelerates the process of dual photography, allowing him to transform images such as the one in (a) into dual images taken from the point-of-view of the projector (b). Since the light transport between the camera and projector has been captured, these images can also be relit in both the primal (c) and dual domain (d). Image (256 x 256) was captured using 600 patterns.

→ Sen and graduate student Soheil Darabi examine the output of an experimental rendering system which synthesizes images more quickly than conventional techniques.

"Engineering students that come out of this program won't just be good at graphics or game development," says Sen. "I want them to be good engineers who can think in bigger terms so they can work at Intel and Microsoft just as easily as for game development companies or special-effects houses."

Soheil Darabi, a doctoral student in computer graphics and computer engineering, is just one of the students taking advantage of the new opportunities at UNM. He works closely with Sen on compressing sensing research. "With this application based research, I'm learning the importance of being very precise and being conscious of even the smallest details," he says. "In research, and this industry, you come across new kinds of problems all the time. I'm learning the problem solving tools that I'll need for those challenges."

Sen, along with Computer Science Assistant Professor Joe Kniss, has also started the UNM Advanced Graphics Lab within the School of Engineering. The AGL is a laboratory dedicated to the technical side of computer graphics, digital media, and visualization. It offers courses and research projects for students interested in working with computer graphics, especially the different facets of game development. "This unique set of opportunities will give our students real-world experience as well as some exposure which they can use in their resume when looking for a job after graduation," says Sen.

One AGL class is an introductory computer graphics class requiring small groups of students to develop a video game for the Xbox gaming console. The team designs the game story, programs it, and works with artists to develop the scenery and music or develops them on their own. Unlike many final projects that are never seen after the end of the semester, Sen plans to distribute the games through Xbox LIVE so gamers around the world can play them.

This past spring, eight teams produced Xbox games and a handful were selected to go through the licensing process. Working with STC.UNM, the corporation that patents and markets intellectual property at the university, Sen and the students are navigating the legal issues so the games can be launched to Xbox subscribers. Several of Sen's students received awards for their copyrights during the STC.UNM Creative Awards event in April.

Sen says the game development project is good exposure for students and the university. "When we put these games on the Xbox console, we're connecting with a whole new audience that might not learn about engineering and what we're doing at UNM. If kids play the games and see that UNM students created them, they might be inspired to consider engineering and game development as a career."

Working on Xbox games is just the first step. Sen is planning to expand the curriculum to other technologies, including the iPhone. As he continues his cutting edge research and the educational opportunities expand for students interested in computer graphics and visualization, UNM engineers will soon bring better, bolder visions of our world to big and small screens near you. ✦

“IF WE CAN BUILD SUFFICIENTLY LARGE-SCALE NETWORKS THAT HAVE INTERESTING BEHAVIORS, THEY CAN HAVE SOME FUNCTIONS THAT ARE AKIN TO LIFE.”

DARKO STEFANOVIC

MIGHTY MOLECULAR MACHINES

UNM researchers harness the power of molecules

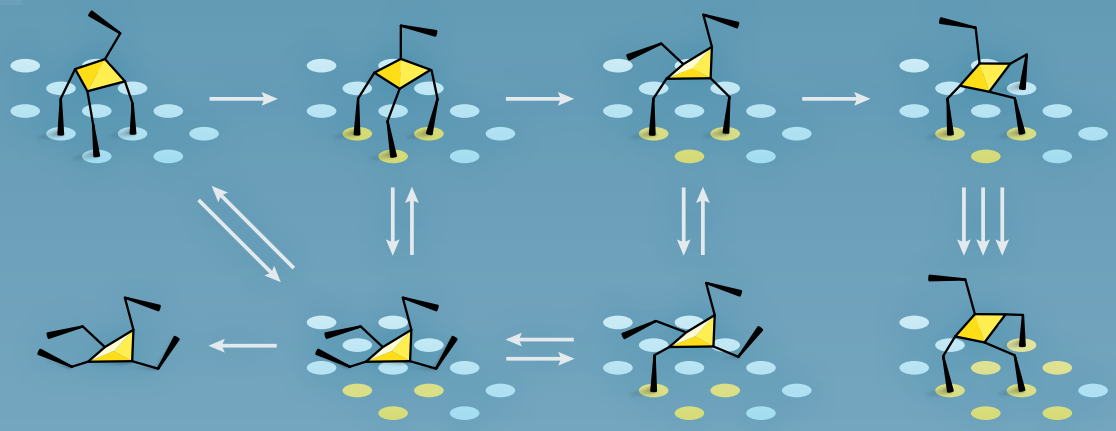
Molecules are the building blocks of our world. But in this age of multitasking, UNM researchers are using computer science to investigate how molecules can do much more: how they can exert their brains and their brawn.

Thinking Molecules

For several years, Darko Stefanovic, associate professor of computer science, has used computer science and modeling techniques to investigate minute decision-making machines using molecular logic gates. Computers run on logic gates, switches that use an input, like a keystroke on a keyboard, to produce a single output. Stefanovic worked with a team of researchers from Columbia University to emulate the silicon-based decision-making devices that power current computers. They used simple logic gates made of DNA molecules that react to different inputs. The ultimate result could be a nanoscale, biocompatible computer that could live in an organism and use its DNA logic to make rudimentary decisions based on what it senses in the environment. For instance, this smart biocomputer could monitor a diabetic’s glucose levels and release insulin when needed.

In 2005, the team successfully demonstrated a DNA-based computing module that could play a winning game of tic-tac-toe. Now the team, along with Steven Graves, associate professor of chemical and nuclear engineering, is working on linking DNA-based logic gates to create cascades. When a specific output drives an input for another logic gate, the cascading reactions can perform complex behaviors.

“The interesting thing about the cascade is that it serves as a model for a naturally occurring, large enzymatic network,” explains Stefanovic. “If we can build sufficiently large-scale networks that have interesting behaviors, they can have some functions that are akin to life.”



In recent work, Stefanovic and Olah (pictured below) have been modeling molecular spiders with defined shapes walking over patterned surfaces made of DNA origami. Such walkers may exhibit directed and superdiffusive motion.

Walking Molecules

Besides making molecules compute, Stefanovic is working with a team to make them walk and carry things. The multidisciplinary team includes computer scientists, chemists, and physicists from UNM, Columbia University, Arizona State University, and Boston University.

The team has attached four strands of DNA enzymes as "legs" on a single molecule to create a molecular walker or "spider." When the spider is placed on a surface coated with a substrate that is complementary to the DNA legs, it moves. At the nanoscale level, the molecular walker is affected by "Brownian motion," the randomized movement that happens as water molecules in solution bombard it from all sides. The research team is studying the dynamics of this diffusive motion

and the interaction of the legs with the substrate in order to control the molecular walker and get it to accomplish a task. Ultimately, these spiders could be used as drug delivery devices or nanoscale sensors.

Stefanovic and Mark Olah, a UNM computer science doctoral student, are charged with developing the computer models to simulate different types of molecular walkers.

"As computer scientists, we can use our models to explore different parameters easily. We can do many simulations, find sets of parameters that move faster or more efficiently, and then share that with the chemists so they can design a spider based on them," says Olah. He is in the process of finalizing some spider models, which experimentalists on the team will use to build the molecular walkers in their labs.

Stephanie Forrest, professor and chair of computer science, sees great potential for the interdisciplinary team's research. "By sharing ideas and techniques, these scientists and engineers are creating a versatile technology that could have wide-ranging applications. In the future, molecular computation could help keep us safe, monitor our health, and even help save the planet." ✦

A Productive Partnership

A collaboration between Harvard University and UNM creates many new opportunities

From elementary school students in Albuquerque to leading researchers in Boston, the Partnership for Research and Education in Biomaterials (PREM) is improving education and inspiring high impact research in biomaterials science and engineering.

Jamie Reed spent a month at Harvard collaborating on microgel beads.

Sergio Mendez's biosensor detects specific viruses.

Funded by NSF, the PREM is designed to help under-represented groups become more aware of and involved in materials science and to stimulate general interest in science and technology. The University of New Mexico, Albuquerque Public Schools, and Harvard University are partners in the program.

The five-year, $2.5 million PREM grant started in 2006 and is a cornerstone of UNM's Center for Biomedical Engineering (CBME), which fosters interdisciplinary research, including biomaterials science and engineering. Gabriel López, director of CBME and professor of chemical and nuclear engineering, led the way to establishing the PREM. "I thought it was a natural fit. Harvard is one of the premier organizations doing biomaterials work. Even though we don't have a traditional materials science program, UNM is recognized around the country as being strong in both materials science and biological research," says López. The UNM team includes co-principal investigators Heather Canavan, Elizabeth Hedberg-Dirk, and Dimiter Petsev, all assistant professors of chemical and nuclear engineering, as well as Julia Fulghum, vice president for research.

Comprehensive Education and Research

One of the goals of the PREM grant is an active, multi-faceted biomaterials education and research program that encourages students to strive for the highest level in their careers. Students from UNM and Harvard participate in visiting scholar exchanges, collaborations with networks of research professionals, professional development resources, and community outreach. PREM research has resulted in the development of a number of new materials and materials systems with applications in the diagnosis and treatment of infectious disease, cardiovascular disease, and cancer.

The PREM helped Sergio Mendez, (Ph.D., CHNE, '04) a post-doctoral researcher in the Department of Chemical and Nuclear Engineering, achieve his goal of becoming a professor. As part of the PREM program to groom minority post-doctoral candidates into the professoriate, UNM offered Mendez a full-time position that split his time between teaching and conducting research.

While he gained experience teaching undergraduate courses, Mendez worked with a team from Harvard to engineer a biosensor that can detect different viruses. The sensor, similar to a pregnancy test, uses a small paper test strip that is coated to detect specific viruses. "This device is low-cost, fast, and could be handed out in a developing country for simple screenings," he says. Mendez also received professional interview skills training at Harvard. His comprehensive PREM experience helped him achieve his goal: this fall he will start teaching at California State University, Long Beach.

Like Mendez, Jamie Reed, who is working on her doctorate in chemical engineering, is advancing her education and research with help from the PREM. Her research focuses on developing microfluidic devices to make micro-sized gel beads that can be used as mini platforms for growing individual cells. Reed worked with a post-doctoral fellow and David Weitz, Mallinckrodt Professor of Physics and of Applied Physics at Harvard. She spent a month in Weitz's lab learning to create the tiny devices that create a stream of solid gel beads about 25 microns in diameter.

When Reed adjusts the temperature, the beads swell, causing the cells to pop off the surface intact. "Many proteins extend out of the cell and into the extracellular matrix, where the cell makes contact with other cells and the tissue culture substrate. These proteins tell the cell whether to proliferate or go into cell death, so keeping these proteins intact is important. These beads allow us to do that," explains Reed. Current methods of pulling the cell off the matrix destroy these critical proteins. Reed is optimizing her device at UNM before researchers at UNM's Cancer Research Facility use the microgels to advance their study of cancer cells.

Kevin Cushing, a graduate student working on his doctorate in Biomedical Sciences at the UNM School of Medicine, is also participating in PREM-supported research. He's working with engineers to create a prostate cancer diagnostic tool that uses microparticles. The particles' intrinsic properties allow them to bind with specific biological

Kevin Cushing explains how the microparticles he is developing will improve prostate cancer diagnosis.

UNM is recognized around the country as being strong in both materials science and biological research.

GABRIEL LÓPEZ
Director of the Center for Biomedical Engineering and professor of chemical and nuclear engineering

elements in samples of blood or urine. Once they bind with the chosen biological particle, they can be separated from other unwanted biological elements and analyzed. "This ability should give our system greater measurement sensitivity and accuracy than other bioassay formats," says Cushing.

Cushing's particles are demonstrating good results. Now he's refining the process to make it more sensitive to lower PSA concentrations in the biological sample. "The PREM has given me the opportunity to work with great engineers who are focused on performing research to benefit society," he says.

Effective Outreach

UNM students participating in PREM research help with outreach programs that introduce elementary, middle, and high schools students to bioengineering and materials science. They give presentations in English and Spanish, coordinate an in-class project, and discuss pathways to careers in materials science. Each age group works with a different kit presented to the class by a university student or faculty member. High school students learn about medical implants and middle school students study polymers. Elementary school students study prosthetics by creating a finger with materials from a kit containing paperclips, straws, rubber bands, and more.

Reed presented the kits in the schools, including her alma mater, Albuquerque High School, and says the experience is valuable for her and the students. "I like going back and telling these kids—especially the girls—about engineering and encouraging them to understand that there are many opportunities for them in bioengineering and related fields. PREM outreach gave me valuable leadership experience, and it was gratifying to hear the enthusiastic response from the students as well as the teachers."

UNM post-doctoral researcher Sergio Mendez helps fifth-graders become bioengineers for a day and develop a "finger" from everyday materials.

Reed says she's gained much more than research experience from the PREM. "I've been given so many opportunities that made me competitive." Reed is parlaying that competitive edge into other important achievements. She recently attended the Lindau Nobel Laureate Meetings, a globally recognized forum that brings together Nobel Laureates with young researchers for a week-long information exchange.

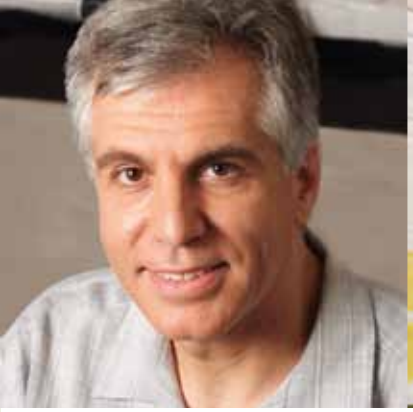
Along with K-12 classroom activities, PREM outreach includes teacher workshops, student mentoring and research internship opportunities, and special events. Harvard professors recently came to UNM and gave a presentation to approximately 200 grade school students on the material properties of chocolate, with live experiments, demonstrations, and chocolate tastings.

Growing Collaborations

Collaboration between UNM and Harvard faculty and students is a mainstay of the PREM. Kathryn Hollar, director of educational programs for the School of Engineering and Applied Sciences at Harvard, works with López to coordinate PREM events and partnerships. "Sharing ideas across the two institutions has been great," comments Hollar. "When people with different expertise get together, intersections are created that develop into new products and research tools."

López is encouraged by the advances created by the PREM and notes that the collaborations now extend beyond Harvard. "We've formed new alliances in bioengineering research and education across the state, including with New Mexico Tech, New Mexico Highlands University, San Juan College, and New Mexico State University." These collaborations are furthering the PREM goals of building a pipeline of students interested in biomaterials science and training New Mexicans for critically needed jobs in biomedical engineering.

The future of this multi-faceted biomaterials education and research program looks bright: a recent NSF programmatic review indicates that the PREM is transforming biomedical engineering research and education in New Mexico. ✦



Dimiter Petsev

Rafi Tarefder

Yasamin Mostofi

Pradeep Sen

Bright Careers

SOE researchers receive NSF CAREER Awards

Every year the National Science Foundation presents prestigious CAREER awards to junior faculty members who demonstrate their leadership through their outstanding teaching and research. Five SOE faculty members received NSF CAREER awards this year and are on the fast track to success.

Dimiter Petsev

Assistant Professor, Chemical and Nuclear Engineering, Center for Biomedical Engineering

Dimiter Petsev received a $400,000, five-year CAREER award for his research on transport control in fluidic micro and nanochannels. "A big part of the research is dedicated to studying the effects of space confinement and proximity of semiconductor materials on the electrostatics in electrolyte solutions and charged biomolecules," he says.

Rafi Tarefder

Assistant Professor, Civil Engineering

Rafi Tarefder has received a $400,000 five year CAREER award to study moisture-induced damage to our nation's asphalt paved roads. His novel approach uses neural networks and finite element modeling to understand and quantify moisture interactions with asphalt-aggregate bonds at the nanoscale, and relates those interactions to the moisture-induced damage at the macroscale. "This could lead to the manipulation of the molecules of asphalt, additives, and other modifiers to create moisture resistant pavements," says Tarefder.

Yasamin Mostofi

Assistant Professor, Electrical and Computer Engineering

Yasamin Mostofi researches ways to make mobile cooperative networks more efficient and robust. She received a $400,000, five-year CAREER award to develop the foundations of sensing and navigation in mobile cooperative networks from a compressive sampling perspective. "The proposed research will make a significant contribution to the understanding and optimization of mobile cooperative networks in information-rich environments," says Mostofi.

Pradeep Sen

Assistant Professor, Electrical and Computer Engineering

Pradeep Sen is developing more effective ways to capture and experience visions of our world. Sen received a $495,000, five-year CAREER Award to develop the mathematical foundations to solve problems in rendering and light transport acquisition for computer graphics. "With this research, we've taken ideas from physics and applied mathematics to create a novel framework that accelerates light transport acquisition. It could be a new way to solve many problems in graphics," explains Sen.

Marwan Al-Haik

Assistant Professor, Mechanical Engineering

Marwan Al-Haik received a $430,000, five-year CAREER award for "Next Generation Multifunctional Composites for Radiations and Impact Hazards Mitigation."

UNM Civil Engineers Help Construct the Long Wavelength Array

The Long Wavelength Array (LWA) is designed to probe the depths of space at the lowest frequencies at which the atmosphere is transparent—between 10 MHz and 88 MHz. The LWA will have approximately 50 stations with 256 radio antennas each that receive electromagnetic signals from astronomical objects. The radio antennas must be connected to the image-synthesizing computers using coaxial cables maintained at constant temperatures.

Three UNM students, **Sudipta Ghorai, AJ Gallardo** and **Sunil Danthuluri**, under the direction of construction management graduate student **Adam Martinez,** spent their summer on the Plain of San Augustin in central New Mexico installing the underground conduits and cables necessary for the first station of the LWA. Civil Engineering Professor **Walter Gerstle** is their faculty advisor. See http://lwa.unm.edu for more on the LWA project.

Mechanical Engineering Department Goes International

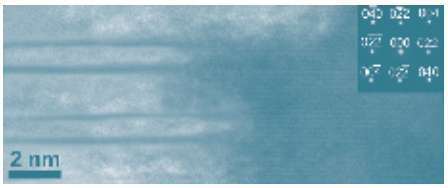
The ME Department continues to expand its international collaborations. Professor **Ron Lumia** returned from a sabbatical leave at the Indian Institute of Science (IISC), where he visited as a Fulbright scholar. His work revolved around the development of new micro-electro-mechanical systems (MEMS) packaging techniques and applications to microgrippers.

National University of Colombia Professor Hugo Zea and two of his students, Yuli Rios Carvajal and Paula Celis Salazar, just finished a three month project working in ME Professor **Claudia Luhrs's** laboratory. They prepared, characterized, and tested catalyst materials used to treat contaminants during waste water treatment. The catalysts were based in iron titania and iron carbon composites and prepared by sol gel and plasma methods.

This spring, SOE Associate Dean **Charles Fleddermann** and ME Chair **Juan Heinrich** visited the Polytechnic of Namibia to start an exchange program. In October, the polytechnic's ME Chair Samuel John will visit the UNM ME Department.

Taking Carbon from Nanotubes to Foams

Assistant Professor of Mechanical Engineering **Zayd C. Leseman's** research group has been fabricating carbon nanostructures using bottom-up approaches with significant success. Utilizing catalytic nanoparticles, the group has grown carbon nanotubes (CNTs) and nanofibers into many different shapes with different functionalities. In a recent development, the group fabricated self-aligned carbon nanotubes with spacings of only a few nanometers *(see figure below)*. This innovation contributes towards the goal of higher density integrated circuits. The group has also grown carbon nanofibers with differing diameters and surface roughness for reinforcement of composite materials. Finally, they have grown varying densities of entangled fibers to make fibrous carbon foams. This newly invented material shows interesting thermal and mechanical properties. The material may be used in applications where blast resistance is necessary and in space vehicles due to its high strength-to-weight ratio.



New Civil Engineering Faculty

The Department of Civil Engineering is pleased to announce the hiring of **Mark Stone** (PhD, Washington State University, 2005) as Assistant Professor. Stone specializes in sustainability issues in water resources engineering, specifically related to human impacts on aquatic ecosystems. Having served as a research professor at the Desert Research Institute, Stone is experienced with arid region hydrology, ecohydrology and ecohydraulics, stream and wetland restoration, and climate change impacts on water resources.

Student Awards

AIChE Poster Winners

Three chemical engineering seniors were winners of the Student Poster Competition in their categories at the 2008 Annual Meeting of the American Institute of Chemical Engineers. **Angelica Sanchez** (pictured at right) won first place, **Cynthia Douthit** won second place, and **Anne Hellebust** won third place.

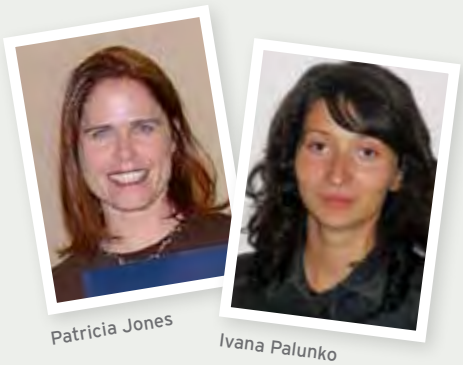
Angelica Sanchez

Rebecca Martinez

Environmental Design Winners

Two teams of chemical engineering seniors (pictured below) were winners in their categories at the 2009 WERC Environmental Design Contest. The first place for Sulfate Removal went to **Norma Wells, Shelly Karlin, Danielle Rivera, and Toi Carden.** Second prize for Brackish Water Pretreatment went to **Cynthia Douthit, Jonathan Paiz, Anne Hellebust,** and **Marta Cooperstein.**

Environmental Design Winners



Patricia Jones

Ivana Palunko

Water Talks

Civil engineering graduate student **Patricia Jones** (pictured above) took first place in a student competition for Best Oral Presentation at the 2009 Rocky Mountain Water Environment Federation/ American Water Works Association Annual Student Conference. Her talk was based on research for a Masters Thesis with CE Assistant Professor Andrew Schuler.

Double Wins

Rebecca Martinez, (pictured above right) MS Student in construction engineering and management, has been awarded the Transportation Research Board Minority Student Fellowship. Rebecca also tied for second place for the 2009 Construction Industry Institute (CII) Academic Poster Session Award.

IEEE Session Chair

Computer science doctoral student **Hairong Lei** recently served as software session chair for the 2009 International Conference on New Trends in Information and Service Science. He also presented "Software's Eight Essentials." The proceedings will be published by IEEE's Computer Science series. He is working with Joe Kniss, UNM assistant professor of computer science.

Computing Innovation

Computer science PhD student **Sushmita Roy** received a Computing Innovation Fellowship for her proposal to develop "A machine learning framework for learning networks across multiple species". The fellowship was awarded by The Computing Community Consortium and the Computing Research Association with funding from the NSF.

Croatian National Award

Electrical and computer engineering doctoral student **Ivana Palunko** (pictured at left) is among three winners of the 2009 National Science Award granted by Croatia's National Endowment for Science, Higher Education and Technological Development. Palunko earned the award in the field of technical and biotechnical sciences for the journal paper based on her master's thesis titled "Small helicopter control design based on model reduction and decoupling."

IEEE Graduate Scholarship Award

Sarita Prasad, (pictured below left) an ECE graduate student working with Professor Edl Schamiloglu, has been selected as one of four recipients of the 2009 Graduate Scholarship Award of the IEEE Nuclear and Plasma Sciences Society. The award comes with a prize of $750 and a one-year membership in the IEEE NPSS.

Sarita Prasad

Elena Berliba

Outstanding Student Award

In February, mechanical engineering senior **Elena Berliba** (pictured above right) received the 2009 New Mexico Society of Professional Engineers Outstanding Senior Engineering Student of the Year award. Beliba is now pursuing her master's degree with research in synthesizing and characterizing nanoparticles.

Copyrights Awarded

Copyrights Awarded

Five of ECE Professor **Pradeep Sen's** students (pictured above) were awarded copyrights for video games they developed in Sen's course, ECE/CS 412 Introduction to Computer Graphics. Professor Sen (second from right) joins new copyright holders (left to right) ECE bachelor's student **John Harger**, ECE doctoral student **Craig Vineyard**, ECE master's student **Jeremy Wright** and ECE nondegree graduate student **Justin Kellogg**. Not pictured is computer science master's student **Guanyu Wang**.

Computer Science Chair Stephanie Forrest and CS graduate student George Bezerra discuss poster layout for a National Science Foundation Briefing and Research Expo presented to the Senate Committee on Commerce, Science, and Transportation on Capitol Hill in July.

Supporters help SOE make discoveries, realize dreams

Alumni, donors and friends play a vital role in the innovative research and student success at the School of Engineering. SOE supporters contribute to the school for different reasons and in different ways. To learn more about SOE's supporters and friends, please go to www.soe.unm.edu. For ways to help School of Engineering faculty and students, please contact SOE's development officers: Pam Hurd-Knief at 505-277-0230; frognm@unm.edu or Sharen Hart at 505-277-5541; sharhart@unm.edu.

Bryant W. Lemon, Sr., Albuquerque, NM
Founder and CEO, BRYCON Construction

Bryant W. Lemon, Sr. believes strongly that higher education is the key to individual personal growth and to the long-term advancement of the construction industry. Recently his extended family and BRYCON Corporation created the Bryant W. Lemon Sr. Fund for the benefit of the Civil Engineering Construction Programs to encourage bright young minds to explore the exciting world of construction. The endowment is also a way to give back to the community that has supported the success and growth of BRYCON Construction.

Dr. Charles 'Chuck' Farrar, Los Alamos, NM
'83 MS CE, '88 PhD Engineering
Director, Engineering Institute,
Los Alamos National Laboratory

In 2008, Chuck Farrar, a technical authority in health monitoring and structural dynamics, received the prestigious designation of Fellow in the American Society of Mechanical Engineers International. In addition to the LANL Engineering Institute, he has managed the Los Alamos Dynamics Summer School for the past 10 years. Farrar says, "I received outstanding instruction and mentoring from the faculty at UNM that continued long after I graduated. I now try to replicate that support with a next generation of engineering students and early career staff through my work at LANL's Engineering Institute."

Dr. Scott Kim, Fullerton, CA
'84 MS NE; '88 PhD Engineering
Founder, CEO Lattice Electro Optics

Sung-Ho Kim came from Korea to UNM on a graduate fellowship and says, "I cannot thank UNM enough for the education I received and the career opportunities that I have had." During his schooling at UNM, he worked with an optics firm, a relationship that continued after graduation. That connection led him to founding his own company, Lattice Electro Optics, which produces specialized, high-quality optics for the telecommunications, laser and semiconductor industries worldwide.

Katherine Love, Albuquerque, NM
'09 BA English Candidate
Special Events Coordinator,
UNM Engineering Student Services

Katherine Love's own decade-plus long quest for an English degree makes her sensitive to the challenges college students face. An ongoing contributor to SOE scholarship and mentoring programs, she says, "I do it for the kids, to help them succeed, to watch them grow. It is a way to say thank you to the teachers I have had and to the School of Engineering faculty who are so dedicated to our students."

New Mexico Technology Council
Albuquerque, NM

Lisa Adkins, current NMTC president and a UNM graduate, says, "NMTC sees a vital need for excellence in technology education. The future of the technology industry depends on today's high school and college students." In the 2008–2009 academic year, NMTC provided a scholarship for a computer science student.

Thomas Gray, Seattle, WA
'61 BS EE
Retired, The Boeing Company

Thomas Gray had an exceptional 34-year career at Boeing which included flight testing the company's commercial aircraft and working in the development tests of the Boeing hydrofoils and Space Shuttle Carrier aircraft. In retirement, his interests are equally varied—from membership in the Tuskegee Airmen, Inc., to participating in a recent historical tribute to the nation's railroad Pullman porters. Gray is a very active community volunteer. His loyalty to UNM and the SOE is reflected in his annual contributions to the Electrical and Computer Engineering Department and his affiliation with the UNM Alumni Association as a past board member and past president of the Seattle alumni chapter.

Karen Douglas, Albuquerque, NM
'79 BS Biomedical Engineering
Program Manager and Safety Engineer,
National Nuclear Security Administration, DOE

As a UNM undergrad, Karen Douglas was part of the Associated Western Universities

fellowship program at Sandia National Laboratories. A faculty mentor and a research publication led to a job with the General Electric Nuclear Energy Business Group and a 1983 master's degree in Materials Science and Engineering from Stanford. Today she continues advanced training related to nuclear safety issues. "My educational background has provided valuable tools and a strong analytical approach to technical issues encountered throughout my engineering career."

Bodie C. Pryor, Port Arthur, TX
'35 BS ChE
Retired

In 1941, Bodie Pryor led a team at B.F. Goodrich to transfer the process for creating synthetic rubber from the lab to manufacturing, which revolutionized the industry. After initiating changes in pollution control in the plastics and rubber industries, Pryor worked along with the National Institute of Health to discover causes of kidney and bladder cancers and leukemia in the rubber industry. At age 96, he still has an insatiable curiosity to learn new things.

Lemna "Lem" Hunter, Albuquerque, NM
'91 MS ME
CEO & Founder, Vibrant Corp.

Hunter started engineering consultancy Mechtronic Solutions Inc. in 1993 and grew the company and added manufacturing capabilities. In 2006, he founded Vibrant, which specializes in non-destructive testing of aerospace components. Hunter was selected as an inaugural "Who's Who in Technology" awardee by the *New Mexico Business Weekly.* He credits former mechanical engineering chair and School of Engineering dean Dr. William Gross for fostering his entrepreneurial approach to engineering.

William Miera, Albuquerque, NM
'80 BS ME, '90 MSME
CEO & Founder, Fiore Industries

Fiore Industries, an Albuquerque-based company that focuses on R&D engineering, testing, and support services was recently named the "Small Business of the Year" by the Greater Albuquerque Chamber of Commerce. Founded by CEO Bill Miera, Fiore's clients include the Air Force Research Laboratory and the Center for Countermeasures. Miera says, "We've been working very hard this year and it's a great honor to have that work recognized and to receive this award from the Chamber."

James McNally, Albuquerque, NM
'86 PhD Engineering
Director of Operations, Applied Technology Associates

After a 20-year Air Force career, Jim McNally helped launch TruTouch Technologies, Inc. In 2009, he joined Applied Technology Associates as director of operations, where he is working on precision-sensing measurements and control devices. McNally was selected as an inaugural "Who's Who in Technology" awardee by the *New Mexico Business Weekly.* McNally says, "I am honored to receive the recognition. It is an acknowledgment of the quality of the research expertise developed at CHTM, where I got my start 25 years ago. The advanced technology development instincts acquired while part of CHTM have guided me throughout my career."

Have you been promoted, taken a new job, or received an award honoring your achievements? Please let us know. Send your update to UNM Engineering, MSC01-1140, 1 University of New Mexico, Albuquerque, NM 87131 or email soedev@unm.edu. You'll find more information about these alums and others on soe.unm.edu.

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School of Engineering
MSC01-1140
1 University of New Mexico
Albuquerque, NM 87131-0001