

UNM engineering

+
ENGINEERING
ECONOMIC
GROWTH
+



From the Dean

Greetings,

The School of Engineering at the University of New Mexico has a multifaceted mission that touches a wide range of stakeholders. Being part of a flagship public university places upon us the obligation to deliver a world-class education at an affordable cost to a highly diverse student body. Being a research institution demands a culture of innovation, entrepreneurship, social engagement, and societal impact. Creating an environment in which research and education are highly integrated and mutually supportive is a defining trait of UNM Engineering.

The School's distinguished track record of research accomplishments is reflected in the exceptionally high level of external research support (\$300,000 in annual research expenditures per faculty), the number of prestigious awards received by our faculty (highlighted throughout this issue), and our economic impact on the region (see pages 2 and 3).

What these statistics do not capture is the depth of our partnership with the forces of economic development in the State, the breadth of scientific and engineering engagement with the National Laboratories, and the multidisciplinary dimension of our research and academic enterprise, which entails a wide range of collaborations with colleagues within and outside engineering both regionally and globally. Equally important is to highlight the fact that our students, at all levels, participate in and benefit from being involved in leading-edge research that is relevant and benefits society. They may start by pursuing undergraduate research, by gaining experience on an internship, by helping in a laboratory, or by engaging in graduate research. Along the way, student lives are changed and a new generation of talented engineers and entrepreneurs are ready to engage in rewarding careers, which contribute to improving the quality of life of our citizens and the world.

The world around us is changing and we need to make our contributions to shaping the future and to respond to the changing needs of our state, nation, and the world. These concerns are gradually being crystalized in the form of a new set of aspirations likely to guide the evolution of our research and academic programs:

- We will be an active participant in the process of transforming the engineering field – as it becomes increasingly multidisciplinary, it will entail the engineering of systems at varying sizes and complexities, whether they are physical, biological, digital, or social in nature.
- We are committed to educate a technically sophisticated citizenry able to make informed political decisions regarding issues involving science and engineering.
- We will continue to strive to be an engine for economic development in our state.
- We will seek to increase our ability to graduate engineers and scientists ready to join the creative class of innovators who are reshaping our industry and keeping it in the lead.
- We will partner with leading institutions across the world in order to provide our students with an increasingly international experience and in order to promote the creation of new enterprises with ties to our state.
- We will seek to instill in our students a sense of responsibility for the profession, the society, and all individuals who use or are affected by engineering products and processes.

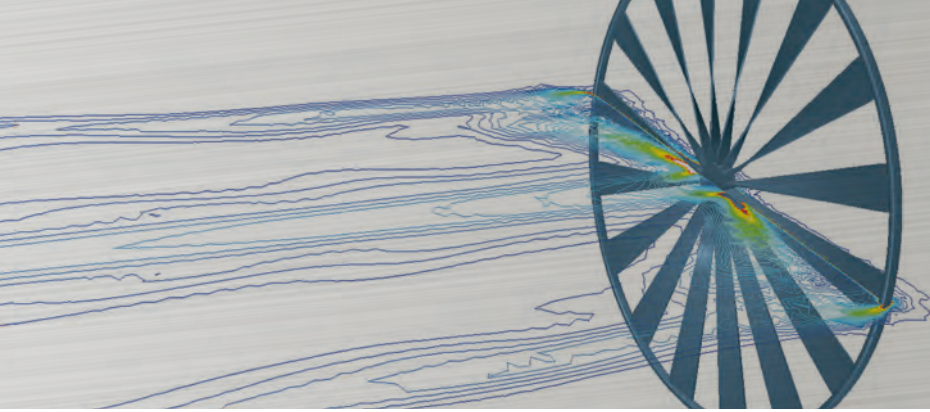
My sincere hope is that you will be part of this ambitious transformation. By being engaged with the school and by contributing your time, gifts, and ideas, we will be able to make these aspirations a reality.

Sincerely,

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

Gruia-Catalin Roman

Dean, UNM School of Engineering



Mechanical Engineering Assistant Professor Svetlana Poroseva and her research group are developing fluid models that will provide accurate, reliable, and timely flow simulations. Those computations will be conducted in collaboration with Los Alamos National Laboratory. Poroseva's group is also analyzing a promising new wind turbine design capable of generating energy at the low wind speeds that are typical for New Mexico.

Contents

Points of Pride

Chaouki T. Abdallah Appointed Provost

In September, UNM President Robert G. Frank appointed **Chaouki T. Abdallah** as Provost and Executive Vice President for Academic Affairs until 2016. Abdallah, who has served as interim provost since 2011, was recognized for his strong performance, sensitivity to the concerns of the faculty, and enormous support throughout UNM. Previously, Abdallah was the chair of the Electrical and Computer Engineering Department. He is a senior member in the IEEE and a recipient of the IEEE Third Millennium Medal.



Luke Lester Wins the 2012 Harold E. Edgerton Award

SPIE, the international society for optics and photonics, recognized **Luke Lester**, interim chair of the Electrical and Computer Engineering Department, with the 2012 Harold E. Edgerton award for outstanding contributions to optical or photonic techniques in the application and understanding of high speed physical phenomena.

Fourth Best Postgraduate Engineering School

The UNM School of Engineering has been named the **fourth best postgraduate engineering school** in *HispanicBusiness* 2012 Best Schools for Hispanics, an annual list of graduate programs across the U.S. that embody diversity on campus. UNM Engineering's ranking is based on 22% Hispanic enrollment, 31% Hispanic graduation rate, strong student services, the number of Hispanic faculty, and reputation. Retention rate for Hispanics in the '10-'11 academic year was 74%.

Engineering Economic Growth

- 02 Visualizing Innovation
- 03 Engineering Economic Growth
- 04 Centered on Success
Interdisciplinary research spurs growth at centers
- 06 Chemical and Nuclear Engineering
- 07 Civil Engineering
- 08 Computer Science
- 09 Electrical and Computer Engineering
- 10 Mechanical Engineering
- 11 Beyond the Classroom
- 12 New Faculty
- 13 Five for Steve Brueck
- 14 Agents of Change
UNM Engineering partners in four ERCs, expanding research and education
- 16 Faculty Innovation®
- 17 Alumni, Supporters, and Friends

UNM Engineering
2012, Volume 8

UNM Engineering is published annually by the University of New Mexico School of Engineering. Subscriptions are free; requests should be submitted to the address below. Material may not be reproduced without permission.

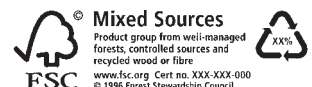
School of Engineering, Centennial Engineering Center, Room 3071, MSC01 1140, 1 University of New Mexico, Albuquerque, NM 87131-1140. 505-277-5521 www.soe.unm.edu

Managing Editor
Tamara Williams

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

Design
Brian Hurshman, Sparkplug Studio

Interested in receiving UNM Engineering electronically?
Sign up online at www.soe.unm.edu/subscribe.html,
email soe@unm.edu or call 505-277-5521.

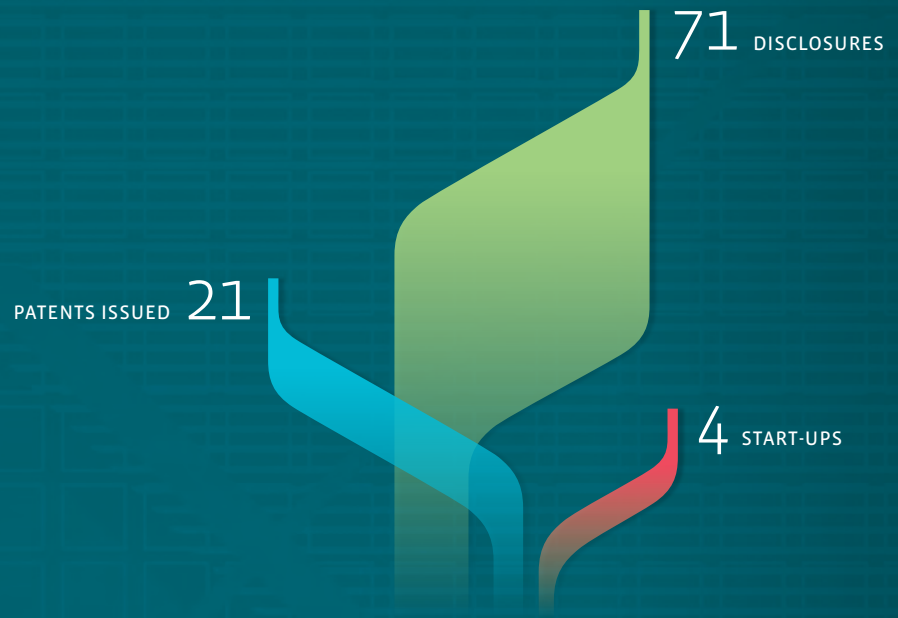


Visualizing Innovation

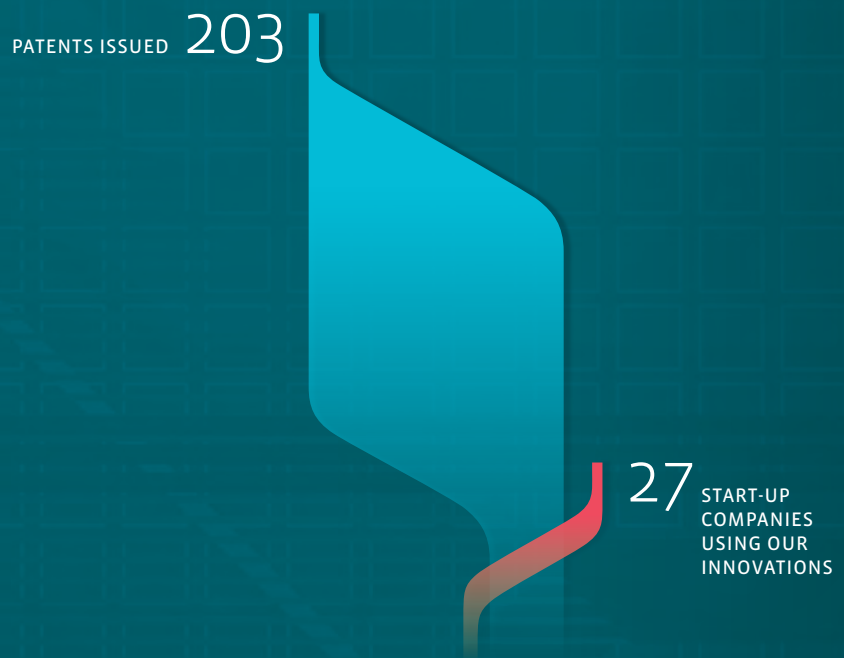
UNM Engineering researchers are addressing global challenges and work with STC.UNM, the University of New Mexico's technology transfer office, to move new discoveries from the laboratory to the marketplace.

"Innovation is thriving at UNM's School of Engineering. By any measure, the number of new ideas, patents, transfers of technologies to established companies, as well as new start-up companies, the School of Engineering is prolific. In addition, the Engineering faculty have a strong interest in seeing their innovations translated into the marketplace, creating jobs and public benefit from the research conducted at UNM."

Elizabeth (Lisa) J. Kuuttila,
PRESIDENT AND CEO, STC.UNM



UNM Engineering Innovations for FY 2012



UNM Engineering Innovations since 1995

Engineering Economic Growth

The breakthrough ideas that will make our world a better place are taking shape every day at the UNM School of Engineering. A culture of innovation thrives in labs and in classrooms, where faculty train highly qualified students with unique skill sets. Those students move into the community and use their knowledge, skills, and energy to power change and economic growth.

Research is fundamental to that process. UNM Engineering research expenditures have surpassed

\$30 million for the past four years and current annual expenditures per faculty exceed \$300,000. That research yielded 21 patents as of September 2012, making UNM Engineering a leader in generating patents.

The school's research isn't just stateside; researchers are building on successful international collaborations in Latin America and are expanding those efforts to Asia and Europe. The three perspectives below shed more light on these strategies and the school's direction.

What makes UNM a great place for advancing biomedical research? Part of the answer lies in the outstanding capabilities of our colleagues in the School of Engineering in materials synthesis and self-assembly, imaging, lithography and functional nano/micro/macrosystems. I am thrilled to see trainees on both sides of campus develop and apply the newest technologies for a better understanding and treatment of cancer. The extra effort needed to become an interdisciplinary scientist will hugely expand their career opportunities.

Janet M. Oliver

Regents' Professor and Frederick H. Harvey Chair of Pathology
Director, NM Spatiotemporal Modeling Center
Director, NM Cancer Nanotechnology Training Center

The worldwide shortage of qualified engineers demands innovative solutions that respond to present global challenges. Clearly, no institution alone can confront these global multilingual and multicultural challenges. Partnerships are essential. We seek partners to create undergraduate and graduate student exchanges and joint entrepreneurial activities that take ideas from the laboratory to the marketplace on the world stage. Our collaborative initiatives span Latin American, Europe and Asia.

Ramiro Jordan

Associate Dean for International Relations; Associate Chair and Director of Undergraduate Programs, Department of Electrical and Computer Engineering; Founder and Executive VP, Ibero-American Science and Technology Education Consortium (ISTEC)

The School of Engineering is at the forefront of preparing the graduates that the state and the nation will need. As a leader in engineering education, research, and service, the school focuses on brainforce development, and graduates engineering and computer science professionals who are ready to work anywhere. UNM Engineering is producing broadly educated students who may work in companies that have not yet been created, on technologies yet to be devised, to create solutions to specific problems, but to also help shape the intellectual edifice of humanity.

Chaouki Tanios Abdallah

Provost
Executive Vice President for Academic Affairs

centered on > success

Interdisciplinary research spurs growth at centers

Center for Biomedical Engineering (CBME)

Director: Andrew Shreve

Transforming a bulky hospital instrument into a true bedside device. Inventing new fabrics that actively kill bacteria. And figuring out how subtle changes in the shape of a human protein can lead to debilitating disease. These are a few of the many top-notch projects at UNM's seven-year-old Center for Biomedical Engineering (CBME).

¶ CBME researchers use engineering know-how to solve real-world medical problems, with a special emphasis on the huge problem of rising health care costs. To achieve this, their work spans the practical to the fundamental, from near-term inventions to long-term research. ¶ CBME's director, Andrew Shreve, is actively developing new partnerships around the university and with industry. "This is a really exciting cross-disciplinary area," says Shreve. "We're building a collaborative community of researchers at all levels from faculty to high school students." ¶ The center also focuses on education, including a class on Good Manufacturing Practices (GMP), a new doctorate in engineering with an emphasis on biomedical engineering, and a new master's degree in biomedical engineering. Students are being prepared for positions in academia and in laboratories across the nation and worldwide as well as in the large number of biotech companies in New Mexico. "These programs set the stage for some exciting opportunities and careers for our students," says Shreve.

NOTABLES

- Technology from David Whitten's Lab has just been licensed to a new start-up company (see page 16).
- The number of students in UNM's brand-new BME graduate programs is currently 19 and growing, well above the initial forecast.

Center for Emerging Energy Technologies (CEET)

Director: Andrea Mammoli

The Center for Emerging Energy Technologies (CEET) supports research on a range of technologies that can meet society's future energy needs, are scalable, and don't rely on finite resources or scarce materials. While energy conversion materials are still CEET's largest enterprise, Director Andrea Mammoli is expanding CEET's scope to systems and devices. Research activities will span three levels: materials science at the nanoscale, devices ranging from millimeters to centimeters in size, and systems that can measure from meters to several kilometers in size. ¶ In order to manage that breadth of research, Mammoli is increasing the number of collaborations to achieve shared goals in emerging energy technologies. CEET's newest partnership is with the Fraunhofer Institute's Center for Sustainable Energy Systems (CSE). Fraunhofer is a German non-profit organization that supports the transfer of technical knowledge into real-world applications. CSE shares CEET's interest in photovoltaics research, building energy systems and power grids, and it has a photovoltaic testing facility in Albuquerque. The partnership will help the center expand its research while providing internship and education opportunities for students.

NOTABLES

- In May, CEET and Japan's New Energy and Industrial Technology Development Organization (NEDO) unveiled a state-of-the-art microgrid facility outside of Albuquerque designed to be a showcase for future smart grid projects. (See UNM Engineering, Fall 2011.)
- CEET will be the first US academic participant in the DESERTEC Foundation, a global civil society initiative aiming to shape a sustainable future.

UNM's research centers were established to foster collaborative research between various disciplines and the public and private sector as well as to facilitate interdisciplinary advanced degrees for students. They've achieved those goals and, at the same time, have garnered international recognition for their work. Here are highlights on four of those research centers.



Center for High Technology Materials (CHTM)

Director: Steven Brueck

Founded in 1983, the Center for High Technology Materials (CHTM) is a preeminent center for interdisciplinary research and a powerful economic development engine in New Mexico. CHTM's annual research budget of \$7M to \$8M is funded by external research contracts from both federal agencies and industry. ¶ CHTM researchers and students study intelligent imaging from photonics to semiconductors. "We go from theoretical models to machines that build real focal plane arrays *and* we take the images with them," explains Steven Brueck, director. "Very few universities run that whole gamut." (See page 7 for an interview with Brueck.) ¶ The center's most active research areas include quantum dot infrared detectors, lasers, and superlattice detectors. In 2010, CHTM researchers developed the first multi-watt quantum dot VECSEL (vertical external-cavity surface-emitting lasers) to operate at long wavelength and high power, a significant step towards high power laser applications in display technology, telecommunications, and circuits. ¶ Lithography research is another of CHTM's biggest successes. Researchers have managed to shrink the process down to scales of only a few atomic spacings and are using lithography in many applications, including creating a revolutionary tunable laser. "In this process, we're finding new physics and new capabilities that will give us new devices," comments Brueck.

NOTABLES

- To date, 117 patents have been awarded and CHTM has helped spin off 11 start-up companies.
- More than 47 technologies (40% of CHTM's patents—a very high average) have been licensed. Some very large companies, including Samsung, Toshiba, and NEC, have licensed technologies developed by CHTM researchers.

Center for Micro-Engineered Materials (CMEM)

Director: Abhaya Datye

"Our center is focused on building an environment for collaborative, interdisciplinary nanomaterials research," explains Abhaya Datye, director of the Center for Micro-Engineered Materials (CMEM). "Nanoscience enables advances in many fields such as porous materials, catalysts and most recently, drug delivery for treatment of cancer," he says. Datye notes that the new Cancer Nanotechnology Training Center (CNTC) grant originated from collaborations created through such interdisciplinary research activities. ¶ CMEM provides state-of-the-art facilities for the generation and characterization of powders, mesoporous materials, nanomaterials, thin films, and coatings. CMEM also manages highly specialized nanomaterials characterization facilities in collaboration with the Earth and Planetary Sciences Department. Two state-of-the-art x-ray diffraction spectrometers were recently installed in a newly renovated lab. These machines give researchers the power to focus x-rays on small particles, thin films, and nanoscale materials such as meteorites to get high quality data. "This facility has unique *in situ* capability; not many places in the U.S. have that ability," explains Datye.

NOTABLES

- The Chinese Institute of Engineers-USA (CIE-USA) awarded CMEM faculty Hongyou Fan the prestigious Asian American Engineer of the Year Award for 2012.
- CMEM also supports the Nanoscience and Microsystems Engineering program, a joint degree program with the College of Arts and Sciences.



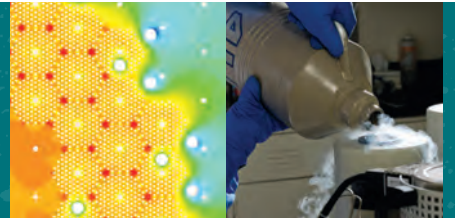
Researchers and students in the **Department of Chemical and Nuclear Engineering** are diligently working with the smallest building blocks in our world to engineer better, safer ways to power our planet; new consumer products; improved medical treatments; and much more. With six internationally-renowned affiliated research centers and strong academic programs, the Department is focused on engaging students in cutting-edge research and making lasting social contributions.

“Chemical engineers and nuclear engineers will play crucial roles in solving some of the grand engineering challenges of the next century. Through strong contemporary academic programs and relevant research, we endeavor to prepare the next generation of problem solvers to address these challenges.”

Tim Ward, department chair

chemical and nuclear engineering

Developing the Foundations for a Sustainable, Safe and Healthy Future



Creating a Healthier Future

UNM chemical engineers apply principles of biology to address drug delivery for cancer treatment, new materials for tissue repair, underlying molecular mechanisms for degenerative diseases, and novel techniques for diagnosing and sensing disease. This research is conducted in well-funded programs through the Center for Biomedical Engineering and the Center for Microengineered Materials.

Collaborative Energy Research

Energy-related research initiatives of ChNE faculty and other UNM faculty received a boost from the recent MOU with Sandia National Laboratories identifying energy technologies as one of several focus areas for collaborative engagement.

The Advanced Materials Laboratories will provide a venue for this research with the addition of a new X-Ray Photo-Electron Spectrometer (XPS), a powerful surface characterization

instrument that will help researchers develop novel materials for battery, fuel cell, and other energy technologies.

Materials and Nanotechnology

Students in the Nanoscience and Microsystems Program have been on the winning teams for the past two years at the UNM Technology Business Plan Competition. Their innovative nano-structured materials include solutions for power generation for mobile electronics and paint coatings with unique visual effects.

Reactor System Designs

What happens to the cooling system of a nuclear reactor under severe accident conditions? What are the risk assessment challenges? New assistant professor Edward Blandford will build a research program to address these challenges with funding from a \$400,000, 3-year Nuclear Regulatory Council (NRC) Faculty Development Grant.

RESEARCH DIRECTIONS

- Biological engineering
- Energy technology
- Materials and nanotechnology
- Nuclear non-proliferation
- Radiation interaction with materials
- Reactor system designs

NOTABLES

- Assistant professor Eva Chi won a National Science Foundation (NSF) CAREER Award, which will help her extend her research on drug delivery for Alzheimer's disease. In her groundbreaking research, Chi is seeking the answer to why proteins in the body go bad and how that affects the development of Alzheimer's.
- Funding from the Department of Energy's Nuclear Energy University Program (NEUP) provided scholarships for two undergraduates, a three-year, \$150,000 graduate fellowship, as well as infrastructure support.



As the **Department of Civil Engineering** celebrates its centennial anniversary in 2012, its leadership and faculty are taking a fresh look at fundamentals. Whether they're developing advanced materials, studying water resources, or creating intelligent transportation systems, the department's researchers and students consider the environmental impacts upfront and factor in ways to minimize them.

“Civil engineering, construction engineering, and construction management focus on the infrastructure systems of our society that define our quality of life. Now we’re refocusing on how we can improve that quality of life with sustainable infrastructure systems.”

John Stormont, department chair

civil engineering

Sustainable Infrastructure Systems



Taking the LEED

Civil Engineering faculty **Mark Russell** provides free courses each semester in the fundamentals of Leadership in Energy and Environmental Design (LEED), a certification program for sustainable infrastructure, to all Civil Engineering graduating seniors and graduate students. More than 20 students have received this valuable training since Russell started the program in 2011. Additionally, new courses are being developed in other building rating systems such as Green Globes and BREEAM.

Design First

The department's introduction to design course has undergone its own redesign to make it more engaging and inspiring for budding civil and construction engineers and construction managers. Now students start with a semester-long, hands-on design challenge, such as redeveloping the UNM duck pond. “This approach is more engaging. It teaches students about the design

process, sustainability concepts, and the ethics related to society from the start,” explains Stormont.

Infrastructure Insight

Most state highway agencies have tried to reduce moisture-induced asphalt damage by applying either liquid chemicals or hydrated lime. The problem is, they didn't know which of the products worked better. Until now.

Rafiqul Tarefder, associate professor and Regents' Lecturer in Geotechnical Engineering, used Atomic Force Microscopy to study the materials at the nanoscale. He was able to verify lime's superior performance. That finding has had a definite impact on the quality of our roadways *and* state budgets.

“The outcome of this research helps highway agencies save taxpayer dollars invested to combat moisture-induced wear and tear of the nation's roadway infrastructure,” says Tarefder.

RESEARCH DIRECTIONS

- *Advanced infrastructure materials and mechanics*
- *Environment, water and resource development*
- *Intelligent transportation systems*

NOTABLES

- *The Army Research office recently granted associate professor Andy Schuler a three-year \$418,000 award to harvest energy from bacterial metabolism in wastewater treatment. The project is being conducted through UNM's Center for Emerging Energy Technologies (CEET).*
- *Associate Professor Kerry Howe received a new one-year \$510,000 research contract from the South Texas Project (STP) Nuclear Operating Company to investigate industrial water quality and treatment issues.*



Computing is woven into the fabric of our lives, from the way we power our communities and manage finances to how we communicate and relax. Because computers are so prevalent in our lives, the **Department of Computer Science** is working towards giving everyone a better understanding of the role computers play in our lives while expanding research and education in four key areas that will help the department grow.

“We are thinking about where the world is going, what our role in that world might be, and what resources we have to fashion our exciting future.”

George Luger, interim department chair

computer science

Computing Everywhere and Everyone Computing



Computing in the Large

UNM computer scientists are studying ways to scale up computational systems, analyze the mountains of data being generated, and solve large societal challenges such as understanding activity in the brain. Using techniques from artificial intelligence and machine learning, CS researchers working with the Mind Research Network analyze neuroimages to best understand how they reflect cortical connectivity.

Cybersecurity

Taking a broad view of cybersecurity, UNM's computer science researchers are considering how to protect computational systems from malicious acts in the biological, electronic, and social realms. Through his groundbreaking research on Internet censorship in China, **Jed Crandall**, assistant professor, is also revealing important information related to intrusion detection and network security.

Computational Foundations of Life

Fine-grained, large-scale, and distributed computation permeates our universe, including the natural world, the man-made world, and everything in between. Living systems process and create information as a critical component of survival. For example, in the intersection of computer science and biology, bioinformatics, there are important algorithms to be identified. Computer science faculty, including **Melanie Moses** (with a PhD in Biology), **Stephanie Forrest** (the ACM 2012 Allen Newell Award winner), **Darko Stefanovic**, and **Lance Williams** address these issues.

Visual Computing and Physical Interaction

The ability to visualize and interact with data helps users actually see abstract ideas and experience new worlds. Assistant Professor **Joe Kniss** is pushing the envelope of the human computer interface with the HexDex, a hexagonal platform that moves with a player who rides on it while interacting

with a supersize screen or dome that immerses the player in a fully rendered environment, such as outer space.

RESEARCH DIRECTIONS

- *Computing in the large*
- *Cybersecurity*
- *Computational biology*
- *Visual computing and physical interaction*

NOTABLES

- *A team led by UNM CS received the ACM SIGSOFT Distinguished Paper Award at the premier academic software engineering conference, the International Conference on Software Engineering (ICSE).*
- *Assistant professor Tom Hayes received an NSF CAREER Award on randomized algorithms for sampling from enormous families of mathematical objects, as well as an NSF award on bridging the gap between physical intuition and computer science knowledge.*

High-efficiency solar panel materials that harness more power from the sun. Better brain imaging technology that detects disease more accurately. Robust and survivable cloud computing under large-scale natural disasters. And powerful infrared detectors that improve our national defense. Researchers and students in the **Department of Electrical and Computer Engineering** use a multidisciplinary approach to problem solving in the lab and the classroom to create the materials, devices, and systems that will improve life for everyone.



“We are embracing a culture of excellence in research, service, and teaching that prepares our students to lead the next generation of scholars and entrepreneurs.”

Luke Lester, interim department chair

electrical and computer engineering

Engineering Solutions for a Better World



Building a Better Robot

Research conducted in ECE will help robots become better at interacting with humans and their surroundings. This area of study, called cyberphysical systems, focuses on the communication, control, power, and energy needed for robots to do the things that biological creatures do naturally, such as climb stairs or navigate an unmapped region.

The multi-university Army Micro Autonomous Systems and Technology (MAST) grant led by ECE interim Chair **Luke Lester** and **Rafael Fierro**, assistant professor, studies how to accomplish these goals for crawlers and fliers that weigh less than 50 grams.

A New Generation of Intelligent Infrared Detectors

Sanjay Krishna, professor and Regent's Lecturer, and his research group have been developing fourth generation infrared detectors by encoding color, polarization, and gain in a pixel by

using a variety of nanoscale architectures including quantum dots, superlattices, and plasmonic structures. The concept of this “Infrared Retina” was awarded a U.S. Patent in 2011.

Krishna hopes to expand this success through a university-wide intelligent imaging initiative that integrates novel sensors with powerful signal processing techniques to solve a variety of problems in engineering, medicine, cancer research, and biomedical diagnostics.

Sustainable Energy Pathways

With a new \$1.7 million National Science Foundation grant, three ECE researchers and four others at UNM will develop novel energy harvesting devices designed to transform the electrical infrastructure into a more sustainable one. The broader goal is to foster new social behavior about this energy usage with approaches such as 3D animations and new apps for smart phones.

RESEARCH DIRECTIONS

- Brain imaging and data fusion
- Cyber-physical systems
- High power microwaves
- Intelligent imaging systems
- Smart lighting and high efficiency solar
- Space systems

NOTABLES

- *Edl Schamiloglu, Gardner-Zemke Professor, was awarded a high profile \$7.5 million Department of Defense Multidisciplinary University Research Initiative (MURI) grant to study innovative uses of metamaterials in controlling and radiating intense microwave pulses.*
- *Professor Majeed Hayat and colleagues won a \$1.05 million award from the Defense Threat Reduction Agency to mathematically identify precursors to cascading failures in power grids so that preventive actions can be taken to avoid massive blackouts.*



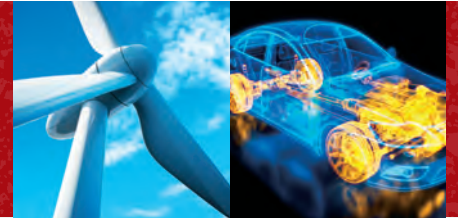
The **Mechanical Engineering Department** is aiming higher — much higher — these days. With new chair Chris Hall at the helm, the department will focus on space systems research and capitalize on New Mexico’s active space industry. He hopes to have space systems engineering graduate programs in place soon. Hall says space research meshes well with his other new vision for the department, more interdisciplinary projects.

“Mechanical Engineering is an inherently interdisciplinary field, traditionally dealing with mechanical systems such as automobiles, buildings and rockets. We are leading research and educating young engineers in the analysis and design of subsystems ranging from sensors made from nanomaterials to building energy control systems.”

Chris Hall, department chair

mechanical engineering

Meeting the Energy and Transportation Needs of an Evolving World



Building a Better Turbine

Wind energy has experienced substantial growth in the past decade, but to make it even more efficient and cost-effective, planners need a better understanding of airflow around and behind turbines.

Assistant Professor **Svetlana Poroseva** and her research group are developing fluid models that will provide accurate, reliable, and timely flow simulations. Those computations will be conducted in collaboration with Los Alamos National Laboratory. Poroseva’s group is also analyzing a promising new wind turbine design capable of generating energy at the low wind speeds that are typical for New Mexico.

Making Connections with Dynamic Research

How do complex, interconnected systems really *work*? Assistant Professor **Francesco Sorrentino** and his research group are finding out with their pioneering research. They’re

studying the stability of dynamic hypernetworks, networks of complex systems such as power grids or shoals of fish that are connected through two or more interaction mechanisms.

The results of this research are crucial in how we analyze and control systems. In one facet of his breakthrough research, Sorrentino is studying the interaction between the electrical gap junctions and chemical synapses in neurons in the brain. Better understanding of that process could ultimately be applied to neurophysics.

Space Partnership

This Spring, UNM and the Air Force Research Lab (AFRL) held a workshop to foster collaborative research between the organizations. The goal is to create a national multidisciplinary research Center of Excellence to advance research, education, training, and career options for faculty and students while supporting space systems development for space missions.

RESEARCH DIRECTIONS

- Energy systems
- Multi-scale systems
- Space systems

NOTABLES

- Research Professor **Matthew Pleil** was awarded a \$3.36 million National Science Foundation grant for the Southwest Center for Microsystems Education. This grant enables extensive outreach and training activities in the commercially thriving area of microelectromechanical systems (MEMS), with universities, community colleges, other NSF Centers, and high schools.
- A new **High Altitude Balloon Program** challenges teams of mechanical and electrical engineering students to launch various payloads using high-altitude balloons. The balloons, which reach an altitude of 100,000 feet, will be used as a platform for testing experiments in imaging, communications, and biotech.



Top Ten Finish, First Rate Program

UNM LOBO *MotorSports* (above) took home its best overall win to date in the Formula SAE in Lincoln, NM in June, combining prowess in marketing, design, endurance, and overall performance. The UNM team took home 5th place in presentation, 6th place in endurance, and 10th overall in the international competition.

The three-semester credited course teaches students hands-on engineering skills in research, design, manufacturing, marketing, management, finances, as well as teamwork and leadership.

The Smartest House Under the Sun

UNM students are helping design and build a house that will have almost every feature under the sun. It will be powered by the sun, too. UNM and Arizona State University (ASU) have been chosen to participate in the U.S. Department of Energy Solar Decathlon 2013, a biennial competition that challenges collegiate teams to design, market, and build solar-powered homes. Houses will be showcased in Fall 2013 at the national competition site at Orange County Great Park in Irvine CA.

The 860 square foot *aSUNm house* (above right) will combine an eclectic, modern design with features such as a solar thermal system for water heating, solar photovoltaic (PV) system for electric generation, and both AC and DC wiring. "Students are learning the

technical details required in planning an energy-efficient home," says **Olga Lavrova**, assistant professor in the Department of Electrical and Computer Engineering and one of the faculty leads for Team *aSUNm*. "They're also learning how to collaborate with people across disciplines, across universities, and across time zones."



First in Environmental Design

A team of UNM chemical engineering students won first place in the 22nd International Environmental Design Contest held at New Mexico State University in April 2012.

Craig Garcia, Zachariah Harris, Andrew Gomez, Stephen Clark, and Peter Crowder (above) received first place for designing an improved method for pretreating water on sea-going ships. The team developed a solution using an ultra-filtration membrane to remove particulates from seawater. The design can be applied to both seawater and inland applications, reducing the environmental impact produced by the current pretreatment process.

Internship Program Expands

Close to fifty UNM Engineering students were busy over the summer with paid 2-month internships at high tech companies, engineering firms, national labs, state agencies, and research with UNM faculty. The internships are part of the NSF-funded Science, Technology, Engineering and Mathematics Talent Expansion Program (STEP), which offers mentoring, conference participation, career development and paid internships to freshmen and sophomores.

Some students used the summer to develop a launch and recovery system for high altitude helium balloons with equipment donated by the U.S. Air Force Research Laboratories. Interns at Los Alamos National Laboratories worked on projects ranging from researching less expensive ways to desalinate water, to building data-fitting software to find parameter values for cell signaling systems, to reworking 3-D modeling software to recreate a shell for computing high intensity physics calculations.

The program was so successful that UNM Engineering Dean Catalin Roman wants to expand it. Tariq Khraishi, who leads STEP, was appointed Assistant Dean for Internship Programs and he will work with STEP Coordinator Susan Buffington to double the number of internships and enable students of all levels to participate.

UNM Engineering Welcomes New Faculty

Chemical and Nuclear Engineering

Sang Eon Han, Assistant Professor

Han received his PhD in Chemical Engineering from the University of Minnesota in 2009 and worked in the



NanoEngineering group at MIT as a postdoctoral scholar. His research is on photonic crystals and plasmonics with applications to solar

and thermal energy harvesting. Prior to his PhD, Han was a research scientist at LG Chem working on optical thin films for liquid crystal displays.

Edward Blandford, Assistant Professor

Before coming to UNM, Blandford was



a Stanton nuclear security fellow at the Center for International Security and Cooperation (CISAC) at Stanford University. His

research focuses on advanced reactor thermal-fluids, best-estimate code validation, reactor safety, and physical protection strategies for critical nuclear infrastructure. Blandford received his PhD in Nuclear Engineering from the University of California, Berkeley in 2010.

Civil Engineering

Gregory Gould, Assistant Professor in Sustainable Transportation Engineering

Gould comes to UNM from the Natural Resources Defense Council in Santa Monica, California, where he was a Transportation and Air Quality Science Fellow. His interests span transportation

and air quality issues with a particular focus on the environmental and



financial sustainability of transportation systems and environmental justice. Gould received his PhD in Civil and Environmental Engineering from University of California, Davis, in 2010.

Computer Science

Michalis Faloutsos, Department Chair (starting in January 2013)

Faloutsos is well known for his work in Internet routing, cyber-security, complex systems, and ad hoc networks. He received the ACM Test of Time award in 2010 and his research has been supported by many NSF and military grants for a cumulative total



of more than \$6 million. Faloutsos co-founded a cyber-security company in 2008, offering services as stopthelacker.com, which received two SBIR grants from the National Science Foundation and institutional funding in Dec 2011. He comes to UNM from the University of California, Riverside, where he is a professor of computer science. Faloutsos earned his PhD in Computer Science from the University of Toronto in 1999.

Patrick Kelley, Assistant Professor

Kelley's research is in the area of



information design and security policies, and he has a special interest in educating users about privacy concerns

on the web through design and data visualization. He earned his PhD in Computation, Organizations, and Society at Carnegie Mellon University.

James Willson, Lecturer 2

Willson has been a research assistant and teaching assistant at Washington



University and The University of Texas at Dallas, where he received his PhD in Computer Science in 2011. His research interests include computer networks

and software systems, including wireless networking, mobile computing, parallel and distributed systems, social networks, and network algorithm design.

Electrical and Computer Engineering

Daniel Feezell, Assistant Professor

Feezell joins UNM after being a Project Scientist in the Materials Department and the Solid-State Lighting and



Energy Center at the University of California, Santa Barbara. His research interests include growth, fabrication, and characterization of

group III-nitride materials and devices for energy efficiency and renewable energy applications. Feezell received his PhD in Electrical and Computer Engineering from the University of California, Santa Barbara in 2005.

Welcome

Five for Steve Brueck

UNM Distinguished Professor **Steve Brueck** has mentored more than 34 students who have received advanced degrees and is a highly-published researcher in the fields of optical lithography/microscopy, nonlinear optics, and nanophotonics. As director of the Center for High Technology Materials (CHTM), Brueck has overseen the Center's growth for 26 years. Here he reflects on his own achievements and what's made CHTM such a success.

NOTABLES

- *Fellow of the American Association for the Advancement of Science*
- *Fellow of the Institute for Electrical and Electronic Engineers*
- *Fellow of the Optical Society of America*
- *Founding editor of IEEE Journal of Special Topics in Quantum Electronics*
- *Awarded the 2000 IEEE Third Millennium Medal*



What are you most proud of in your career?

The long term success of CHTM. It's a testimony to the UNM leadership and the faculty and students we are able to recruit. The contributions of many faculty, staff, and graduate students have enabled this long track record.

What's a research highlight for you?

My group is internationally known for our work in nanoscale optical lithography and in the functional materials that this capability enables. We have contributed to epitaxial materials growth, semiconductor lasers, nanophotonics, infrared detection, and nanofluidic studies of biological structures.

How has CHTM contributed to economic development in New Mexico?

Our most important contribution is the large number of students—about 400—that have graduated with advanced degrees awarded for research conducted at CHTM. Many of them remain in New Mexico and are contributing to the economy and building the state's high-technology core. The faculty have started companies, often with students or colleagues from UNM or the national laboratories. CHTM has also provided access to equipment, expertise, and consulting to a range of companies.

What is the latest start-up company out of CHTM?

Our newest start-up is SKInfrared, LLC, founded by Sanjay Krishna, professor and Regents Lecturer, and his wife Sanchita Krishna, a cancer biologist. They're collaborating with the UNM School of Medicine to apply Sanjay's infrared imaging technology to medical applications, including early detection and diagnosis of skin cancer.

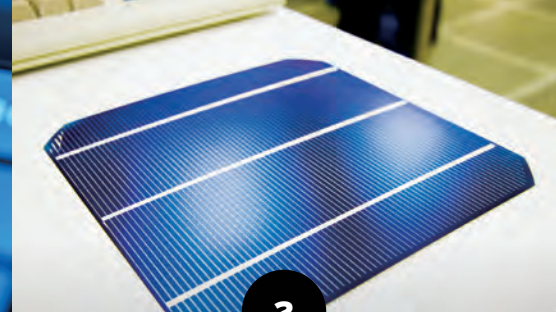
What makes CHTM such a valuable partner?

We have a multidisciplinary environment, a culture of collaborative applied research, and a well-established track record of research funding. We also emphasize intellectual property development so that our work is available for small companies to adopt and commercialize.

Agents of Change



1



2

UNM Engineering partners in four ERCs, expanding research and education

The National Science Foundation's Engineering Research Centers (ERCs) are change agents bringing together educational institutions and industry to address global challenges. One of the goals is to create new industries or transform existing industries; another is to expose graduate and undergraduate students to interdisciplinary research. A focus of every ERC is actively involving groups traditionally underrepresented in engineering to exceed the national engineering-wide averages.

UNM Engineering offers qualities that make it an excellent ERC partner, including proven research teams, a substantial underrepresented population, and a culture of discovery and innovation. UNM Engineering is a partner in four of the 22 ERCs, joining only two other institutions at this level – the Massachusetts Institute of Technology (four ERCs) and the University of California at Berkeley (five ERCs).

“UNM Engineering participates in four of only 22 active centers nationwide. Very few other schools have achieved this level of participation in these prestigious, highly competitive awards.”

STEVEN R. J. BRUECK

UNM Distinguished Professor of Electrical and Computer Engineering, Director of the Center for High Technology Materials, UNM Lead for NASCENT and for the Smart Lighting ERC

Innovations in Mobile Computing

In September 2012, NSF announced a new ERC to develop nanoscale manufacturing systems for mobile computing, the Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies (NASCENT) Center. UNM is collaborating with the University of Texas at Austin, the lead institution, and the University of California Berkeley to develop innovative nanomanufacturing, nanosculpting and nanometrology systems that could lead to versatile mobile computing devices such as wearable sensors, foldable laptops and rollable batteries.

UNM activities will be led by **Steve Brueck**, distinguished professor of Electrical and Computer Engineering and director of the Center for High Technology Materials. A testbed for nanomanufacturing metrology will be built at CHTM on UNM's south campus.

“This grant is testimony to the research accomplishments and national competitiveness of our faculty,” says UNM President **Robert Frank**. “Mobile devices play such a big role in all of our lives now and our students will have an opportunity to participate in cutting edge research that will impact their future development.”

On a Quest for Revolutionary Materials

<http://qesst.asu.edu>

The Quantum Energy and Sustainable Solar Technologies (QESST) ERC is helping create revolutionary energy devices through the development of new photovoltaic technologies and materials. Ultimately, these materials could be integrated into everything from solar cells on buildings to tiny solar devices on backpacks and clothing. Led by Arizona State University with 11 universities from around the world, QESST is one of the NSF's largest ERCs.

UNM will serve as the integrated photovoltaic testbed for the QESST ERC and will lend expertise on quantum dot solar cells and novel semiconductor materials. “We will study how to combine the many different material designs from our partners into a single solar module that will be much more efficient than current technology,” says **Olga Lavrova**, assistant professor in the Electrical and Computer Engineering Department (ECE) and ERC testbed leader.

Lavrova will use unique electrical circuits and optical techniques that will slice the solar spectrum into multiple bands and then direct the light onto photovoltaic devices that optimally harvest the incident energy. Testing results will help participating organizations refine their materials and transform them into marketable products.



3

Lights Get Smart

<http://smartlighting.rpi.edu>

Rensselaer Polytechnic Institute leads the Smart Lighting ERC and collaborates with four universities including UNM to produce “smart” lights, devices that not only generate light but emit it at wavelengths which can be modulated to transmit the Internet, play music, and much more. The ERC is now in its fourth year.

In one facet of the research, **Payman Zarkesh-Ha**, ECE associate professor, is focusing on Visible Light Communication (VLC) to create an LED light that will illuminate an environment for data communication. “VLC has become a very attractive research topic in the lighting industry,” he explains. “It’s projected that the new light version of WiFi, called LiFi, in conjunction with conventional WiFi technology, will become a major wireless communication technique for indoor applications.” Zarkesh-Ha is developing a new device that integrates LED and photo detector arrays on a single chip that can enable blazing fast data speeds for visible light communication.



4

Biorenewable Chemicals ERC

<http://www.cbirc.iastate.edu>

The amount of fossil fuel on earth is limited, and the energy we get from it will run out someday. Iowa State University leads the Center for Biorenewable Chemicals (CBiRC) ERC, and the 12 universities are working to replace our world’s petroleum feedstocks with renewable feedstocks that can be transformed into bio-based chemicals. While energy can come from various sources such as the sun or nuclear reactions, all chemicals and liquid fuels are based on carbon-containing molecules. Recently, CBiRC made it past the important NSF three-year review and is now in its fourth year. At UNM, the CBiRC is housed in the Center for Micro-Engineered Materials (CMEM).

“What we bring to the table is the ability to synthesize and study catalysts at an atomic scale,” says **Abhaya Datye**, distinguished professor of chemical and nuclear engineering and director of CMEM. “Our role is in nanoscale engineering of these catalysts and how to modify them and make them better.” In conjunction with other ERC team members, Datye has already developed a new process that helps protect oxide catalysts from liquid water at high temperatures and pressures. Biomass always contains water, so the novel coatings developed at UNM serve as a protective layer making the catalyst last longer and stay more active.

After UNM creates the catalysts, the other partners in the ERC use them in reactions that will ultimately make it possible for a biorefinery to replace the petroleum refineries we depend on today.



Industry Participation

A mix of international organizations, large and small companies, as well as start-ups help each ERC stimulate entrepreneurship and speed technological innovation for technology transfer. For example, QESST has attracted dozens of companies involved in manufacturing, materials, production and installation. Close to 30 industry members work with CBiRC, and through CBiRC’s Innovation and Industry Collaboration program, member companies leverage a unique network of highly respected expertise from academia and industry.

Reaching Out to the Community

Each ERC also seeks to engage and encourage pre-college students in the engineering enterprise. During the summer of 2012, for example, UNM participants in the QESST ERC sponsored a residential camp for economically disadvantaged incoming freshmen. The students learned how to fabricate and solder solar cells as well as design and race solar cars. At the weeklong UNM Smart Lighting camp, middle and high school students explored light emitting diodes. These ERCs also mentor high school interns who conduct research in UNM laboratories.



Stephanie Forrest Receives International Acclaim

Computer Science Professor **Stephanie Forrest** has received international recognition for significant contributions to the fields of cyber security and biology. The Association for Computing Machinery (ACM) selected Forrest for the **2012 Newell Award** in recognition of her fundamental, paradigm-changing contributions to computer science and the biological sciences, most notably for bringing together models of immune systems, automated diversity, and network epidemiology, with significant impact on real computer and biological systems research and practice.

Forrest's expertise was requested at the prestigious **World Economic Forum** Annual Meeting 2012. In a session titled "Managing Complexity with the Santa Fe Institute," Forrest and three other speakers addressed the question, "How can the latest research in complex systems enhance resilience and performance?" She also spoke on a panel titled "Risks in a Hyperconnected World," which examined risk management and risk resiliency.

UNM selected Forrest as the **2012 Annual Research Lecturer** in recognition of her exceptional abilities and knowledge, outstanding research efforts, creativity, leadership, and mentorship to a number of students and faculty.

Recognizing Innovation

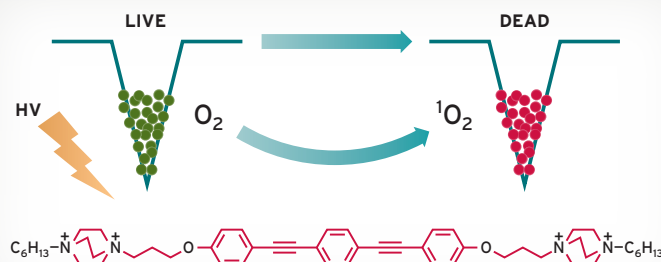
STC.UNM, the University of New Mexico's technology transfer office, honored UNM faculty and researchers who received patents and disclosed copyrights at an awards ceremony on April 25. Engineering faculty and researchers were among 44 UNM faculty, staff and students to be honored. Several UNM Engineering innovators were issued more than one patent; **Steven J. Brueck**, Director of the Center for High Technology Materials, was issued six patents last year.

Stephen D. Hersee received the 2012 Innovation Fellow award from STC. UNM for the number of technologies he developed and their economic impact in the marketplace. Hersee retired from UNM in Spring 2012 and was a professor in the Department of Electrical and Computer Engineering and member of the Center for High Technology Materials.

Recent Start-Ups Tackle Health Challenges

P.D. Laboratories signed an agreement to license technology developed by **Sang M. Han**, professor in the Departments of Chemical and Nuclear Engineering and Electrical and Computer Engineering and **Mani Hossein-Zadeh**, assistant professor in the Department of Electrical and Computer Engineering. The company will develop two technologies for separating and detecting protein biomarkers in blood for the presence of heart, cancer, and infectious diseases.

Oligocide, Inc. was co-founded by Research Professor **David Whitten** from the Department of Chemical and Nuclear Engineering and Center for Biomedical Engineering and Professor Kirk Schanze from the Department of Chemistry at the University of Florida. The company was formed to commercialize a novel platform of antimicrobial materials that kill bacteria, viruses, and some fungi more effectively than industry-standard antimicrobials.



Materials developed by Oligocide completely kill all bacteria in a biofilm (film containing large colony of bacteria) with light.

Critical Gift for a Capital Need

In 2008, former Computer Science Chair Stephanie Forrest faced the dilemma of overflowing computer classes, cramped settings, a lack of dedicated lab space, as well as unhappy faculty and students. So she turned to CS alum and long time scholarship supporter **Jeff P. Van Dyke** of VanDyke Software for help.

Thanks to a very generous capital gift from Van Dyke, the Computer Science Department was able to use shell space in the Centennial Engineering Center to create a large, configurable computer lab space dedicated for use by students and faculty. "I know the important role quality equipment and lab space play in the education of students," says Van Dyke. "I was very happy to be able to help the Department fulfill this need."

Quiet Transformational Philanthropy

During the 2011-12 academic year, a two time alum got to know his alma mater better and discovered current and long terms needs. The more he learned, the more he wanted to help make a systemic change to his "home" Department. He committed to a significant planned gift that will ultimately fund a much-needed endowed faculty position. "I was offered the chance to help effect a change," says the donor. "I made my ideas known and described the changes I would like to see. You don't have to be a member of the 1% to bring about change."

Crafted in collaboration with a program, a department, or the School as a whole, estate gifts can be a way to make your plans.

Widening the Circle

After receiving his B.S. in Electrical Engineering in 2008, **Jake Hollowell** made a promise to himself to repay the generosity he received through scholarship support while at UNM. Within a year of his graduation, he fulfilled that promise and made a donation to help current UNM Engineering students with their financial needs.

Achieving that success boosted his confidence. Hollowell decided to aim higher and invite friends and family to create an endowed scholarship for others who share his values. Fellow alums, friends, and family supported his efforts and created the Visionaries of Infinite Potential (VIP) Endowed Scholarship.

The scholarship supports undergraduate students with financial needs who are committed to giving back through volunteering and eventually making donations of their own. Initial donors include fellow Engineering alum **Daniel Garcia** (BSME '07, MSME '09), UNM alums **Noel King** and **Brian Hesch**, Jake's mother **Virginia Hollowell**, and friend **Judson Williams**.

"The VIP Scholarship encourages everyone to consider setting small goals that can be achieved and then exponentially setting higher and higher goals," Hollowell says. "As Napoleon Hill said, 'Anything the mind can conceive and bring itself to believe it can achieve.'"

Supporting Next Generation Imagers

Raytheon Vision Systems (RVS), one of the leading suppliers of infrared technologies worldwide, is supporting exploratory research on a new generation of intelligent infrared detectors at the Center for High Technology Materials (CHTM). "RVS seeks high caliber partners for fundamental research and development," says **Ed Smith**, Senior Principal Engineer at RVS. "CHTM has a strong reputation in the infrared industry for original and novel work in all areas of infrared device technology."

Steven J. Brueck, CHTM director, and Sanjay Krishna, professor in Electrical and Computer Engineering and Regents Lecturer, are leading the new project. Krishna's group is internationally recognized in the area of infrared imaging, while Brueck's group is a pioneer in the fabrication of near infrared metamaterials.

"The gift by RVS will help us explore 'Meta-Infrared', the idea of combining metamaterials and plasmonics with infrared detectors to incorporate color, gain, and polarization in the pixel," says Krishna. "This is similar to creating cones in the human eye that are sensitive to different colors."

Applications for this novel enhanced infrared technology include enabling a pilot to see the landing strip in color through smoke or fog and a neurosurgeon to locate a blockage in a cerebral shunt.



Did the UNM School of Engineering change your world?

If so, help ensure that it changes the world for others, too! Include the School of Engineering in your legacy plans. To learn more about estate planning opportunities, contact the UNM Engineering Development office, 505.277.0664 /courtg@unm.edu

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

Graduates of 1962 Return for Golden Grads Reunion

In May, the UNM School of Engineering hosted a reunion for the Golden Grads (BS, MS & PhD) who earned their degrees fifty years ago. The festive occasion included lunch, updates about the School, and tours. Attendees reminisced about their time at UNM and shared a few career highlights.

Many who attended worked at Sandia National Laboratories and related their experiences helping produce the first nuclear weapons, monitoring the test ban treaty, dismantling arsenals, and participating in research and development. "It was an honor and pleasure to learn more about our 1962 Golden Grads," Dean Catalin Roman said. "They have played a very important part in our nation's history and I felt deeply moved by listening to the stories they were able to share with us."



Golden Grads Heinz Schmitt, Anthony Russo, and John Kane were in the first class of the Technical Development Program at Sandia National Laboratories. Photo courtesy of Sandia National Laboratories



(above) Mechanical Engineering Golden Grads and ME faculty

(right) Electrical Engineering Golden Grads and faculty

