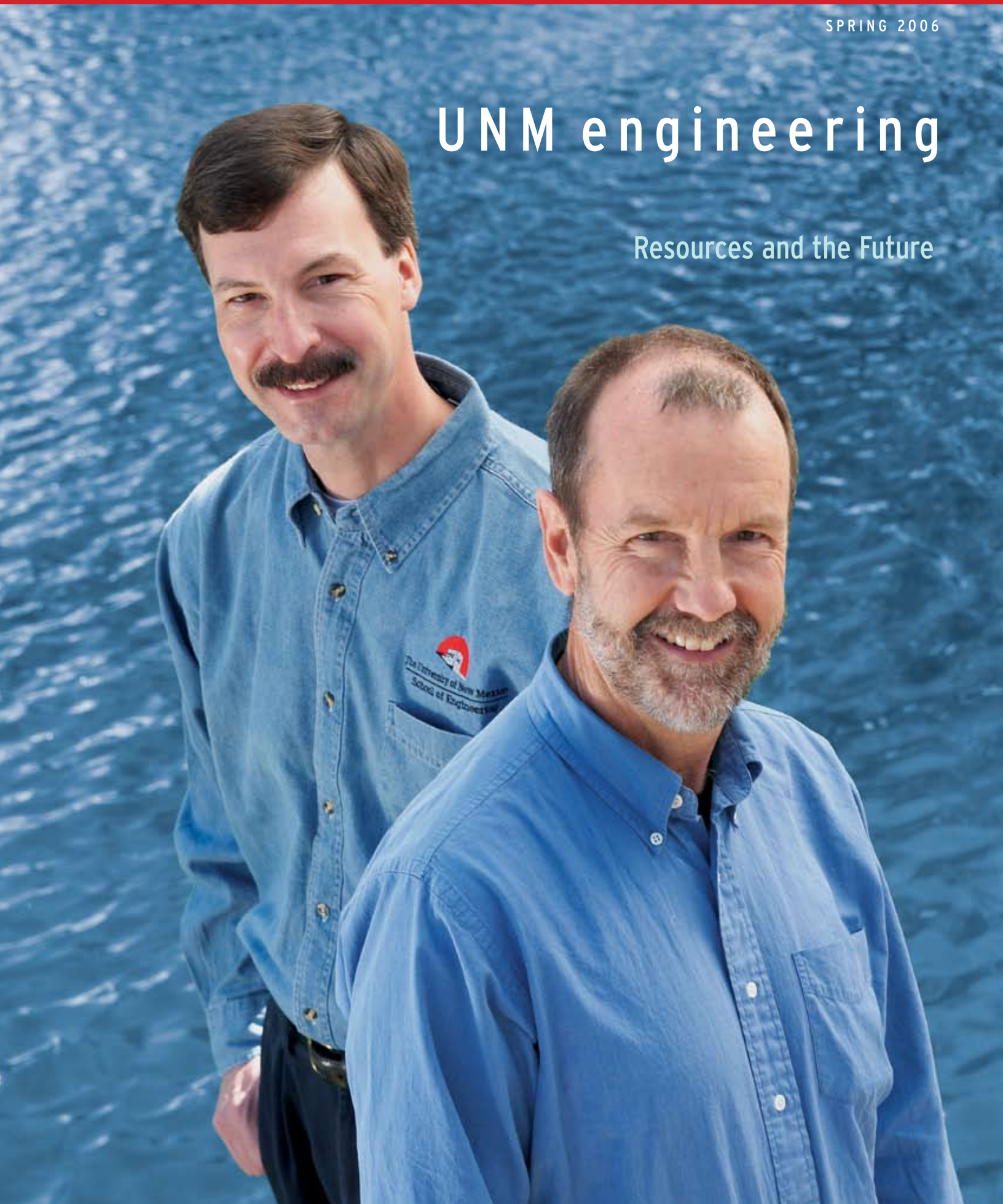
THE UNIVERSITY OF NEW MEXICO SCHOOL OF ENGINEERING

SPRING 2006

UNM engineering

Resources and the Future



How can we improve our natural resources and build a better, more sustainable future?

From the Dean

Engineers use their training, ingenuity, resourcefulness, and new technologies to solve real-world problems. These tactics are especially important in building a better, more sustainable future. As engineers, we learn to think globally, taking into consideration expanding populations, limited resources, and the repercussions of previous energy choices. We collaborate with our multicultural teams to improve current resources and make new ones available.

And so it is at UNM. School of Engineering faculty are deeply involved in improving the efficiency of current resources, developing innovative approaches for new energy sources, and teaching the next generation of engineers to develop better technologies for the future.

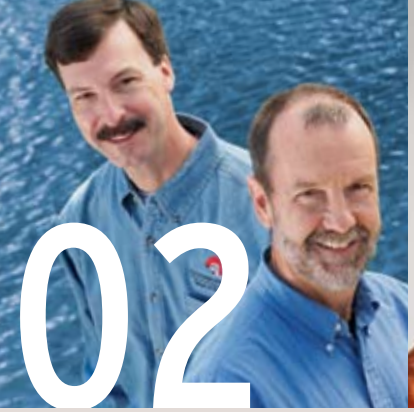
With no new water sources and the demand for fresh water growing, Civil Engineering Professors Bruce Thomson and Kerry Howe are hunting for new ways to quench the world's thirst. How do you make salt water useful? How do you dispose of waste water in environmentally conscious ways? Thomson and Howe are innovators in solving these problems. Their research will improve the outlook of one of our most precious resources.

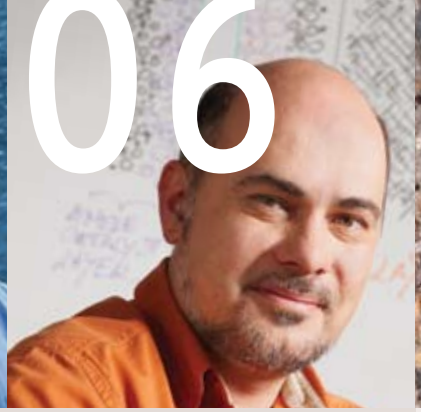
Sometimes preparing for the future involves going back to the past. One of our teams is transforming an old technology by using a very new technology. Professor Plamen Atanassov is leading several student teams in researching novel materials for fuel cells, which were invented in 1838. Their research uses nanotechnology approaches to improve this portable, mobile power supply of the future. The applications for fuel cells are far-reaching — including off-grid power supplies, transportation, and consumer electronics.

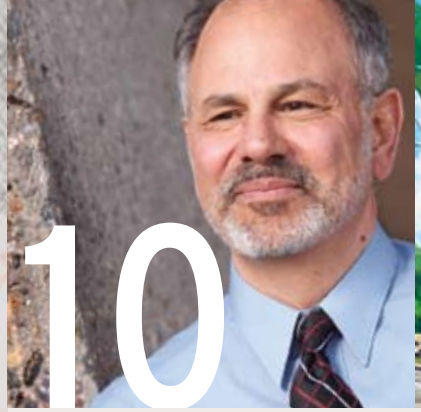
Certainly preparing for the future involves missions in outer space. Professor Mohamed El-Genk of the Department of Chemical and Nuclear Engineering has led an internationally recognized academic program in space nuclear power and thermal propulsion since 1984. His team also works on next generation reactors for the renaissance of nuclear power and promotes the peaceful use of nuclear energy. Their annual international conference includes an outreach program for future engineers and scientists.

As you read through the articles in this issue, you'll learn how our engineers are creating better resources for the future through technological development. You'll also see how we are teaching students to contribute to the social, technological, and economic development of our state, nation, and global community.

Joseph L. Cecchi
Dean of Engineering







Points of Pride

■ The editors of *Hispanic Engineer & Information Technology* magazine selected UNM Chemical and Nuclear Engineering professor **Gabriel P. López** for the prestigious 100 Most Important Hispanics in Technology and Business list for 2006. Honorees are chosen for this annual list because of their leadership and outstanding work in technology.

■ Computer Science and ECE Professor **Manuel de Hermenegildo**, the Prince of Asturias Endowed Chair in Information Science and Technology, is the recipient of the Julio Pastor Award, Spain's 2005 National Research Award for Mathematics and Information Technologies. The award, granted by Spain's Education and Science Ministry, recognizes outstanding merit in scientific and technological research by Spanish scientists.

■ The Annual Transportation and Paving Conference in January 2006 organized by Professor **Jim Brogan** of the Civil Engineering Department attracted over 500 professionals from all over the United States. The conference provides a forum for researchers and practitioners to learn from each other and promotes the creation and transfer of technology in all aspects of transportation. New Mexico Governor Bill Richardson delivered the keynote address.

■ Electrical & Computer Engineering Professor **Edl Schamiloglu's** highly successful co-edited volume, *High Power Microwave Sources and Technologies*, has just been published in Chinese by Tsinghua University Press. The title was originally published in 2001 by IEEE Press/John Wiley & Sons. To see the English edition, go to ieee.org or amazon.com.

■ The solar thermal system in the Mechanical Engineering building will undergo modernization and refurbishment, resulting from a $198,500 grant from the State of New Mexico. The project, headed by Professors **Andrea Mammoli** and **Peter Vorobieff,** will offer substantial energy savings, in addition to providing a resource for teaching renewable energy, efficiency and conservation concepts. The system will be fully instrumented and its operations eventually will be viewable online in real-time.

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UNM Civil Engineering Professors and water experts Kerry Howe, *left*, and Bruce Thomson, *right*, research ways to improve the outlook for the future.

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

Design
Cisneros Design

Photography
Eric Swanson

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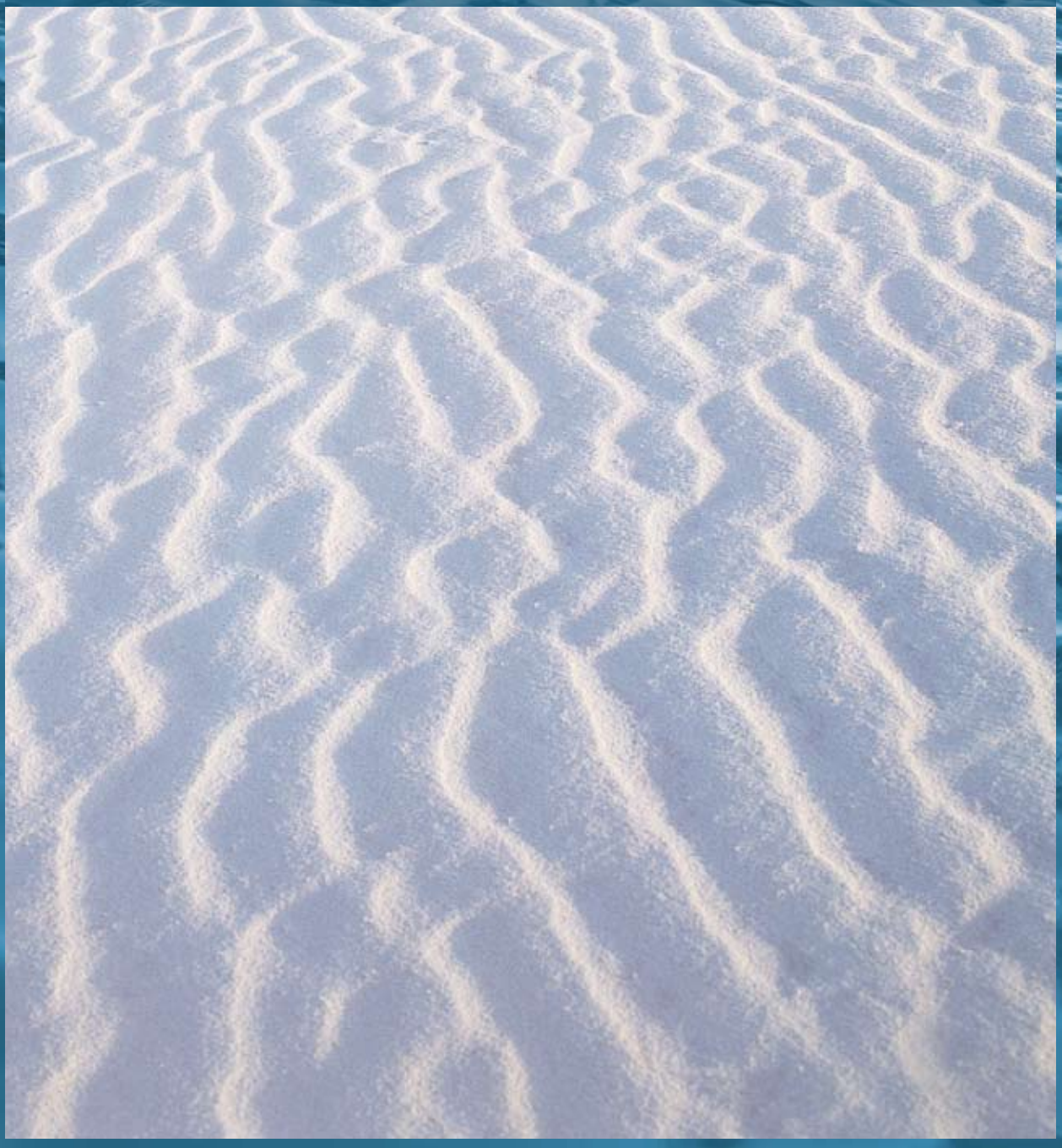
School of Engineering
Farris Engineering Center, 107
MSC01-1140
1 University of New Mexico
Albuquerque, NM 87131-0001
505-277-5521
www.soe.unm.edu

Water Hunters

UNM RESEARCHERS TAP INTO TECHNOLOGY TO QUENCH THE WORLD'S THIRST



UNM professors Kerry Howe, *left*, and Bruce Thomson, *right*, are water treatment experts working to improve the outlook for the future.

CLOUDCROFT, NEW MEXICO IS A CHARMING MOUNTAIN TOWN WITH A POPULATION OF 750, A SKI AREA, THE NATION'S HIGHEST GOLF COURSE — AND A SERIOUS WATER SHORTAGE. DURING WINTER, THE TOWN USES ABOUT 70,000 GALLONS OF WATER DAILY. IN THE SUMMER, THE TOWN'S CENSUS SOARS, AS DOES THE DEMAND FOR WATER. IN THE SUMMER OF 2004, CLOUDCROFT'S WATER SHORTAGE WAS SO CRITICAL THAT THE TOWN HAD TO TRUCK 20,000 GALLONS OF WATER IN EVERY DAY.

Cloudcroft is fixing its water shortage by building a novel water treatment plant that will supplement its existing water supply with recycled wastewater. University of New Mexico Regents Professor of Civil Engineering Bruce Thomson is a member of the New Mexico Environment Department task force working with Cloudcroft on the project. He is helping with treatment process selection and developing performance standards for the system. Those standards are critical given the negative perception of treated wastewater flowing from the town's taps. "We're shortening the distance from the discharge point to the intake point," explains Thomson. "The public is uncomfortable about the concept."

Cloudcroft's new system is actually a combination of two treatment processes, membrane bioreactor (MBR) and reverse osmosis (RO). MBR is a variation on conventional wastewater treatment that replaces standard clarifiers with a special membrane to remove bacteria. The conventional process removes 99% of the bacteria; MBR removes 99.9999%. The water from the MBR process then goes into an RO system, a high pressure treatment process that removes sodium, chloride, and other ions by forcing the water through a special synthetic membrane that allows water molecules to pass through but prevents most others from doing so. Water from this MBR to RO process will be almost as high quality as distilled water. Cloudcroft will store most of this treated water in a pond rather than pump it into a larger water source like a river or aquifer. "To the best of my knowledge, nobody in the U.S. has done anything like this," says Thomson.

New Sources, New Technologies

The water shortage in Cloudcroft is a snapshot of what's happening in communities across the Southwest, the nation, and the world. Fresh water resources are scarce and demand is growing. So researchers like Thomson are hunting for new ways to quench the world's thirst.

Kerry Howe, assistant professor of civil engineering and water treatment expert, is also on the hunt for water. Howe is studying new water sources and optimizing current water treatment systems. His research is funded by a contract from Sandia National Laboratory's Jumpstart Program. "Jumpstart finds technologies and people that are doing things that are not five or ten years out but that could be implemented a little faster," explains Richard Kottenstette, a member of the technical staff at Sandia National

Nishant Ahuja, a graduate student in Civil Engineering, prepares a reverse osmosis (RO) membrane for laboratory testing.

Finely ground adsorption media is placed in a high pressure column in preparation for small scale column testing of its ability to remove arsenic from drinking water.

"There are no new water resources. So now we're looking at high salinity sources and how we can reuse the water we have."

Regents Professor Bruce Thompson

Laboratory and acting project manager of the Jumpstart Program. "Recently we've been looking at ways to ensure adequate supplies of water in the U.S."

Howe's research matches that goal. "One thing that we're trying to do is take water that you don't want to drink and make it water you do would want to drink," says Howe. The water in question is brackish (moderately salty) or saline (very salty), and it's plentiful. Ninety-seven percent of the world's water is saline. Experts estimate that brackish groundwater resources in New Mexico are three times greater than fresh water resources. How do you make salt water useful? Reverse osmosis is one answer. The process separates a feed stream into a product stream of potable water, and a waste stream, or concentrate that contains most of the salts. RO is used mainly in coastal communities but Howe is optimizing it for inland use. He's finding ways to increase the recovery rate, or the fraction of the total flow recovered for potable use. "If we go to a municipal reverse osmosis plant today, they might be running at a 70 percent recovery rate. What we're trying to do in the lab is to develop technology that would allow them to run at 90-95 percent recovery," says Howe.

To do that, he's controlling precipitation, or the point where minerals in the water turn to solids. Solids accumulate on the RO membrane surface and reduce the flow of water through it. In Howe's lab-based RO system, he adjusts flow rate, water velocity, and other conditions, so that minerals in the feed stream are concentrated just to the point of precipitation. When conditions reach that level, Howe sends a portion of the stream through another process where precipitation occurs. "We're trying to take something that would have happened within our reverse osmosis system and would have clogged the system and limited recovery, and we're putting in a separate process that will remove the solids separately," explains Howe. The process works. In a recent test, Howe operated his RO process for one week with a solution that was 100 percent supersaturated and experienced zero loss of flow.

Kottenstette says that Howe's findings are important to the bigger picture. "This is an important step forward. This will go into our body of knowledge as to how these unit operations work in an actual desalination application," says Kottensette.

From Waste Stream to Revenue Stream

Howe is also tackling the challenge of waste stream disposal. Coastal RO plants simply dump their high-salinity concentrate back into the ocean. Inland communities have to find other cost effective, environmentally sensitive ways to dispose of huge volumes of concentrate.

That's why Howe is turning the concept of the waste stream on its head. "The overall goal is to actually take that waste stream and turn it into something you can sell," he explains. Howe and a team of students have conducted a nationwide inventory of the mineral content in ground waters. Depending on the region, waters contain high levels of silica, calcium chloride, calcium sulfate and other minerals. Each mineral has a market value that could be parlayed into an income stream. For instance, calcium sulfate is used to manufacture gypsum board for construction. Now Howe's team is working with industries to turn waste streams into revenue streams.

The Arsenic Challenge

Calcium sulfate and other minerals have potentially lucrative second uses, but one common element found in ground water doesn't: arsenic. The toxin must be removed from water sources. Now, the EPA has lowered the maximum arsenic concentration in drinking water from 50 parts per billion to ten parts per billion, which adds to the arsenic removal challenge.

Large municipalities have the budget and technical expertise to remove arsenic from their water using a

"One thing that we're trying to do is take water that you don't want to drink and make it water you would want to drink."

Assistant Professor Kerry Howe

precipitation process. It's a greater challenge for smaller communities with smaller budgets. The most appropriate arsenic removal approach for small towns is often adsorption. In this process, water is passed through columns filled with an arsenic removal medium made of ferric oxide, which looks like coffee grounds. Arsenic forms chemical bonds with the ferric oxide which causes it to adsorb, or stick, to the medium's surface.

There are about a dozen commercially available adsorption media, and each works differently depending on the water source. By choosing the right medium, a community can maximize its arsenic removal process and save money. However, testing the efficacy of different media is prohibitively expensive and time-consuming for small municipalities.

Bruce Thomson has an answer. Last year Thomson unveiled a small, rapid process to test efficacy of arsenic removal media. His process, called Rapid Small Scale Column Testing (RSSCT), accelerates the standard testing process and costs less. Standard tests take up to a year, cost tens of thousands of dollars, and require columns that can be eight feet tall. RSSCT takes just weeks, costs about $10,000, and uses four-inch columns filled with finely ground adsorption media.

Thomson has already used RSSCT to test water for six New Mexico communities and expects that number to grow. "Over the next two or three years a couple dozen communities in New Mexico will want to do this testing with us," says Thomson.

Alicia Aragon worked with Thomson to develop the RSSCT procedure as a Ph.D student at UNM, and now uses the technology as a postdoctoral appointee in Sandia National Laboratory's Geochemistry Department. She uses RSSCT to evaluate arsenic treatment processes for communities in New Mexico and throughout the country. "I mimic the pilot studies with RSSCT and look at how the small scale test can predict the results of the pilot test," says Aragon. The pilot tests take up to a year to yield results; Aragon has hers in two weeks. So far, the tests are yielding the same results. "This is especially good for small rural communities and Indian reservations," says Aragon. "For them to quickly get results and know what's best for their water — that's going to help a lot."

Ironically, effective arsenic removal creates another challenge: how to dispose of arsenic-laden adsorption media. Once again, Thomson and Howe are searching for answers. Together they're studying what happens to the arsenic-laden wastes after disposal. "Once you collect this arsenic and put it all in one place, if it leaches off the media and gets into the groundwater, you create a whole new groundwater contamination problem," explains Howe. "Our new research may lead to decisions about what kind of landfills this media should go into."

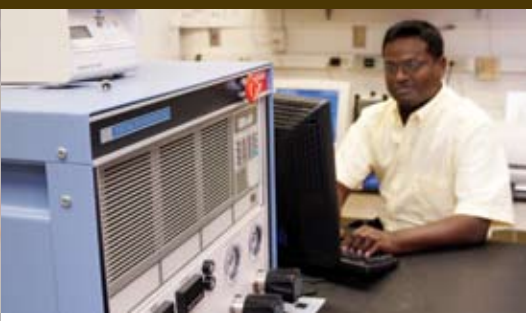
Finding water sources, treating water, managing concentrates; it's a complex and vital cycle for every society. Howe and Thomson's research sustains the process and improves the outlook for the future. "We cycle things through our environment," comments Howe. "Our job as environmental engineers is to try to minimize the hazards associated with that and to maximize our use of those resources in an environmentally conscious way."

POWERING THE FUTURE

UNM RESEARCH IMPROVES FUEL CELL TECHNOLOGY

WHICH IS THE MORE COST-EFFICIENT POWER SOURCE: THE LITHIUM BATTERY POWERING YOUR CELL PHONE, THE TINY BATTERY THAT MAKES YOUR TIMEX TICK, OR THE POWER FROM THE GRID THAT MAKES YOUR ELECTRIC STOVE WORK?

Ph.D. student Madhusudhana Dowlapalli is researching how to create an electrochemically resistant material that would inhibit the corrosion process of fuel cells.



"We're using nanotechnology approaches to design materials to address key issues in fuel cell development."

Assistant Professor Plamen Atanassov

When you run the numbers and factor in, among other things, the cost of the power source and its expected life span, you'll find that based on price per kilowatt, electricity from the grid is the best bargain of the three. In fact, we readily pay up to a thousand times more for some energy sources, like telephone batteries, than we do others.

From those examples, it's clear that society will pay different prices for energy based on the need for the specific circumstances of its use. "Introduction of a new power source or new energy conversion device is a question of winning the price game with the existing sources that address the same need," says Plamen Atanassov, assistant professor of chemical and nuclear engineering.

If you replaced any of those conventional power sources or energy carriers—batteries, oil, or electricity from the grid—with a fuel cell, you'd pay somewhere between $1–$10 per kilowatt. It's a reasonable price for some applications, but not cheap compared to electrical power derived from gas or coal. However, with new materials and better engineering, a fuel cell's price per kilowatt is dropping. As it does, these lightweight, efficient, and almost emission-free devices will replace conventional energy conversion devices and power our future.

What's Old Is New Again

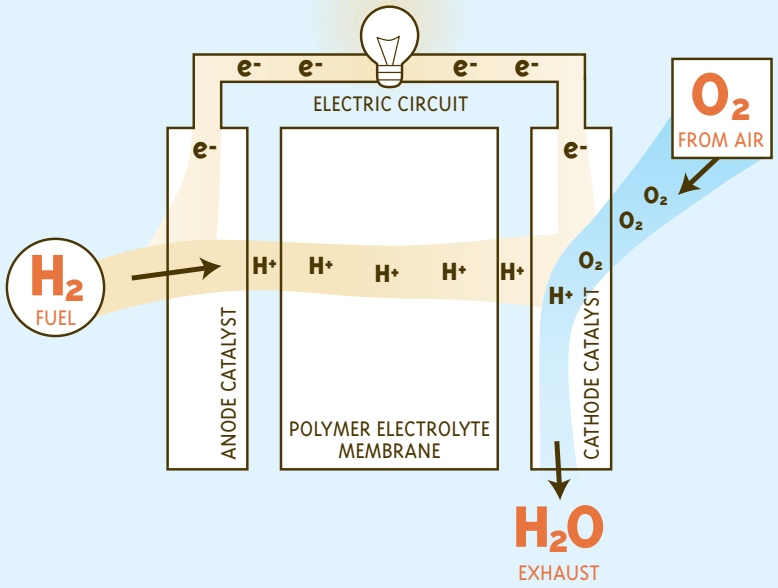
Actually, the power source of the future isn't new at all. Fuel cells, which use electrochemical processes to turn chemical energy in hydrogen gas and oxygen into electricity, were invented in 1838. In the 1960's, the U.S space program used fuel cells to power spacecraft electrical devices. Today they keep the lights on in offices and hospitals, and even power some cars. Still, fuel cells haven't gained traction as a primary power source because of the lack of necessary infrastructure, engineering challenges, and cost drawbacks. But considering all their potential—and with growing pressure on conventional energy sources—researchers and companies around the world are racing to improve fuel cell technology.

Atanassov is deeply involved in fuel cell research and in teaching the next generation of engineers to develop better fuel cell technology. A charismatic and popular instructor, Atanassov is leading several student teams in researching novel materials for fuel cells, bio sensors, and bio fuel cells. "We're using nanotechnology approaches to design materials to address key issues in fuel cell development," explains Atanassov.

Two of those key issues are the durability and affordability of fuel cell materials. A team of Ph.D. students working with Atanassov is addressing both factors. The students are trying to lower the cost and improve the performance of the catalytic layer in the cathode side of the fuel cell. "Our group is among many in this country that are making a very serious contribution in this research," says Atanassov. "Most of the teams, however, are from industry or the national labs. We're among the few well-recognized academic groups in the area." The team, Madhusudhana Dowlapalli, Tim Olson, and Elise Switzer, collaborates in a lab in Farris Engineering Center, where they analyze processes, create new materials, and then run tests on a fuel cell test station that measures their success in an actual fuel cell environment.

Three Researchers, Three Approaches

The catalyst, which reduces oxygen in the fuel cell, is made of carbon black, a type of carbon powder. The carbon black structure serves as a support for platinum nanoparticles. Platinum's price—well over $1000 an ounce—is a limiting factor in manufacturing more affordable fuel cells. The supply of platinum is also limited, which could make it a strategically important metal



Schematic representation of the basic fuel cell design: the fuel, hydrogen, flows into a porous anode where it is oxidized, producing a charge that is passed through an external circuit; oxygen from the air is reduced on the cathode, where it forms water while reacting with the protons migrating through the polymer electrolyte membrane.

if fuel cells are generally adopted as an energy conversion device. That's why Switzer is focusing on how to use the platinum more efficiently. She's developing ways to enhance the catalytic efficiency by applying smaller, dispersed patterns of platinum particles on nanostructured carbon black supports. At the same time, she hopes her approach will result in more effective transport of reactants and products through the catalytic layer.

Olson is trying to get around the cost of platinum by replacing it altogether. He's researching alternative catalyst coatings called pyrolyzed metallo-porphyrins, a group of chemicals that can be heat-treated to enhance their catalytic activity in reducing oxygen. Pound for pound, porphyrins aren't as effective as platinum, but they are much less expensive, so more of them can be loaded onto the catalyst to achieve results similar to platinum coating. "I'm studying the mechanism as to why these materials work the way they do, and why they work as well as they do," explains Olson. So far, he's focused on one type of porphyrin—pyrolyzed cobalt porphyrin—that has good potential for better oxygen reduction.

While Olson and Switzer are optimizing the catalyst materials, Dowlapalli is studying the interface between the materials; specifically the chemical reaction that occurs where the platinum and carbon black connect. That interface causes corrosion which, over time, reduces the fuel cell's efficiency. Dowlapalli is changing the types of carbon black used to make the catalyst structure and varying the load of platinum on the catalyst to better understand the reaction. His ultimate goal is to create an electrochemically resistant material that would inhibit the corrosion process.

It's a step-by-step process for Switzer, Olson, and Dowlapalli, but they all see the bigger picture. "I think if I'm successful in my research, it will lead to an increase in the life of whatever the fuel cell is in and that's really important," says Dowlapalli. Indeed. Their nanoscale changes have big implications for a better, more sustainable way to power the future. ✦

Atanassov and Ph.D. student Elise Switzer are improving the durability and affordability of fuel cell materials.

UNM AWARDED $3.5 MILLION FOR FUEL CELL RESEARCH

A new $3.5 million grant will allow Plamen Atanassov the opportunity to study the use of natural substances, such as glucose and ethanol, as electrical power sources for smaller devices. These bio-fuels will then be used to power small surveillance devices. Atanassov will serve as principal investigator on a research project titled "Fundamentals and Bioengineering of Enzymatic Fuel Cells" for a grant awarded to the University of New Mexico and its collaborators by the Department of Defense through the Multidisciplinary University Research Initiative.

U.S. Senator Pete Domenici announced the grant, saying, "I commend UNM for being the recipient of this competitive research money. Studying and developing natural sources of power has become an emerging priority. This is a tremendous opportunity for UNM to advance communication mechanisms for our men and women in uniform."

Based at UNM, the project will include collaborators from Sandia National Laboratories as well as Columbia University, Michigan State University, St. Louis University, Northeastern University, and the University of Hawaii–Manoa.

Alumni Profile: Samantha Lapin

An Engineer Who Means Business

What are best friends for? In Samantha Lapin's case, a grade school best friend made a suggestion that would change her life. Lapin's friend was enrolling in the University of Arizona (UA) engineering program and suggested that Lapin — who says she was "clueless" about what to study — should do the same. Lapin enrolled and excelled. Today, Lapin leads a thriving Albuquerque-based technology company and is deeply involved in shaping public policy.

After graduating from UA and working for the government, Lapin enrolled at the University of New Mexico where she earned her M.S. in nuclear engineering. She conducted her research assistantship at Sandia National Laboratory. "UNM is such a good school," says Lapin. "The great thing about doing your graduate work here is access to the laboratories and to professionals at the labs."

Eventually, Lapin joined POD, Inc., which provides solutions for IT system development, integration, and support. A few years after she joined the company, POD was downsized. Lapin was promoted to President and CEO and charged with turning the company around. She displayed a business acumen that helped the company grow and thrive. Gary Cooper, associate professor in chemical and nuclear engineering at UNM, has known Lapin for years. As her master's thesis director, Cooper saw that Lapin's talents extended well beyond engineering. "Sam didn't seem like a traditional engineer; she had a different outlook," says Cooper. "She clearly has a knack for business and seeing trends."

With her business sense and people skills, Lapin led POD through a recent merger with RESPEC, an integrated consulting and services firm in South Dakota. RESPEC had 60 employees working at Sandia National Laboratory, and wanted to expand its presence in Albuquerque. POD was a perfect match. "Now we're a total resource," says Lapin. "And there's a real connection between the companies in terms of people and mindsets."

Lapin works with public policy organizations because she sees the impact they can have on her company and its employees. "You really do feel like you have a chance to make a difference," she says.

Shaping Public Policy

Lapin uses her collaboration skills, engineering background, and natural drive to shape public policy affecting small businesses and technology firms in New Mexico. She is an active member of the National Association of Women Business Owners, and serves on a number of boards including the Association of Commerce and Industry, a lobbying group, and Next Generation Economy Initiative, which fosters an innovation-based economy and entrepreneurial endeavors in New Mexico through public and private partnerships.

Lapin has received wide recognition and numerous awards for her community involvement and leadership abilities including Alumni of the Year for the Chemical and Nuclear Engineering Department at UNM. She says she works with public policy organizations because she sees the impact they can have on her company and its employees. "You really do feel like you have a chance to make a difference," she says. Indeed, with her hard work and dedication, Samantha Lapin does make a difference. ✦

UNM fosters new space power research — and empowers future engineers

(Em)powering the next

Exploring the deepest reaches of space, driving a rover on Mars, and establishing human outposts on the moon require incredible feats of engineering. One of the most important engineering challenges is developing the technology for reliable, safe, long-lasting, and lightweight power systems to sustain missions in space for 10–15 years, or even longer. When it comes to space nuclear power technologies, the University of New Mexico is leading the way.

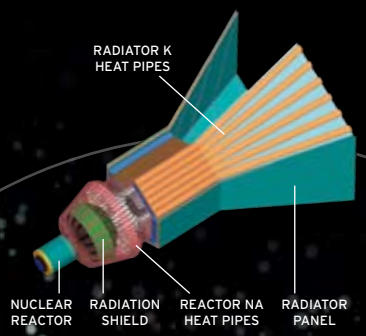
While some energy sources like solar energy can't be sustained for missions too close or too far from the sun, one source is sustainable: nuclear power. UNM has an internationally recognized academic program in space nuclear power and thermal propulsion since 1984. Mohamed El-Genk, Regents' Professor of chemical and nuclear engineering and founding director of the University of New Mexico Institute for Space and Nuclear Power Studies (UNM-ISNPS), has helped lead the program from the start. "We have the best academic program in the country in space nuclear power and thermal propulsion in terms of the breadth of our research, research productivity, and technical expertise," says El-Genk.

Next Generation Technology

El-Genk, other ISNPS researchers, and students are currently developing the next generation of space nuclear power systems for ambitious exploration missions to the farthest planets in the solar system. "If we want to explore Mars or the ice resources on the moons of Jupiter such as Europa and Ganymede, we need serious power for that," says El-Genk. "We design safe and reliable nuclear power systems for destinations where solar energy is nonexistent."

Research teams at UNM-ISNPS are focusing on three space reactor designs that avoid single-point failures: the liquid metal-cooled Sectored Compact Reactor (SCoRe); the gas cooled Submersion-Subcritical Safe Space reactor (S^4) designed to operate with multiple Closed Brayton Cycle (CBC) Engines; and the liquid metal heat pipe cooled Scalable AMTEC Integrated Reactor System (SAIRS). These reactor designs feature redundancies to ensure continued operation of the power system — and the mission. Safety and longevity are also key factors. "These reactors are designed to remain safe in case they are submerged in wet sand and flooded with seawater, following a launch abort accident," says post-doctorate candidate Jeff King. "Passive cooling using heat pipes, designing light-weight heat rejection radiators, and dynamic simulation of space power systems with either static energy conversion or turbo-machinery, are other major focus areas for research at UNM-ISNPS," explains Jean-Michel Tournier, assistant research professor.

Space-oriented research is only half the research equation for UNM-ISNPS faculty, graduate and undergraduate students. They're also working on next generation reactors for the renaissance of nuclear power for domestic energy production and for sustaining a hydrogen economy; better thermal management of electronic equipment;



OPPOSITE RIGHT: Regents' Professor of Chemical and Nuclear Engineering Mohammed El-Genk founded the UNM Institute for Space and Nuclear Power Studies.

LEFT: SAIRS Light weight 100 kWe power system with AMTEC energy conversion for future NASA Space exploration missions, developed at UNM-ISNPS.

CENTER: El-Genk says the outreach program is the most valuable part of STAIF.

RIGHT: El-Genk with members of ISNPS research team, Assistant Research Professor Jean Michel Tournier, Jack Parker, Ph.D., Dr. Jeff King Post-doctorate fellow, and Steven Hatton, M.S.

generation

and the advanced fuel cycle for reducing nuclear waste generated by commercial reactors. El-Genk says the UNM-ISNPS not only advances engineering research and education in cutting-edge areas, but also supports the larger educational mission of the university. "The University does research that benefits society and mankind, while preparing the next cadres of the trained workforce," explains El-Genk. "Fostering innovations in energy development and improving the efficiency of current power sources is one way the university achieves that goal." He adds that another way the university helps the community and the nation is by encouraging the next generation of students to pursue careers in engineering and the sciences.

A Successful Forum

Both of those goals coalesce at UNM-ISNPS, established in 1984 as a research organization that focuses on advancing space and nuclear power technologies and promoting the peaceful use of nuclear energy. ISNPS provides a variety of educational and research opportunities for both graduate and undergraduate students. Since 1984, more than 45 Ph.D. dissertations and master's theses have been completed at ISNPS.

ISNPS convened its annual international meeting, the Space Technology and Applications International Forum (STAIF), in mid-February in Albuquerque. Approximately 600 people attended, including congressional representative Heather Wilson, administrators from NASA, and leaders from industry, researchers and engineers from DOE laboratories, universities, government, and both domestic and international organizations. The meeting hosted five concurrent conferences covering diverse areas in space technology and exploration and featured exhibits, paper presentations, and awards.

Jeff King not only presented two papers at STAIF, but also received the Manuel Lujan, Jr. Student Paper Award for his paper presented at last year's meeting. "Attending STAIF is good professional experience," says King. "It has been an inspiration and a focus throughout my graduate career because it brings together a wide range of people within my field and allows me to make contacts within the space power community." Two other UNM students received awards and recognition at the conference — Paul Howard Smith and Steven Saavedra both received the General Ernest Hardin Scholarship.

The Next Generation of Engineers

STAIF goes beyond the standard conference format of workshops and presentations to include a valuable educational component for future engineers and scientists. Each year the forum sponsors a design competition and a special session for middle and high school students from throughout New Mexico. "This year, more than 65 students entered their designs for a moon-based resort. The winning students and their teachers received monetary awards, and all participants earned accolades from STAIF attendees," says Steven Hatton, M.S. He and Jack Parker, Ph.D., helped organize the outreach activities.

"To me, the outreach program is the most valuable part of STAIF," says El-Genk. "If we can make a difference in even one of these students' lives, then we're successful." Through their outreach and research, El-Genk and other ISNPS researchers and students are not only developing the next generation of space and nuclear power systems, they're empowering future engineers to follow in their footsteps. ✦

Alumni Profile:
Sandra Begay-Campbell

The Power to Change the World

People live in outer space for weeks and information speeds around the globe at the touch of a button. Yet, just two hours from Albuquerque, families don't have electricity in their homes. "It's unfathomable to me to not have this particular situation resolved," says Sandra Begay-Campbell, a principal member of the technical staff at Sandia National Laboratory, member of the University of New Mexico's Board of Regents, and member of the School of Engineering's Board of Visitors.

Begay-Campbell addresses that challenge and others as a leader of Sandia's Renewable Energy Program. In part, the program implements new, sustainable energy solutions to improve conditions on tribal lands and provide new opportunities for Native Americans. As a member of the Navajo Nation with two engineering degrees, Begay-Campbell — a self-described "injuneer" — is uniquely qualified for her job.

As a member of the Navajo Nation with two engineering degrees, Begay-Campbell is uniquely qualified for her job.

Sustainable Solutions

Begay-Campbell educates tribes about available technologies, then assists with funding and implementing the technology. The focus is on sustainable technologies like solar, wind, and biomass power, which are ideal for Native Americans because of their often remote locations and cultural ties to the land.

One recent renewable energy project helped the Navajo Nation install a system of 350 stand-alone photovoltaic cells that provide power to some of the reservation's most isolated residents. Now, with Begay-Campbell's help, the Navajo Nation and the Hopi Nation are exploring the potential of large-scale wind farms to generate power that could be used on the reservations and sold back to the grid. "This idea is very positive, environmentally friendly, and in keeping with current trends in research," says Begay-Campbell.

Support System

Begay-Campbell earned her B.S. in civil engineering from UNM and then studied at Stanford University, where she earned an M.S. in structural engineering. Before joining Sandia, she worked at two other national laboratories, and served as executive director for the American Indian Science and Engineering Society (AISES), a non-profit organization whose mission is to increase the number of American Indian scientists and engineers.

Begay-Campbell's professional work and community involvement have earned her numerous awards and recognition, including the Governor's Award for Outstanding Women from the New Mexico Commission on the Status of Women and the 2005 UNM School of Engineering Distinguished Alumnae Award.

Her most recent — and perhaps most widespread — recognition arrived on bookshelves across the nation in February. Begay-Campbell is featured in *Changing Our World: Stories of Women Engineers*, a new book celebrating the contribution of women engineers in modern life. The book's introduction notes that the women between its pages were chosen because "they wanted to give back to society and make the world a better place to live." Through her work and contributions to community, Begay-Campbell upholds that standard every day. ✦

Distinguished Alumni Awards

2005

Each year, a peer review committee selects the recipients of the prestigious UNM School of Engineering Alumni Awards, based on their dedication to the field and service to the community. Applications are reviewed, discussions are held, decisions are made, and plans commence to celebrate the award winners. On October 6, 2005, the four awardees below were honored at a gala attended by alumni, faculty, staff, students, friends, and family members. The evening's sponsors were Bohannan-Huston Inc., Stephen C. Mitchell, Kenneth Prestwich Consulting, Sholtis Engineering and Safety Consulting, William and Theresa Moulds, Peter Bussolini, Kenneth and Millie Hansen, Cecilia and Mark Horner, Arthur E. Verardo, and Samuel Mould.

Sandra Begay-Campbell
UNM Regent
BSCE 1987

Sandra Begay-Campbell solves problems to make the world a better place to live (see article on previous page). One of her many projects involved providing electricity through solar panels and other alternative energy solutions to hundreds of remote tribal members on the Navajo Reservation. She is a role model because of her professional expertise and service to the community, not only for Native American and women engineers, but for all engineers.

Larry F. Neely
MSEE 1960

In his professional career, Larry Neely focused on bringing safety and efficiency to thousands of gas customers around the world. He received numerous awards, including the Silver Snoopy Award for Professional Excellence on the Apollo Program and the Apollo Achievement Award, and served on the Boards of several organizations. Now retired, he continues to serve his community in a variety of volunteer activities.

Ronald D. Boyd, Ph.D.
MEME 1970

An excellent teacher and mentor to young engineers, Dr. Ronald Boyd is the only faculty member at Prairie View A&M University to hold both an endowed chair and a distinguished professorship. Boyd is a Fellow in the American Society of Mechanical Engineers, the founding director of the Engineering Research Center at Prairie View, Director of the Thermal Science Research Center, and an industry consultant.

YOUNG DISTINGUISHED ENGINEER
Torsten A. Staab
MSCS 1998

Torsten Staab is team leader for Homeland Security Technologies at the Los Alamos National Laboratory. He has written numerous peer-reviewed publications in laboratory automation informatics, holds a U.S. patent for developing a next generation sample collection and tracking device, and teaches IT and software engineering-related short courses. Staab embodies the Young Distinguished Engineer in his enthusiastic quest for knowledge and service to the community.

invigorating engineering

education and innovation

Step into the UNM School of Engineering Administrator's office and you will see a number of architectural plans tacked on the wall. Walk through the Dean's Office conference room on any given Monday afternoon and you will find School of Engineering deans, faculty, and staff collaborating with a group of architects on a new facility designed to invigorate engineering education and innovation.

The new $42 million Centennial Engineering Center will house technologically advanced classrooms, modern laboratories, and a variety of meeting spaces to accommodate engineering education, cutting-edge research, and collaborations among faculty, students, and School of Engineering community partners.

The vision for the new facility goes beyond a center for education, research, and community outreach. It is also part of a strategy to accelerate American research and development and reclaim our heritage as the world's most prolific innovators. There is growing national concern that the rate of future U.S. innovation will decline. Both federal funding and corporate investment in research have been decreasing in recent years. At the same time, many foreign countries are dramatically increasing their spending on research, developing new products, and offering excellent employment packages, luring many of America's best engineering graduates abroad and causing students who might have gone to the U.S. to stay in their own countries.

The "brain drain" underscores the enormous importance of attracting and

"This new facility will enhance engineering education and give our students and faculty an ideal environment to undertake innovative research and technologies to work on issues that affect us all."

Joseph L. Cecchi, Dean, UNM School of Engineering

educating the next generation of engineers and computer scientists with high-quality, technologically advanced resources to prepare them to compete in the global marketplace and continue America's leadership in research and discovery. That is also the vision for the new UNM School of Engineering's Centennial Engineering Center.

According to Joseph L. Cecchi, dean of the School of Engineering, the Center will play a key role in helping researchers accelerate innovation and improve the way we live, work, and communicate. "Since 1906, when the UNM School of Engineering was founded, our alums have developed innovative solutions to complex societal problems," Cecchi says. "This new facility will enhance engineering education and give our students and faculty an ideal environment to undertake innovative research and technologies to work on issues that affect us all."

Next Generation Education

Construction is scheduled to begin July, 2006 with an estimated completion date of August 15, 2008. With a "pueblo revival" style to fit in gracefully with the rest of the buildings on campus, the Center's contemporary features include a glass atrium, a large courtyard with a fountain, two entry towers, and a set-back third floor that offers openness and light.

The new facility will provide students with more convenient access and comprehensive support to services that are currently spread out over several buildings. Wireless classrooms, Internet conferencing facilities and fully-equipped labs will provide an environment for discovery and collaboration. Associate Dean for Academic Affairs Charles B. Fleddermann explains, "The Center will have the latest technology and equipment in a space conducive to innovation." Civil Engineering will have six state-of-the-art teaching and research labs in environmental engineering, microfluids, soil mechanics, structural mechanics, hydraulics and concrete testing. Numerous multidisciplinary labs will expand UNM's pioneering research in nano-materials studies, alternative energy, and bioengineering.

The building will also serve as a nucleus for the new programs offered at the UNM School of Engineering. The Construction Management graduate degree was developed to meet the demand of non-engineering construction professionals who would like to earn a master's degree. Life-enhancing research, such as non-invasive technologies for early detection of diseases, is facilitated by collaborations with the new Center for Biomedical Engineering and the UNM School of Medicine. The multidisciplinary Integrative Nanoscience and Microsystems graduate program was designed to create radical changes in the way we diagnose, treat, and ultimately, prevent cancer. Exciting new programs in 21st century aeronautical and aerospace engineering are being planned.

Building the Future

A variety of funding sources have already recognized the vital need for the new Center. In 2005, UNM student government supported increasing student fees that were then used to fund the largest portion of the new Center's costs, equaling $25 million. State appropriations over the past few years and private donors have provided additional support. Now the School is conducting a capital campaign to raise the remaining construction and equipment funds, as well as funding for student and faculty support, research, and programmatic needs.

Soon the architectural drawings will be stored away and the new facility will be fulfilling its promise of invigorating engineering education and innovation. "In the meantime, it is even more important to stay focused on our missions of teaching, research, and service within the School," says Cecchi. "I see a very bright future, and I look forward to pursuing it with the faculty, staff, students, alums, and partners of the School of Engineering."

Chemical and Nuclear Engineering

On March 3, 2006, UNM Professor of Chemical and Nuclear Engineering **C. Jeffrey Brinker** was honored during a special symposium at Rutgers University. The Rutgers Graduate School-New Brunswick and the Department of Materials Science and Engineering presented Brinker with the Alumnus Award for Distinguished Accomplishment and Service. Brinker has a dual appointment at UNM and is a senior scientist at Sandia National Laboratories.

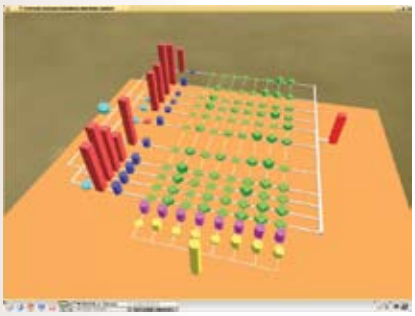
Brinker achieved the highest percent increase in total citations in the field of Chemistry from the first (January 1995-February 2005) to the second (January 1995-April 2005) bimonthly updates to the *ISI Essential Science Indicators™* Web product, according to a recently published in-cites analysis. Brinker is also among the top 1% of scientists publishing in the field of Materials Science.

A concerted effort by the UNM Chemical and Nuclear Engineering Department has allowed at least 10 students and one faculty member, all displaced by Hurricane Katrina, to continue their work at UNM. Three seniors majoring in Chemical Engineering at Tulane University, each with only a small suitcase, made the drive from Houston to Albuquerque to start classes on September 7. The same day they arrived, a Tulane engineering research team also landed at UNM, including Professor **Yungfeng Lu,** a UNM alum who received his Ph.D. in chemical engineering.

Chair: Julia E. Fulghum
505-277-5431
chne@unm.edu

Civil Engineering

Undergraduate student research is an important emphasis in the Civil Engineering Department. A number of CE students received awards for research posters at the Undergraduate Research Symposium at UNM. Undergraduate student **Molly McCuskey** is the first-place winner of a national scholarship from the Rocky Mountain district of the Chi Epsilon Honor Society based on her research, academic accomplishments and service. This summer a new program on Pavement Inspection funded by the NM Department of Transportation will involve a dozen additional undergraduate students working with **Dr. Susan Bogus** and **Dr. Lary Lenke.**



Dr. Timothy Ross and **Dr. Mahmoud Taha** are collaborating with a group of other researchers from UNM, New Mexico State University, Los Alamos National Laboratory, and Monterey Institute of International Studies in developing a complex decision science system to systematically identify the optimal allocation of defense measures necessary for mitigating chemical and biological attacks. With the aide of artificial intelligence and computer visualization, the research team examines possible frameworks to explore the interaction between defense vulnerabilities, defense measures' effectiveness and possible consequences of attacks. The project is funded by the Defense Threat Reduction Agency and is led by **Dr. Frank Gilfeather** (UNM) with a funding level of approximately $1 million per year.

Chair: Arup Maji
505-277-2722
civil@unm.edu

Computer Science

Professor **Manuel de Hermenegildo** (below with King Juan Carlos of Spain and on page 1 under ***Points of Pride***) has been honored with another prestigious award: the Aritmel Prize, the only award in Spain specifically for computing research. The award was given in Granada, Spain, at the National Computer Science and Engineering Research Conference. Hermenegildo is the first recipient of the award, which will be given annually. The prize goes to a researcher for "outstanding scientific contributions in

the area of computer science and engineering." Hermenegildo was chosen for contributions in the areas of software development, programming languages, and automatic program parallelization.

Jijun Tang, who received his Ph.D. from the UNM CS department in August 2004 and started in Fall 2004 as Assistant Professor of Computer Science and Engineering at the University of South Carolina, just received a three-year, $850,000 NIH grant to support his work on his very first PI application. NIH granted him more funds than he had requested, indicating their confidence in the advancement his research will bring to this field.

Computer Science Department Chair **Deepak Kapur** was invited by the Science Foundation of Ireland to be a site reviewer for the Cork Constraint Computation Centre (4C), University College, Cork, Ireland. The Centre was established in October 2001 to promote research in Artificial Intelligence, Information and Communication Technology in Ireland with an initial funding of 6.35 million Euros.

Chair: Deepak Kapur
505-277-3112
csinfo@cs.unm.edu

Electrical and Computer Engineering

ECE Professor **Luke Lester** received the University of New Mexico Libraries Faculty Acknowledgement Award on January 26, 2006. Dr. Lester was singled out "for the exemplary contribution he has made to his students, his college, the university and the field of education."

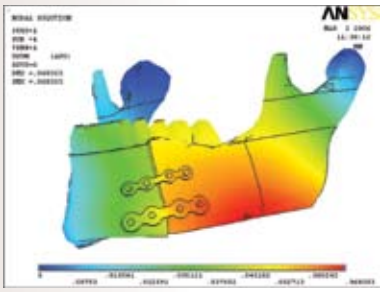
Dr. Lester is associate director for research at UNM's Center for High Technology Materials. In June 2001, Lester co-founded Zia Laser, which is the first company to commercialize quantum-dot semiconductor laser products. Zia Laser's work includes epitaxial growth, wafer processing, and laser testing and packaging. Lester served as Zia's chief technology officer from 2001 to 2004. The company is a CHTM spin-off.

An ECE student intern's research has been accepted for publication. **Saifur Rahman** participated in an eight-week internship ECE offers to students at the Indian Institute of Technology in Kharagpur, India. Rahman worked with ECE Prof. **Majeed Hayat** and his Ph.D. graduate student **Jorge Pezoa** on a problem in infrared image processing. Their work was recently accepted for publication in the *Journal of the Optical Society of America A*, one of the premier journals in image processing. The title of the paper is "Multi-Model Kalman Filtering for Adaptive Nonuniformity Correction in Infrared Sensors."

Chair: Chaouki Abdallah
505-277-2436
info@ece.unm.edu

Mechanical Engineering

The Stryker Leibinger Micro Implants Fellowship is a new $150,000 graduate fellowship in Biomechanical Engineering to encourage the study of the biomechanics of various bone fixation techniques, especially in craniomaxillofacial surgery. The Stryker Leibinger Micro Implants Corporation was prompted to donate the funds through the efforts of Mechanical Engineering Professor **Tariq Khraishi** and Department of Surgery Professor **Jon Wagner** and recent collaborations between the School of Engineering and the UNM School of Medicine. So far two Masters students, **Scott Lovald** and **Naresh Chaudhary,** are working on research related to fixation techniques in maxillofacial surgery. Above is a picture of the finite-element numerical 3-D modeling that the group is performing on a fractured mandible, or human jaw, stabilized with a titanium plate and a set of screws.



Chair: Juan C. Heinrich
505-277-2761
mecheng@unm.edu

The University of New Mexico

School of Engineering
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