THE UNIVERSITY OF NEW MEXICO SCHOOL OF ENGINEERING

SPRING 2005

UNM engineering

The Biology of Computer Security

From the Dean

responsibility

Public Responsibility and the School of Engineering

For most universities, "public responsibility" is an important part of the core mission. This can take many forms, but one salient aspect encompasses activities that directly benefit the university's regional community. This is particularly important for state supported institutions, like the University of New Mexico. Moreover, the School of Engineering at UNM is uniquely positioned to play a major role in helping ensure that UNM meets these objectives. Part of this derives from the fact that engineering, as a profession, is fundamentally concerned with improving the welfare of society. Societal implications permeate our practice and education. But another important part stems from the culture of our School of Engineering, a culture that embraces a myriad of exciting interactions with our regional partners.

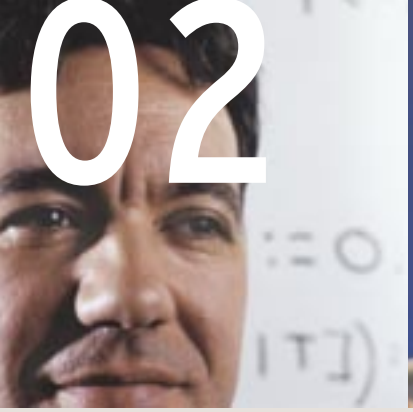
There are four broad aspects to how we at UNM School of Engineering view our public responsibility. Educating the technical workforce and providing an excellent education in engineering and computer science is certainly our primary responsibility. Second, the research we do here ranges from working on solutions to critical societal problems to important technical innovations that improve lives. You'll read about some of these teaching and research initiatives in this issue. Intellectual property generation and commercialization are the third components of our public responsibility. Out of twelve UNM startup companies, nine use School of Engineering patents. Of the fifty-one UNM inventors campus-wide, twenty-seven are from the School of Engineering. Fourth, our collaborations support regional interests and fortify New Mexico's economy.

This issue reflects our contributions to the public welfare with articles on how three UNM researchers are improving our lives through technological developments. Professor Stephanie Forrest translates biological processes into programs that protect privacy and shield computers from attacks. Professor Manuel Hermenegildo and his multi-national team are creating tools for developing smarter computer code that will result in software systems that are far more reliable, timely and efficient. Professor Steve Brueck's innovative approaches in nanolithography and suite of tools have multiple applications in nanotechnology.

UNM joins with more than 50 other universities around the country in encouraging more interest in engineering and science in grades kindergarten through twelve, thanks to a National Science Foundation GK-12 Grant. This grant funds fellowships so that engineering and science graduate students can serve as resources for science and math teachers in the public schools.

At the UNM School of Engineering, societal implications permeate our practice and education—and this issue! We hope you enjoy reading it.

Joseph L. Cecchi
Dean of Engineering



Points of Pride

Darko Stefanovic, assistant professor of computer science, was named the School of Engineering's Regent's Lecturer based on his outstanding research, teaching, and service accomplishments. Stefanovic has several grants funded by the National Science Foundation and continues to pursue further research funding.

Edl Schamiloglu, professor of electrical and computer engineering, is leading a team of School of Engineering and Math and Statistics faculty members to develop the Institute for Infrastructure Surety (IFIS). The Institute will study threats to civilian infrastructure and their mitigation. For more information on IFIS, visit www.ece.unm.edu/ifis.

Ron Lumia, professor of mechanical engineering, was elected as an Institute of Electrical and Electronics Engineers Fellow in January 2005. He was selected for his "leadership in the development of open architecture control systems for applications in robotics and automation." Lumia was one of a select group chosen for the honor after rigorous evaluation by the IEEE board of directors.

Kerry Howe, assistant professor of civil engineering and water treatment expert, is co-author of *Water Treatment Principles and Design,* a recently completed textbook that will be used by numerous universities to teach water treatment courses. Howe is also conducting several water quality and quantity research projects.

Sang Han, assistant professor of chemical and nuclear engineering, has been awarded a highly competitive $1 million, four-year National Science Foundation Nanoscale Interdisciplinary Research Team (NIRT) proposal. The proposal is entitled "NIRT: Fundamental Understanding of Nanofluidics for Advanced Bioseparation and Analysis." Co-primary investigators on the proposal are Steve Brueck, professor of electrical and computer engineering, professor of physics and astronomy, and director of the Center for High Technology Materials; Gabriel López, professor of chemical and nuclear engineering; Dimiter Petsev, research assistant professor of chemical and nuclear engineering; and Cornelius Ivory, Washington State University.

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UNM Engineering
Spring 2005
Volume 2, Number 1

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UNM Engineering is published by the University of New Mexico School of Engineering.

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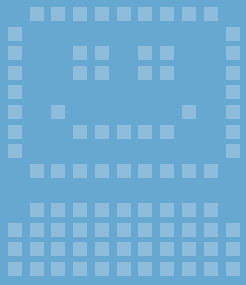
www.soe.unm.edu

"Right now, most software programs are riddled with bugs that cause small nuisances or major malfunctions."

Professor Manuel Hermenegildo



re-tooling COMPUTER PROGRAMMING

MULTI-NATIONAL TEAM CREATES TOOLS FOR DEVELOPING SMARTER CODE

FROZEN KEYBOARDS. ERROR MESSAGES. LOST DATA. SYSTEM FAILURE.

UNM Computer Science Professor Manuel Hermenegildo is working to make the software glitches that cause everyday annoyances—and catastrophic accidents—things of the past. As the University of New Mexico Prince of Asturias Endowed Chair in Information and Technology, Hermenegildo leads a team of computer scientists and engineers that is advancing the state of the art in program development.

"Right now, most software programs are riddled with bugs that cause small nuisances and major malfunctions. Computer programs are pervasive; they're at the heart of every artifact out there. So if computer programs are behind all the devices, we better find a way to write those programs so that they don't have errors and they're able to do the tasks that they're supposed to do," says Hermenegildo.

Hermenegildo's ultimate goal is to help developers build error-free software and to expedite the code writing process. He has assembled a multi-national team of graduate students and faculty to work on the research. His collaborators include graduate and Ph.D. students in Spain and Argentina, as well as faculty members at the Technical University of Madrid in Spain. The team also collaborates with researchers from several other countries, including the United Kingdom, Australia, Denmark, and Germany. Together they're creating a sophisticated toolbox for programmers. That toolbox will include a higher-level language for writing smarter, simpler code: tools that verify software and find bugs, and certified modules, or blocks of pre-approved code.

Tool 1: A Smarter Language

The first step in the process is to replace today's relatively low-level languages, which often result in what Hermenegildo calls "unmanageable code," with a higher-level computer language. The more powerful statements used in a higher-level language allow programmers to write code that is closer to the problem being solved than to the computer's machine code.

Not only does a higher-level language speed the writing process, but it makes it easier to find bugs in the program. In addition, the simplified format helps the software developer and the end user understand the code better.

Hermenegildo's team has already developed a higher-level language called Ciao. Ciao is open source code, available at http://www.ciaohome.org.

Professor Manuel Hermenegildo leads a team that is creating tools to change the process of writing computer programs.

> "If we eventually put it out there, I think the world will change."
>
> Computer Science Professor Manuel Hermenegildo

Several thousand people around the world are already using Ciao to write applications that range from streamlined electronic commerce software to artificial intelligence systems.

Ciao contains a novel combination of programming features, including functions, predicates, constraints and assertions, which allow software developers to actually describe instructions and knowledge in a natural way. Traditional computer languages are imperative and require programmers to write commands as a long series of relatively small steps. Ciao is more declarative, allowing programmers to separately describe what needs to be done, rather than how it needs to be done. Using Ciao, programmers can write the logic of the problem and then have the computer reason about the problem.

Hermenegildo says that advances like predicates and constraints aren't widely used in computer languages today, but he expects them to "percolate" to the point where mainstream languages will eventually adopt the ideas, in the same way that other advanced languages features, such as garbage collection, are now present in some of these mainstream languages, like Java.

Tool 2: Certified Programs

Whether it's software for a $50 accounting program or a piece of multi-million dollar medical equipment, chances are it's not verified to always run correctly. Hermenegildo says only a very small percentage of software programs today are fully certified. "The problem with the certification process we have right now is that it's slow, tedious and expensive," he says.

To put the challenge of certification in perspective, he gives a basic calculator program as an example. If a programmer needed to test every possible number combination for the calculator, the process would take a few centuries. The standard procedure for checking software today is for one team to program the software and a different team to conduct a limited number of spot tests on the completed code. Only after the software is installed in a device and shipped to thousands—if not millions—of users can undetected errors start to surface.

While they're designing structures, civil engineers and architects use tools that certify the structure's stability. Providing similar tools to certify a program's functionality is one of computer science's fundamental objectives, first proposed by Professor Tony Hoare. Hermenegildo and his team are determined to convert this objective into practical tools suitable for everyday use. They envision tools that can be used routinely and as an integral part of the development process, such that the program is verified against specifications and errors are flagged while the program is being written.

Hermenegildo put that theory to the test successfully with a program development tool he calls CiaoPP. The tool was written using the Ciao language. "We now have a tool that in a good number of cases can reason accurately about complex properties of a program, including resource usage characteristics like time or memory consumption and other security elements," explains

Hermenegildo. "I believe we really have a number of clear firsts in some of these areas."

The principles of the certification process are general. Hermenegildo says that with time they could be applied to all computer languages. "The scientific advance is how to automatically infer interesting properties of programs. With our techniques, which are, in turn, based on the technique of 'abstract interpretation,' you can automatically infer that a program will take a long time or a short time. Right now, it's hard and tedious for programmers to look at a program and say it will take a certain amount of time," explains Hermenegildo.

Currently CiaoPP only works for the Ciao language and in its own particular environment. The team distributed the beta version of the program to a few universities for research. Soon, they will release the program to the public.

Tool 3: Building Blocks

Ciao facilitates code writing and CiaoPP certifies the higher-level code while it's being written. Then programmers can use Ciao and CiaoPP to create the last element in the toolbox: verified component-based software, essentially modules of computer code certified to do a specific function time after time without any errors.

Imagine an engineer designing a new car. Rather than write and test new software for the car's brake system, he could order verified software components designed to control an automotive brake system. Not only would he have the code he needed right away, the code would be certified to be free of bugs. Eventually, programmers would be able to pull these modules off the shelf, and link them together to write problem-free programs much faster.

Tools To Build The Future

Efforts such as Hermenegildo and his team's high-tech toolbox would change the way programmers work and reduce the costs of software development and maintenance. But the implications extend beyond the realm of programming to changing the way the world works. Hermenegildo sees programmers, designers and engineers freed to achieve bigger, better goals. "The future of this research is that these ideas work on all programs, all the time, and with all the computer languages people use everyday. This will require combining our techniques with those developed by other teams and also some new advances. But if we eventually put it out there, I think the world will change. If we can reduce the complication, then we can think at a higher level and do better and more interesting things." ✦

A ROYAL VISIT TO THE SCHOOL OF ENGINEERING

Last October, the University of New Mexico and the School of Engineering were honored to host Their Royal Highnesses, the Prince of Asturias, Don Felipe de Borbón y Grecia, his wife Princess Letizia, and Mr. Iñigo de Oriol e Ybarra, the President of Iberdrola, Spain's electrical utility.

His Royal Highness and Oriol e Ybarra met with administrators and faculty regarding the Prince of Asturias Endowed Chair in Information and Technology. The $1.5 million endowment, established in honor of the heir to the Spanish throne, is funded by Iberdrola. Also during the visit, Oriol e Ybarra received the University Medal from UNM for his efforts in organizing the endowment.

"Thanks to the vision of men like His Royal Highness and Sr. Oriol e Ybarra, President of Iberdrola, UNM has become one of the leading universities in the western hemisphere in its commitment to advancing the state of information science and technology throughout the Americas," said University president Louis Caldera.

Through the endowment, a UNM research team is pursuing advancements in information science and technology. Iberdrola is interested in the research as a way to optimize many of its corporate functions. Manuel Hermenegildo, professor of computer science and electrical and computer engineering, holds the chair. The endowment also funds three graduate assistantships and three undergraduate international scholarships.

The entire program is generating significant scientific results and strengthening a valuable international partnership. "With the Chair's international dimension, this is truly an exceptional opportunity for UNM to take an important role in the continued development of the U.S./Spain bilateral relationship in science and technology," said Joe Cecchi, dean of the School of Engineering.

The UNM endowment is one of three in the United States named for the Prince of Asturias, and the only one outside the humanities. ✦

THE BIOLOGY OF COMPUTER SECURITY

NAME THIS SYSTEM: IT EFFECTIVELY PROTECTS ITS HOST FROM FOREIGN ATTACKS. IT'S EXTREMELY RESILIENT AND ABLE TO ADAPT TO CHANGING ENVIRONMENTS. IT'S MASSIVELY PARALLEL WITH AN ESTIMATED 10^8 INDEPENDENT COMPONENTS RUNNING AT THE SAME TIME. AND IT'S ALL AROUND YOU.

WHAT *IS* THIS AMAZING ORGANISM? IT'S YOUR IMMUNE SYSTEM. AND IT'S THE MODEL FOR A NEW CLASS OF COMPUTER SECURITY PROGRAMS CREATED BY A RESEARCH TEAM LED BY STEPHANIE FORREST, PROFESSOR OF COMPUTER SCIENCE AT UNM.

A Multidisciplinary Dialogue

Forrest has been exploring ways to apply concepts from biology—particularly the immune system—to computer security since the early 1990's. "I was interested in the immune system as a computational device. It performs a lot of information processing and it does it in a way that's very different from how our computers work today. Our immune systems do an especially good job of noticing when you're infected, deciding what response is appropriate, selecting a response and knowing when to turn it off," explains Forrest.

Since she began her research, Forrest and a team of collaborators have translated biological processes into programs that protect privacy and shield computers from attacks. "It's a dialogue between biology and computer science. It's not a one way mapping, but rather a conversation between the two disciplines," says Forrest. The approach was a breakthrough in computer science. "There are few other groups that have focused as deeply on biology and computer science as we have." Other institutions and researchers are now delving into the field.

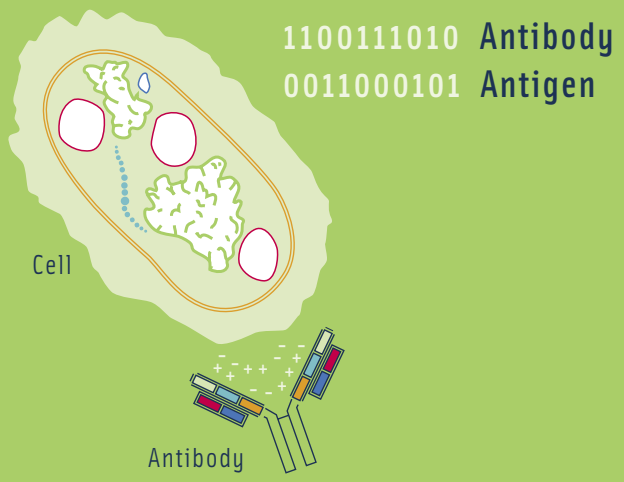
From Principle to Program

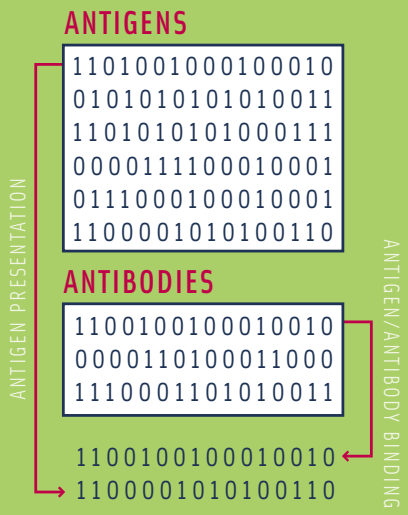
New commercialized security products already use concepts that stem from Forrest's line of research. Now she and graduate student Justin Balthrop are working together with Matthew Williamson, Senior Research Scientist at Sana Security Inc., on a personal computer firewall called Riot. The program uses immunological principles to detect and respond to attacks from worms and email viruses.

"I think computer security has become a problem of national significance."

Stephanie Forrest, UNM Professor of Computer Science

Immune System Modeling





MOVING FROM BIOLOGY TO BITS: Recognition of foreign material in the immune system is accomplished by binding between complementary cell-surface molecules. The left side of the figure shows an antibody molecule (a detector) binding to an epitope of a possibly infected cell. To represent this process in bits, a string of ones and zeros is used to represent each molecular pattern. Then, binding between two strings is determined according to a match rule (e.g., at how many positions in the string are there corresponding symbols?), as shown on the right side of the figure.

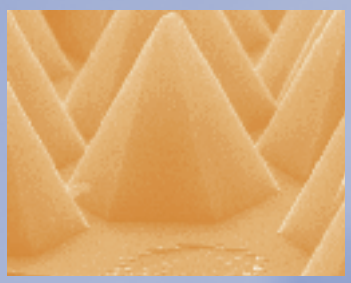
On the detection side, Riot generates detectors, which are random strings—each, a unique combination of sixty to seventy zeros and ones—that can learn a computer's normal rate for making various connections to other computers, like *http* connections for searching the web and *smtp* connections for sending email. Attacks on the computer cause connection rates to rise, so the detectors go to work. They act much like their biologic counterparts, the evenly distributed lymphocytes, or T-cells and B-cells in our bodies that are responsible for sensing foreign pathogens. These specialized cells have receptors that bind to bacteria and neutralize them similar to the way that Riot's detectors make matches which connect with patterns of viruses and worms.

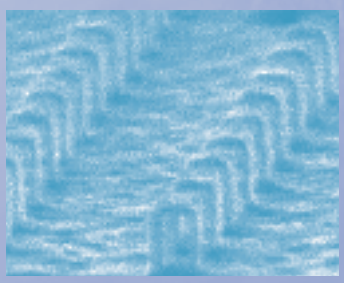
That binding process triggers a response mechanism called "throttling" which returns connection speeds to normal levels and creates a queue for the remaining connections. Throttling slows the spread of the attack, allows the computer to allocate resources normally, causes most of the malicious connections in the queue to automatically time out, and gives the computer owner more time to prevent damage or install a patch. The throttle concept also has biologic roots. It is based on homeostasis—our body's ability to maintain an array of physiological mechanisms within certain acceptable parameters as the environment changes.

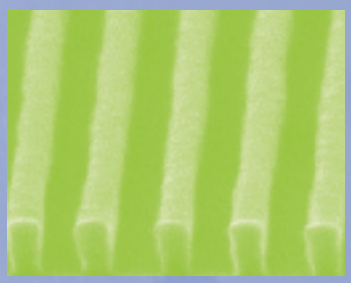
Like our immune system, Riot is adaptive. It is capable of learning norms for its environment and, by generating randomized detectors, it is able to keep pace with those changes and respond accordingly. The researchers hope that Riot will be able to detect and limit damage from a wide variety of viruses, worms, port scans, misconfigurations, hijacked computers, and even prevent stolen computers from being used by others.

Forrest and her team are currently testing Riot on their own computers. "An important part of our research strategy is building prototypes of our ideas and then living with them running on our own computers," says Forrest. She says that once Riot is mature enough, the team will release it as open-source code. Riot's predecessors and other biologically based programs are already available at http://www.cs.unm.edu/~immsec.

As the Internet expands, processing speeds increase, and attackers become more aggressive, Forrest's research is even more important for the everyday computer user. "I do feel that computer security is now everybody's problem. And I hope that these methods will eventually lead to solutions that are incorporated into software people will run on a daily basis," she says. "I think computer security has become a problem of national significance." ✦

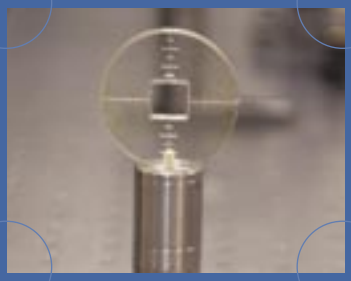






PATTERNS OF THE FUTURE

UNM RESEARCHER CREATES TOOLS FROM NANOSCALE PATTERN



Professor Steve Brueck is working hard to stay ahead of the law—Moore's Law, that is. The famous prediction states that the number of transistors per integrated circuit doubles every two years. The semiconductor industry pegs advancements in power directly to Moore's Law, demanding faster, denser processors every 18 to 24 months. That means packing more power onto already small computer chips. Thanks to Brueck, the industry—and science as a whole—is staying ahead of the curve.

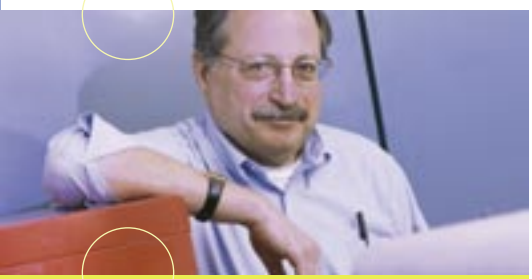
Brueck is a UNM professor of electrical and computer engineering, and physics and astronomy. He also serves as the director of UNM's Center for High Technology Materials (CHTM), an interdisciplinary research center at UNM with programs in microelectronics, optoelectronics and nanoscience. CHTM has been a Center of Excellence for SEMATECH, a consortium of the world's semiconductor manufacturers.

At CHTM Brueck and a dozen post-doctorate and graduate students work in clean rooms and labs to perfect a process called nanolithography, a way of replicating patterns to unprecedented dimensions. They use customized optical lenses, lasers and measurement instruments to refract beams of light on to photoresists or chemical

"That's the importance of Steve's technology—it provides the capability for everyone to do interesting things, not only to the semiconductor industry, but also to biotech, lighting, materials science and other fields as well."

Kevin Malloy,
Professor of Electrical and Computer Engineering
and Associate Dean for Research

Professor Steve Brueck



polymers that are sensitive to light. Intensity variations in the light create localized chemical reactions, which result in tiny patterns when the resists are developed. These patterns can define transistors, wires, channels or other features that can be incorporated into larger devices. Brueck's research spans the entire process of nanolithography, from perfecting the tools and lenses used to create the patterns, to the chemistry that occurs on various substrates.

But what really distinguishes Brueck's research is the size of the patterns he creates. His work is at the nanoscale level, where a nanometer equals one billionth of a meter. This past summer, Brueck and his team made a breakthrough by producing the smallest pattern on record.

"We have the first good patterns at 45 nanometers that I know of in the world. These patterns occur over large areas—up to 10 centimeters, so there are over a million repetitions of the pattern. This is much more than is possible with any other technique. We're able to drive the manufacturing costs way down because of the size and number of repetitions," says Brueck.

For comparison, the electronics industry is currently working at the 90 nanometer node. The International Technology Roadmap for Semiconductors (ITRS), an industry-wide roadmap for semiconductor development, projects that manufacturers won't reach the 45 nanometer node until 2010. Brueck and his team are clearly pushing the envelope.

Brueck's latest achievement is based on laser interference, the standing wave in laser intensity that is formed when two coherent (i.e., oscillating in lockstep) laser beams are incident on the photoresist. This is directly analogous to the standing wave that forms on a child's jump rope when you tie down one end and shake the other at just the right frequency. The scale of this intensity pattern is related to the wavelength of the laser beams—the repeat distance for the wave—which is only 200 nanometers for the lasers Brueck uses. And there is one other new trick, dunking the whole experiment in water. Light bends when it enters water, as is familiar to anyone trying to pick up a rock in a pond, and this bending can be harnessed to reduce the size of the printed features.

Kevin Malloy, formerly associate director of CHTM and currently associate dean for research for the UNM School of Engineering, points out that Brueck's research not only produces smaller scale patterns, but the processes he's developing are more economical than current approaches. "The work being done by Steve and his group services a $50-75 billion industry," Malloy says. "Their work will help keep semiconductor manufacturing in the United States."

"Nanoscale lithography is an enabling technology," explains Brueck. "It is a new approach to imaging that has potentially unlimited applications." The "nano tools" Brueck is helping to create could be used for everything from biomedical sensors and gas detectors to mobile communications and improved flat panel displays.

Malloy says that Brueck's research will create opportunities in all realms of science. "That's the importance of Steve's technology—it provides the capability for everyone to do interesting things. He provides an incredible suite of tools and visionary techniques, not only to the semiconductor industry, but also to biotech, lighting, materials science and other fields as well. And that's why people are so excited about it." ✦

When I Grow Up, I Want to be...

a Scientist

"Industry projections reveal that we're not producing enough engineers and scientists. There are many reasons, but one of them is that students aren't getting interested in science at an early age."

Charles Fleddermann, professor and associate dean of the School of Engineering

NSF GRANT SPARKS YOUNG STUDENTS' INTEREST IN SCIENCE

The clock struck three, a bell rang, and the halls of Truman Middle School filled with students streaming towards the exits. But seven students moved against the tide, making their way to Jessyca Flores' science lab, where they settled in for one more science lesson--not because they had to, but because they wanted to.

Jessyca Flores demonstrates how to make the color wheel to a student in the Photonics Club.

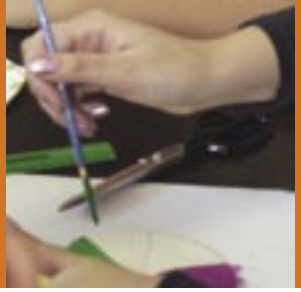
Flores, fellow science teacher Tamara Werner, and Melisa Greenberg, a UNM graduate student, helped the group of students conduct experiments using color and light. They spun color wheels on string to simulate white light, fashioned homemade lasers from flashlights, foil and CDs, and debated why the ocean and sky look blue.

It was all part of Truman's After School Photonics Club. "The different experiments are really interesting and they make science fun," says seventh-grader and club member Adam Martinez. The club is made possible by a National Science Foundation (NSF) GK-12 Grant awarded to the University of New Mexico in the spring of 2004. NSF created the three-year, $1.8 million grant to enrich the learning experience for K-12 students and to spark an interest in engineering, science and math that might inspire students to consider careers in these areas. The grant emphasizes optics and photonics. UNM is one of more than 50 universities around the country participating in the program.

Teaching Tomorrow's Scientists Today

"Industry projections reveal that we're not producing enough engineers and scientists. There are many reasons, but one of them is that students aren't getting interested in science at an early age," says Charles Fleddermann, professor and associate dean of the School of Engineering. Fleddermann is the principal investigator on the grant and he manages the program.

To spark that early interest, the GK-12 grant funds fellowships so that engineering and science graduate students can serve as resources for science and math



"I really like science. And there are not that many women in science, so I think I might become a scientist in the future."

Samantha Smith, Seventh Grader

teachers in the public schools. This year eight fellows from UNM are working on Albuquerque's far west side in a group of schools that includes several elementary and middle schools and one high school. The area is ideal because the schools feed into West Mesa High School, which already has an optics academy. "This way there's a pipeline of elementary school kids who are interested in science that goes to the high school and then ultimately, we hope, to UNM when they graduate," says Mary Jo Daniel, a liaison from Albuquerque Public Schools (APS) who helps manage the program.

Daniel conducted a week-long training session last summer to familiarize the fellows with the classrooms and help them understand how to relate to kids of different ages. Then the fellows worked with teachers at their assigned schools to create age-appropriate programs and schedules for the students. "The program needed to be very flexible because each school has different needs," explains Daniel. Depending on the school and the weekday, the GK-12 fellows can be found planning curriculum sessions, conducting experiments in class, doing research for teachers, or helping students with their science fair projects.

A Win-Win-Win Situation

But it's not just the kids that are learning. GK-12 provides valuable continuing education for teachers too. The program expands their depth of knowledge, specifically in optics and photonics, and gives teachers more tools and experiments to use in class. In fact, the fellows are preparing kits with experiments and educational materials that teachers can use and then pass on to other educators who aren't directly involved in the program.

It's also an education for the fellows. They're learning how to relate to kids and share their knowledge. Greenberg, who is working towards her masters degree in optical science, sees the program as a way to make a difference. "I wanted to do this because I love kids, and especially because I'm a woman and wanted to show young girls that they can grow up to be scientists," says Greenberg.

Steven Green, the fellow assigned to Adams Middle School, says that teaching kids enhances his research at UNM. "Education and learning are two sides of the same coin. You have to learn about something to teach it, so this benefits me and what I'm learning myself," notes Green.

Fleddermann says that UNM has a lot to gain from participating in the program as well. "Many of our students come out of APS. A better relationship with the local school district is likely to get us more students that are better prepared. I'm hoping that a lot of these students will remember that there was this person at UNM who was in their class when they were in eighth grade and that he or she was really cool and taught them a lot about science. I hope they'll think 'I want to be like that and go to UNM'."

Jessyca Flores helps the students make their own lasers from flashlights and tinfoil as part of their photonics experiment.

Will the plan work? A process is in place to evaluate the results of GK-12. Students from UNM's College of Education have developed an assessment tool that measures students' attitudes toward science at the beginning of the year and at the end of the year. Judging by the smiles and bright eyes in the After School Photonics Club, GK-12 is already working its magic. Samantha Smith, a seventh-grader in the club offers confirmation. "I really like science. And there are not that many women in science, so I think I might become a scientist in the future." ✦

Photo Courtesy: INEEL

Into the Lab

UNM JOINS A HIGH-PROFILE CONSORTIUM TO MANAGE A NATIONAL LAB

School of Engineering faculty and students will soon be spending more time in the lab. UNM is part of the Battelle Energy Alliance (BEA) team that won a federal contract to manage the Idaho National Laboratory for the U.S. Department of Energy. The 10-year, $4.8 billion contract to manage Idaho National Laboratory took effect February 1, 2005. The vision for the Idaho National Laboratory is to become a world-class laboratory and national center for energy research.

"It's a major accomplishment for our School of Engineering to be part of this team," said UNM President Louis Caldera. "This contract is another sign of the growing national reputation of our programs—in this case, for our work in nuclear energy generation in space."

The Battelle Energy Alliance won the contract over three other teams. The alliance, led by the non-profit research group Battelle Memorial Institute, includes many members of industry and two academic groups. The National University Consortium (NUC) includes Massachusetts Institute of Technology, North Carolina State, Oregon State, Ohio State University, and UNM. The Idaho University Collaboration (IUC) is comprised of Boise State, Idaho State, and the University of Idaho.

UNM's unique strength in space nuclear power and nuclear science and technology garnered the university an invitation into the BEA team. "We are excited to be part of the team dedicated to making INL an internationally recognized space and nuclear power leader," said Dean of the School of Engineering Joseph L. Cecchi. "We look forward to collaborating on advanced nuclear technology as well as developing an academic center of excellence that will produce the next generation of space and nuclear scientists."

The mission of the 3,000-employee lab in Idaho Falls is to develop advanced nuclear technologies that provide clean, abundant, affordable, and reliable energy to the United States and the world. INL is developing the Next Generation Nuclear Plant, a new nuclear system to produce electricity and hydrogen to support a cleaner, more efficient hydrogen economy in the U.S.

One of the priorities for INL in its quest to become a world-class laboratory is a commitment to scientific excellence, innovation, and creativity. Five centers of excellence and a center for advanced energy studies have been established to further this goal. UNM will be establishing an academic Center of Excellence for space and nuclear research and will be involved in educating and training the future work force in nuclear engineering. UNM will work closely with INL and the NUC and IUC members.

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> Joseph L. Cecchi,
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As part of the academic alliance, UNM expects to offer internships and employment opportunities at the labs and new collaborations with the participating universities. The School of Engineering also plans to expand its nuclear engineering faculty.

Alumni Awards

Visionary. Innovator. Industry leader. Entrepreneur. Volunteer. Those are just a few of the terms describing the six alumni honored at UNM's Sixth Annual Distinguished Engineering Alumni Awards last October. A peer review committee chose the recipients because of their many professional, personal and charitable accomplishments.

More than 150 UNM alumni, leaders in the engineering industry and event sponsors gathered at the University's Student Union Building for a reception and dinner to honor their colleagues.

Sponsors for the evening included Bohannan Huston, Randy Velarde, Sholtis Engineering and Safety Consulting, Kenneth Prestwich Consulting, William and Teresa Moulds, Henry and Chiyeko Togami, Paul D. O'Brien, Regent Sandra Begay-Campbell and Donald Campbell, Juan and Deborah Heinrich, and Samuel Mould.

Harry Woodson Gates, Ph.D.

BSEE 1949
MSEE 1950

Harry Gates has devoted most of his life to teaching, research and service. After working as a research engineer at ITT, he taught at Purdue University for thirty years. Gates' research and expertise resulted in four patents, many classified projects and a number of specialized devices for the visually and hearing impaired. A lifelong volunteer, Gates has used his skills to teach computer programs in Nicaragua and develop business computer programs in San Salvador. He and his wife donated more than 5,000 volunteer hours to the National Parks. Currently he is involved in teaching computer courses to senior citizens.

Mark D. Hoover, Ph.D.

MS CHNE 1976
Ph.D. CHNE 1980

Mark Hoover's 25-year career at Lovelace Respiratory Research Institute focused on protecting workers and the public from respiratory disease. He developed new instrumentation and techniques for research and worker protection and is author or co-author of more than 130 open literature publications. Hoover has served in professional societies and on many national and international safety panels, committees, and delegations. He continues his field work and research as a senior research scientist at the Division of Respiratory Disease Studies, Centers for Disease Control and Prevention.

Burton J. Smith, Sc.D.

BSEE 1967

Burton Smith is a champion of high-performance computer systems, a visionary researcher, and a widely recognized authority in high performance computer architecture and programming languages for parallel computers. Smith designed the ground-breaking Denelcor HEP supercomputer in the early 1980s, which is widely referenced in computer textbooks. He expanded on that invention and developed others at Tera Computer Company, a firm he co-founded. Today, Smith leads the Cascade Project, a Cray-led consortium to produce the next generation of Cray supercomputers. Smith is widely published and is a sought-after speaker.

Bill Taylor
BSME 1954

After earning a mechanical engineering degree from UNM, B.G. (Bill) Taylor went on to a distinguished career with Halliburton. During his 41-year career there, he rose to become president of Halliburton Services and executive vice president of Halliburton, leading the organization to become one of the world's largest oil field services and a premier provider of engineering and construction services. He retired from Halliburton in 1987 as chairman and CEO of the company's Welex Division. Taylor served on numerous industry organizations and was a loyal UNM contributor and supporter. He passed away October 28, 2004.

Jack E. Thompson, Ph.D.
BSME with Distinction, 1961

Jack Thompson's innovations for auto design and development have earned him the reputation as an auto industry pioneer. His accomplished 39-year career at Chrysler/DaimlerChrysler includes implementing virtual product development, introducing computer simulation for crash design and racing, and overseeing the design and construction of the company's Technical Development Center. Thompson generously shares his time and talent to foster children's interests in math and science.

YOUNG DISTINGUISHED ALUMNUS
Ray Mendez, PE
BS Construction Engineering 1997

While Ray Mendez earned his bachelor's degree in Construction Engineering at UNM, he lettered in wrestling and was active in a number of engineering organizations. Today, Mendez is the President and Owner of Conde Incorporated, a civil engineering consulting firm in El Paso, Texas. Mendez is an Embarkation Officer and El Paso Officer-In-Charge with the United States Naval Reserve and he volunteers with a number of community programs.

Langmuir Moves to UNM

Langmuir, the third largest journal published by the American Chemical Society, has a new home in the Department of Chemical and Nuclear Engineering. The publication is devoted to reporting new and original experimental and theoretical research in the fields of colloids, surfaces, and interfaces.

The central office for *Langmuir* moved from Santa Fe to the Mechanical Engineering building in January. Space in the building was renovated for the publication, thanks to collaboration between Mechanical Engineering, Chemical and Nuclear Engineering, the School of Engineering, and the American Chemical Society.

Langmuir editor-in-chief Dr. David Whitten is now a research professor in the Department of Chemical and Nuclear Engineering. "We are very pleased to locate our office at UNM. *Langmuir* is a highly interdisciplinary journal with many contributions in the area of nanoscience. It seems appropriate to have the main office of the journal in an environment where high quality and relevant research is carried out. I am especially enjoying scientific interactions with many new colleagues at the university," Whitten says.

Chemical and Nuclear Engineering

Two undergraduate research teams, including students from Chemical and Nuclear Engineering (ChNE) and Mechanical Engineering, will take to the skies this summer as part of the NASA microgravity research opportunity. Bob Busch and Plamen Atanassov, professors of chemical and nuclear engineering, are assisting the students. This is the fifth year that teams lead by ChNE students have had microgravity projects accepted by NASA.

Construction of the new UNM Keck Nanofluidics Laboratory in the Department of Chemical and Nuclear Engineering is moving rapidly. A Zeiss confocal microscope was installed in February.

Chair: Julia E. Fulghum
505-277-5431
chne@unm.edu
Faculty: 18
Graduate students: 89
Undergraduate students: 81
Annual research expenditures: $4,482,540

Electrical and Computer Engineering

Diana L. Huffaker, associate professor of electrical and computer engineering, received the prestigious 2004 Alexander Von Humboldt Foundation Research Fellowship Award. Huffaker will conduct the research of her choice for up to one year at the Solid State Physics Lab at the Institut fuer Festkoerperphysik in Berlin, Germany.

ZOOM Into Engineering Day at the National Atomic Museum in February targeted 6 to 11-year olds who are interested in science and engineering. The event kicked off the ECE department's broad outreach program that positions local engineers as role models who help kids understand what it's like to be an engineer. Children who participated met their role models at exhibits and communicated with them online.

Chair: Christos Christodoulou
505-277-6580
info@ece.unm.edu
Faculty: 31
Graduate students: 285
Undergraduate students: 260
Annual research expenditures: $10,977,000

Civil Engineering

Susan M. Bogus, Ph.D., P.E., joined the Civil Engineering Department in August 2004 as an assistant professor in construction engineering and management. She received her Ph.D. from the University of Colorado at Boulder and earned her bachelor's and master's degrees in civil engineering from the University of Wisconsin–Madison. Bogus' research interests focus on the integration of design and construction processes, including concurrent design and construction to reduce project delivery time and sustainable design and construction.

Last fall, Bogus was one of 50 faculty members from across the United States to attend a National Science Foundation–sponsored workshop on conducting rigorous research in engineering education. The information and contacts will allow Bogus to pursue her research in workforce development in engineering and construction.

Dr. Bogus was formerly a project engineer and project manager at CH2M HILL, an engineering and construction firm, where she worked on environmental projects throughout the United States.

Chair: Timothy J. Ward
505-277-2328
civil@unm.edu
Faculty: 16
Graduate students: 68
Undergraduate students: 98
Annual research expenditures: $1,593,844

Computer Science

Dr. Terran Lane, assistant professor of computer science, received funding from a National Institute of Health Centers of Biomedical Research Excellence grant to remodel the Machine Learning Lab, housed on the third floor of the Farris Engineering Center. The renovation includes a large meeting room and several new offices, which will serve as working space for research assistants and research post-docs. The new space will allow outside collaborators to meet with Lane and students in an environment that will enhance research productivity and findings. The Machine Learning Lab investigates methods for solving problems integral to artificial intelligence, such as structural analyses, classification, bioinformatics, neuroinformatics, data mining, and network security. The lab currently supports one post-doc, three doctoral students, and several masters and undergrad students.

Chair: Deepak Kapur
505-277-3112
csinfo@cs.unm.edu
Faculty: 16
Graduate students: 242
Undergraduate students: 185
Annual research expenditures: $3,343,249

Mechanical Engineering

Mechanical engineering professor **Tariq Khraishi r**ecently won the American Nuclear Society Materials Science and Technology Division Literary Award for his paper titled "Mechanical Property Degradation in Irradiated Materials: A Multiscale Modeling Approach." The paper was published in "Nuclear Instruments and Methods B, 2001." Khraishi's is one of the first papers to give a good explanation for the phenomenon of "clear channels" observed over many decades in deforming irradiated metals.

Every year, the American Physical Society provides a summary of physics highlights for the past year in a special supplement to APS News. The work of UNM researchers from the Mathematics and Statistics and Mechanical Engineering Departments is featured among the notable physics achievements in "Physics News in 2004" (APS News Vol. 14, No. 2, Feb. 2005). Keith Mertens, research assistant and Vakhtang Putkaradze, associate professor from the Mathematics and Statistics Department, and Peter Vorobieff, assistant professor in mechanical engineering, investigated the behavior of a stream of water flowing down an inclined plane. Such a stream is likely to meander; however, quoting APS News, "the New Mexico team discovered that meandering can be eliminated if water flows down the plane at a constant rate...Moreover, such non-meandering streams often have visually striking 'braids,' a fixed pattern of wide and narrow water regions."

Chair: Juan C. Heinrich
505-277-2761
lsandve@unm.edu
Faculty: 16
Graduate students: 119
Undergraduate students: 189
Annual research expenditures: $1,864,021

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