THE UNIVERSITY OF NEW MEXICO SCHOOL OF ENGINEERING

FALL 2004

UNM engineering

Big Ideas on a Small Scale

UNM researchers focus on microfluidic devices

From the Dean

collaborate

Engineering Small

Over the last 30 years, nothing has transformed engineering and computer science more than the ability to fabricate structures with high precision on increasingly smaller scales – now reaching to less than 100 nanometers. To put this in perspective, 100 nanometers is approximately 1/1000th of the diameter of a human hair.

The most prominent application of this extraordinary capability has been microelectronic silicon semiconductor integrated circuits, or ICs. ICs have revolutionized information technology, communications, consumer electronics, medical diagnostics, and many other areas. Continually shrinking the devices on ICs makes them less expensive and more capable (the essence of "Moore's Law"). That's why the computer you buy today is not only much more powerful than the last one you bought, but actually costs less.

An exciting development has been the extension of microfabrication technology beyond semiconductors to other things like micromechanical devices and sensors. An example in this issue is research led by Professor Gabriel López of the Department of Chemical and Nuclear Engineering. His team, which includes collaborators from UNM's School of Medicine and Center for High Technology Materials, is developing innovative microfluidic techniques to analyze fluids for a broad spectrum of biochemicals.

Microfluidic work represents another major trend in engineering: the increasing integration of engineering with the life sciences and medicine. In part, this is driven by the confluence of microfabrication with nanotechnology, which is taking place on the scale of things like cells and biomolecules (e.g., DNA, RNA, and proteins). The trend is also due to the extraordinary advances in computational capabilities, which have found increasing applications in life and health sciences. Along these lines, we describe another partnership with UNM's School of Medicine, in which Computer Science Professors Paul Helman and Bob Veroff, in collaboration with UNM's Center for High Performance Computing, are applying innovative data mining algorithms to a large volume of data from DNA microarrays. A significant outcome of their research is the discovery of a gene with a high correlation to the severity of leukemia.

Increasing computational power has transformed all areas of engineering and computer science. One of the more impressive examples is our Formula SAE racecar student design project. Under the direction of Professor John Russell of the Department of Mechanical Engineering, this project comprises a three-semester course sequence in which students use state-of-the-art software to design the car's chassis and engine modifications, and broadband data acquisition for real-time monitoring. Importantly, this project brings in many other "real world" issues, such as project management, resources acquisition, and, best of all, spirited team competition.

The collaborative spirit underpinning the articles described above is reflected throughout the magazine in other news and in our department profiles. We hope you enjoy this issue.

Joseph L. Cecchi
Dean of Engineering

Points of Pride

Exciting things are happening in the School of Engineering:

■ In July, **Julie Coonrod**, P.E., Ph.D., was promoted to associate professor and tenured in the Civil Engineering Department. Coonrod teaches undergraduate classes in statics, fluid mechanics, hydrology and hydraulics; and graduate classes in Geographic Information Systems, hydrology, and open channel flow. She also manages the Civil Engineering Bosque Lab.

■ **Plamen Atanassov**, professor of Chemical and Nuclear Engineering, received the annual School of Engineering Junior Faculty Award for Teaching. Atanassov received his Ph.D. in Chemistry from the Bulgarian Academy of Sciences. Last year he received the Junior Faculty Award for Research.

■ **Stephanie Forrest**, professor of Computer Science, was co-author of a paper published in the April edition of *Science*. The article described the spread of computer viruses and technological networks. She co-authored the paper with **Justin Balthrop**, a graduate student, and two researchers from other institutions, Mark Newman and Matthew M. Williamson.

■ During spring semester 2004, the Electrical and Computer Engineering Department and the UNM Music Department collaborated on a unique course that brought musicians and engineers together. Students studied compositional algorithmic processes and the use of audio digital signal processing functions in real-time applications. The course culminated in two public sound and music installations. **Panaiotis**, Ph.D., a research assistant professor in both departments, taught the class.

■ **Peter Vorobieff**, assistant professor in the Mechanical Engineering Department, co-authored a paper published in July by the prestigious scientific journal *Nature*. The paper was titled "Braiding Patterns on an Inclined Plane." The publication was co-authored with **Vakhtang Putkaradze**, associate professor in the Math Department. **Keith Mertens**, a graduate student, also researched and co-authored the paper, his first to be published.

Contents

On the Cover
Gabriel López leads a team of researchers studying microfluidic devices.

UNM Engineering
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The

One lap. Five laps. Nine…Mechanical engineering students from the University of New Mexico watched with rapt attention as car #37, a bright red racecar, zipped around the autocross track at the Silverdome in Pontiac, Michigan. The car was racing in the endurance portion of the 2004 Formula Society of Automotive Engineers (FSAE) competition. FSAE, the largest international engineering competition in the world, challenges engineering students to design, build and race a formula style racecar in one year. The three-day event attracted 140 teams from as far away as Korea, Australia and Finland — all eager to, literally, test their metal.

UNM's car, created by students enrolled in the 2004 FSAE Class, had already garnered an 11th place finish in the marketing presentation and 12th place for its head-turning design. Now the 80 horsepower, 488-pound car was being put to the test in a series of events to evaluate its performance.

At lap 11, UNM's first driver pulled into the pit for the required stop and driver change. The engine was turned off. A new driver slipped into the seat, pushed the starter and…nothing.

In an attempt to score points on fuel economy, the team had created a very lean fuel mixture that caused the engine to overheat. So, the team received a "did not finish" or "DNF" for that part of the test. Team members' spirits were down after seeing the car sidelined. Yet, their team captain, mechanical engineering student Joshua Arvizu, and faculty adviser, Professor John Russell, were happy with the team's performance.

Formula For Success

COURSE INTEGRATES AUTOMOTIVE ENGINEERING AND LIFE SKILLS

Arvizu summed up the emotion of the moment saying, "Everyone had their head down because every single person on that team cared so much about the competition. That's when the team feeling really hit home. Although it felt like we'd failed, I thought we were a huge success because everyone worked so hard to achieve all the success we had this year."

Indeed, the team had excelled. The team finished 39th overall, a school record and a substantial improvement from last year's 62nd place. Their design and construction were also big advancements over last year's entry. Car #37 weighed 120 pounds less than its predecessor, and its unique, versatile design gave the car the capability to run in acceleration, skid pad, autocross and endurance events.

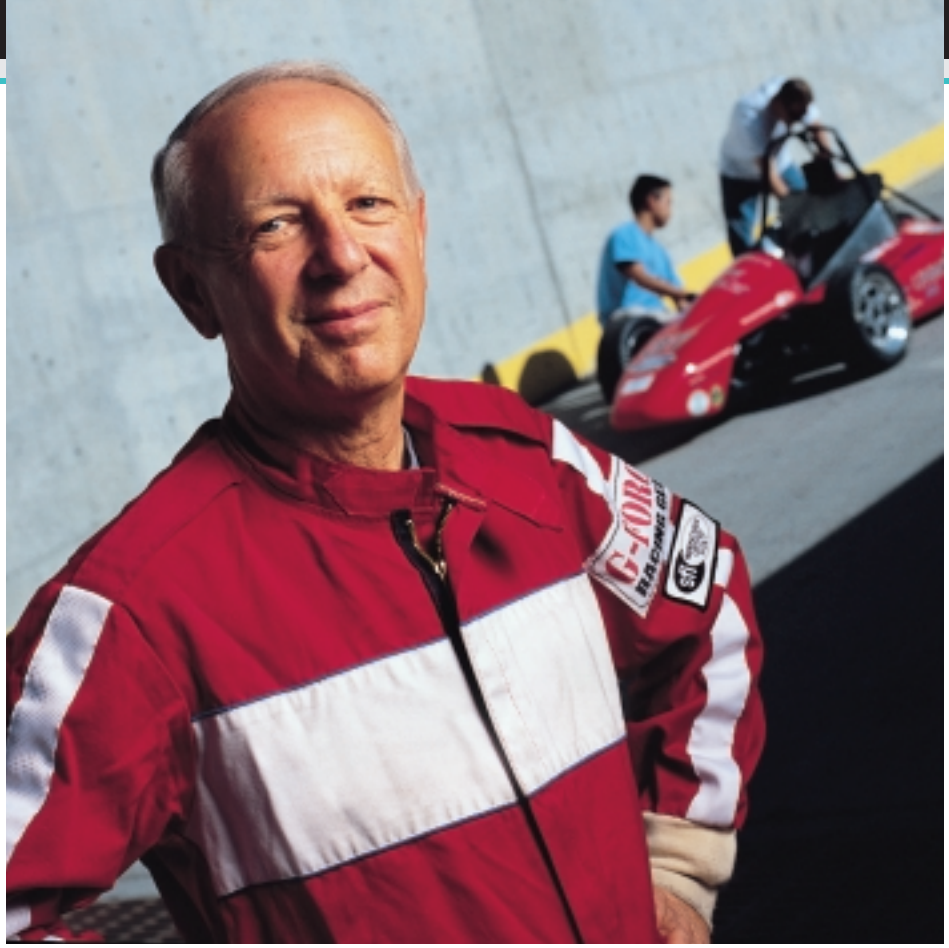
The UNM team may not have won a shiny trophy, but they came away from Pontiac with something far more valuable: knowledge, experience and friendships that will last a lifetime.

A Comprehensive Program

UNM students have competed in FSAE since 1997. At the time, it was a club that students could join on their own time. There was enough interest that the School of Engineering offered the competition as a one-semester class in 1999. But the course did not give Russell and his students enough time to approach the challenge in a comprehensive manner. "We simply could not meet the deadline for being ready for competition with a fully-tested car when we started in September and had to be ready by May," says Russell.

In 2003, this challenge was the impetus for UNM to become the only school in the country to offer a three-semester, for-credit FSAE course. The class is an alternative to the required senior design project in Mechanical Engineering. Students start the course in the spring semester of their junior year. First semester is dedicated to academic study; then students design and build the car in the fall, and test the car before the competition the following spring. The class structure creates an added learning opportunity because students starting the course in the spring overlap with the team that is preparing for the competition.

Students learn about racecar engineering and master the software required to design the car and manufacture all the parts, with the exception of the seatbelt, rims and engine. Then they construct the car, test it and prepare for the competition. Russell says UNM's comprehensive course is about much more than the competition. "This class integrates every engineering course the students have ever had. The course puts it all together — academics, industrial project



Professor John Russell and crew during a practice session.

challenges like managing people, money and schedules, project design, and of course, the excitement of a sport."

While Russell teaches the fundamentals and advises the team, the students are on their own when it comes to making decisions. The team determines all aspects of the project — from the team structure and the car's design, to the production schedule and how they will transport the car to the competition. "They're conditioned to get the answer to the problem at the end of the chapter. Here things are completely open-ended in terms of what to do. My job is to give them the tools to design the car. I don't do it for them. *They* have to pose the problems and then solve them," says Russell. He adds, "But I do retain veto authority." The team also has to have the design reviewed and approved by automotive engineers before it can be built.

Building a racecar from the ground up costs money. This year the production cost — the price you would pay for the car if you bought it off the showroom floor — was a relatively affordable $19,000. The competition limits the production cost of the cars to $25,000, although teams can spend more for capital items required to design and build the car. The University contributed $20,000, including a $5,000 grant from the Ford Corporation. The team had to raise the rest of the money from student government allocations, private donors and fundraising projects. In total, they raised $20,000, which included $1,000 from a local Ford dealership. To keep sponsors up to date on their progress, the team produced five newsletters during the project and invited sponsors to come down to watch the test drives in an empty UNM parking lot.

Team Mechanics

While learning design software and asking companies for donations is tough, the real challenge of FSAE lies in managing the people who will make the car come to life.

The FSAE team functions like a small company with a team leader and managers who oversee different aspects of the project. Team members create and maintain schedules, assign tasks, requisition tools and manage all the administrative and paperwork details. "It's all on their own initiative. I'm not down there telling them that something needs to be done by a certain date. They have to set those dates. It has to be their drive that does it," says Russell.

"The course puts it all together — academics, industrial project challenges like managing people, money and schedules, project design, and of course, the excitement of a sport."

PROFESSOR JOHN RUSSELL

One of the team's first tasks is to choose a team captain, the point person who manages the project and reports to Dr. Russell. The team chose Arvizu. As a 2003 team FSAE "alumni" because he was part of the 2003 team, a talented public speaker, and an energetic personality, he was an obvious choice. Arvizu admits that when he first started FSAE, he wasn't a "car guy," and he was lost when it came to tools and the manufacturing process. But he jumped right in and the FSAE bug bit hard. "Going through the process once, and knowing that I had another year of school left, I thought to myself 'I have to do that again'," says Arvizu.

While not seeking the team captain role, Arvizu accepted it, knowing that it could help him grow. "This was my first real chance to prove to myself whether I can make it as a leader. I was excited about seeing what I could do. What it ended up doing is humbling me extremely," he says. "Managing the team dynamics was the hardest thing I had to deal with. Scheduling and the administrative side was easy compared to dealing with people, keeping them happy, keeping them working and motivated."

That is all part of the plan, according to Russell. "This course is designed like the workplace. They have to come up with an organizational structure and learn how to work within it. And they have to understand business ethics. It's just part of the bigger picture they'll need for their futures," says Russell.

This year's team had 30 students, seven of whom were women. One of the women, Heather Gorenz, designed the car's carbon fiber body. The high ratio of women was a first, according to Russell. "Having so many women on the team was new for us. It brought a new dynamic to the team, which was great," says Russell.

Taking The Checkered Flag

Russell says that he and the students have different goals when the class begins, but all goals converge at the finish line. "Their goal is to win the competition. My goal is to give them tools they can use when they graduate. The racecar is just a neat tool to show them project management, systems engineering and working as a team."

The experience has proven to be very valuable as students look for jobs, especially in the automotive field where companies weigh the FSAE experience heavily. Russell says he has heard of at least one major automotive company that requires four years of automotive engineering experience or just one year of participation in FSAE.

After months of stress, sleepless nights and weeks when he and the team put in upwards of 40 hours a week on the car, Arvizu says it was all worth it. "It's just the most rewarding thing I've done in my life. Sure, it's a competitive challenge. But in the end — and I know this is Dr. Russell's goal for us — it's not about that. You just gain so much experience as an engineer... so much value from the whole process."

Now a staff technologist at Sandia National Laboratories in Albuquerque, Arvizu says what he learned from FSAE has helped him in his current position. It will also serve him well this fall, as he heads to Stanford University to earn his master's in engineering.

Car #37 now sits in the corner of the Lobo Motorsports shop. A shiny, new chassis rests in the center of the room. Pass the shop on any given day and you hear team members, metal on metal, power tools revving...the sounds of the next car, and well-rounded students, under construction.

www.me.unm.edu/~fsae/teams/2004/

Joshua Arvizu and teammate Craig Sinsabaugh.

The crew prepares for a test run.


Big

The channel at left is packed with thousands of microscopic glass beads.

Gabriel López, professor of Chemical and Nuclear Engineering.

Ideas

on a Small Scale

UNM chemical and nuclear engineers help develop unique microfluidic devices

The days of drawing large vials of blood for lab tests may soon be over, thanks to a group of engineers and researchers at UNM's Department of Chemical and Nuclear Engineering. The multidisciplinary team is developing microfluidic devices that require just a few drops to conduct multiple "assays", or tests, to determine whether particular biochemicals are present in a fluid. The devices would test a blood sample for a number of diseases, analyze water for different toxins, or even test air samples for the presence of bacterial spores. But their size is the real surprise – the devices are so small they are measured in microns, a scale where 1,000 microns equal one millimeter.

Gabriel López, professor of Chemical and Nuclear Engineering, is the lead principal investigator on the project. He says that the devices would have a number of benefits. "Right now, if you need multiple blood tests, they have to take a lot of blood from you and run the tests separately. These microfluidic devices can do multiple analyses all at once. If we can make a small device that uses very small samples to do multiple tests, then they don't have to take as much blood, the analysis can be faster, and less expensive too," explains López.

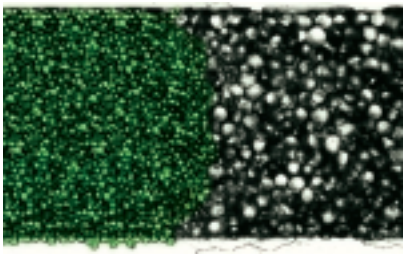


Image of fluorescent glass beads in a microscopic device.

The channels are just 200 microns wide, about the width of a human hair.

"What's important is that we have a research program that is working on many different aspects of this technology and it's bringing together a very wide group of people from a variety of departments. The combination of our team's expertise is unique."

Professor Gabriel López

The minute devices use a screening process developed at UNM. The devices are tiny, glass capillaries or channels molded in silicone rubber and mounted on a glass slide. Each channel is only one or two inches long and just 200 microns wide — about the width of two human hairs. The channels are packed with thousands, and sometimes tens of thousands, of microscopic glass beads. Each bead measures between five and 30 microns in diameter.

Before researchers load the beads into the channels, they coat the beads with receptor proteins that naturally bind with proteins present in specific toxins, bacterium or diseases. Each channel can hold multiple sets of beads coated with different proteins. The sets of coated beads are separated by uncoated spacer beads. Researchers use tubes on either end of the channel to fill the channel with beads and to inject the fluid that will be tested.

The device is then placed on a mounting platform and exposed to a laser. The light "excites" the beads that have bound with a protein in the fluid and they start to "fluoresce", or glow. That fluorescence indicates the presence of a toxin or disease. By measuring the "excited state lifetime" and intensity of the fluorescence, the researchers can measure the level of the toxin in the fluid, and therefore make a diagnosis.

Mission To Miniaturize

The team is working on all aspects of the device in order to refine the analysis process and miniaturize the elements. "We're working on different parts of this technology: putting the beads into the little fluidic systems is one part, doing the detection of the reaction is one part, and developing new ways of detecting reactions from the standpoint of chemistry is another part," says López.

Some researchers are refining the pump system that moves the fluid through the bead-packed channels. "It takes a great deal of pressure to drive the liquid through those tightly-packed beads," explains López. However, the devices' small size and fragile construction cannot withstand too much pressure. To avoid applying pressure, the team has developed an electrosmotic pump, which uses an electric current to move the fluid easily through the beads.

Other team members are constructing a more compact, inexpensive way to detect the change in fluorescence lifetime from the beads — usually a period of just a few nanoseconds. The group had been using a large system that took up an entire corner of the lab and cost more than $120,000. They have managed to shrink most of that capability into an inexpensive, patented system they call CLAOS, or "closed loop auto-oscillating system." CLAOS fits on a small table.

López says the goal for each element is efficiency — in a smaller package. "What we're trying to develop is a system that is more effective and more amenable to miniaturization. The hope is that the different parts of the system will converge in a few years to make a very compact device."

A Successful Collaboration

The process depends on teamwork. The research group includes about 15 researchers from Chemical and Nuclear Engineering, Chemistry, UNM School of Medicine, and the Center for High Technology Materials. A co-principal investigator from each area is assigned to the project. "What's important is that we have a research program that is working on many different aspects of this technology and it's bringing together a very wide group of people from a variety of departments. The combination of our team's expertise is unique," says López. The group is also working with local businesses that are commercializing sensor technologies.

"The work that Professor López and his collaborators are carrying out is a prime example of the exciting outcomes from combining the School of Engineering's work in micro/nano technology with cutting-edge research going on in UNM's School of Medicine. It is enabled by the very effective collaboration among engineering, medicine, and the Center for High Technology Materials. Perhaps most importantly, the group is clearly focused on promoting commercial development of their work," says Joseph L. Cecchi, dean of the School of Engineering.

The five-year research project is funded by a $2 million grant from the National Science Foundation. López says the competition for the grant dollars was extremely intense and UNM's study was one of the largest funded by the organization.

So, what's the big picture for these small devices? López explains, "It might really have an impact on diagnostic capabilities in medical situations by making these tests smaller, cheaper and faster. And then those devices might find applications in science — allowing biologists to determine how biological systems work." ✦

www-chne.unm.edu/

Research Team Receives Keck Grant

In July, a multidisciplinary team of researchers from UNM received a $500,000 grant from the W.M. Keck Foundation of Los Angeles. The foundation focuses on the areas of medical research, science and engineering. The grant will fund a laboratory and research program to explore complex fluid dynamics at nanoscale dimensions. Ultimately, the research could have pharmaceutical, environmental and diagnostic applications. Gabriel López, professor of Chemical Engineering and Chemistry, led the team that won the grant.

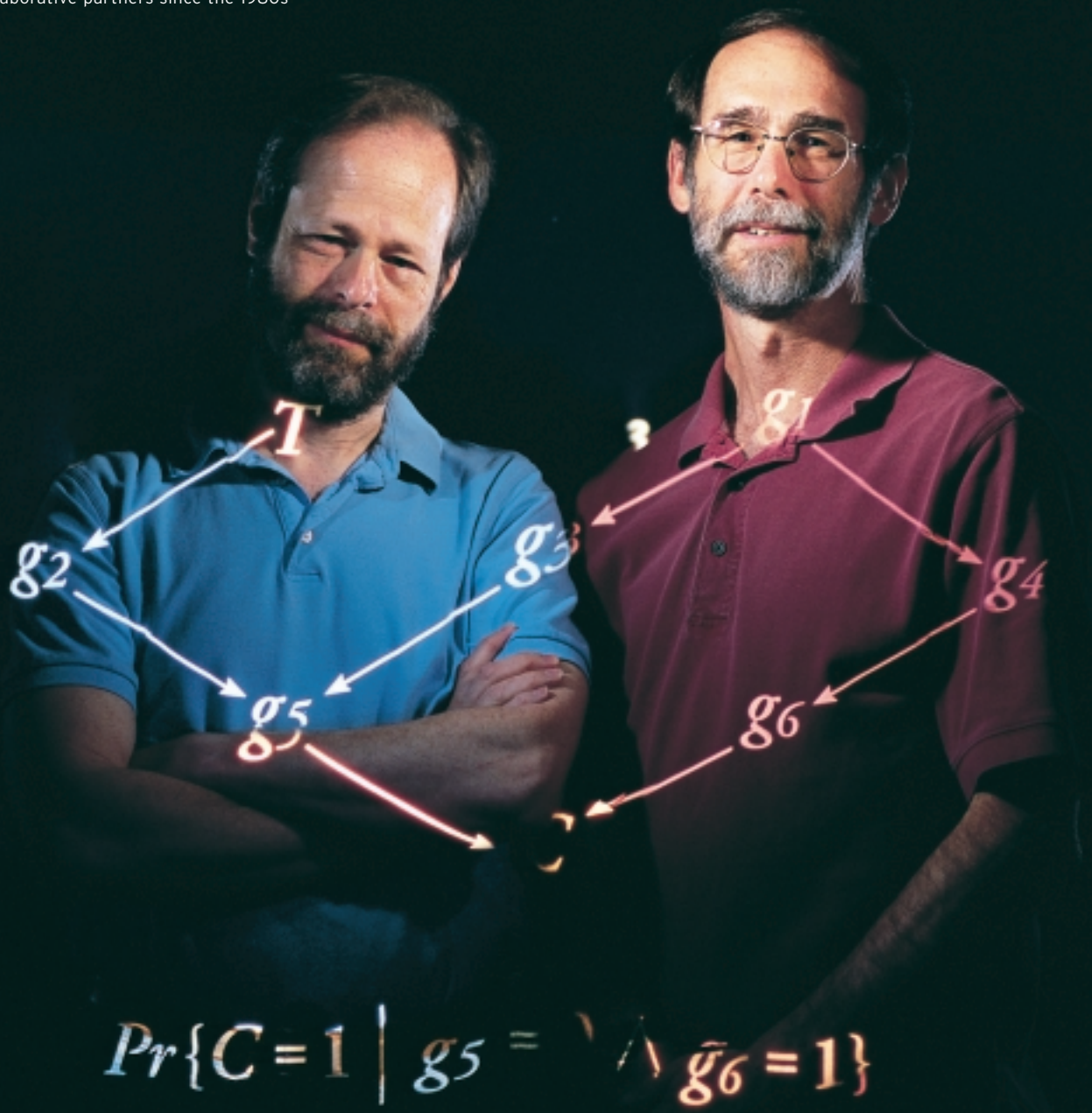
Most of the $500,000 grant will go towards a confocal scanning laser microscope for the UNM Keck Nanofluidics Laboratory. Having the microscope will also create opportunities for research collaborations with Los Alamos National Laboratories, the National Science Foundation and other agencies.

"The Keck Foundation grant will help foster collaborative research between the School of Engineering and the School of Medicine, which is investigating the transport of complex fluids in nano-scale channels. Beyond the support itself, this award clearly recognizes the exciting potential of the work of Professor López and his team."

Joseph L. Cecchi

Dean and Professor
School of Engineering

Paul Helman and Bob Veroff,
collaborative partners since the 1980s



Picture a string of 12,625 numbers, with each number representing a gene. Then imagine 257 of those long, numerical strings lined up, one beneath the other so that you have a massive mosaic of numbers. Now, take a close look at that mosaic and see if you can find any discernable patterns in the numbers that correlate with specific human traits. Impossible? Almost.

A GEM OF A PATTERN

RESEARCHERS USE COMPUTER SCIENCE AND MATH TO DISCOVER A CANCER GENE

Essentially that was the challenge put forth to University of New Mexico Computer Science professors Paul Helman and Bob Veroff by Cheryl Willman, M.D., director of the UNM Cancer Research and Treatment Center and her team. Not only did Helman and Veroff meet the challenge, they made an important discovery that may help save the lives of children with leukemia.

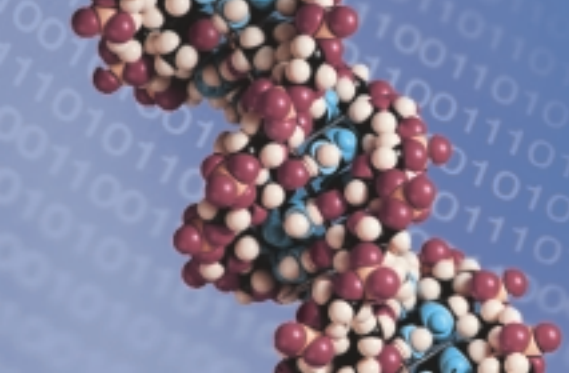
In 2000, a team of medical researchers at the UNM School of Medicine collected microarrays — slides imprinted with DNA chips — from 257 children with an aggressive form of cancer called Acute Lymphoblastic Leukemia (ALL). Each microarray contained 12,625 "probe sets." Each of those probe sets essentially represented the strength of a single gene from the patient. However, the School of Medicine did not have an effective way to analyze the data from the microarrays because of the volume and complexity of the information.

A Perfect Match

"We immediately saw that this problem matched our research interest," says Veroff. He and Helman had worked together since the 1980s when, as new faculty members at UNM, they had written a textbook together. Helman's background is in data mining and machine learning, while Veroff's is in automated deduction. Together they had been researching statistical machine learning, a process that looks for patterns in data using a mathematical model called a Bayesian network, or "Bayesian net." The model is based on a probability theorem developed by Thomas Bayes, an 18th-century mathematician and theologian.

Veroff explains that Bayesian nets can be used to find meaningful patterns in data, and to disregard spurious ones, by using known information about the data to direct the next step of the analysis. "One of the things we do with Bayesian nets is to come up with ways to use as much of the information that is available to us about a problem, to help us make the decision as to what we should look at next," says Veroff.

In 2001, Helman and Veroff started customizing a Bayesian network to handle the huge volume of data from the medical school's microarrays. Helman helps frame the scope of the challenge by noting that there were more pattern possibilities than there are atoms in the universe. "The number of possibilities in the data from the medical school was immense. So they needed an efficient way to look at the



"THIS COLLABORATION...WAS SO SUCCESSFUL BECAUSE THE FACULTY FROM EACH SCHOOL TOOK THE TIME TO LEARN ABOUT EACH OTHER'S 'CULTURE,' TO BRIDGE THE GAPS AND SOLVE THIS IMPORTANT PROBLEM."

Dr. Joseph L. Cecchi, Dean and Professor, School of Engineering

data. We tailored a Bayesian net for the specific characteristics of this problem. We started with a very large data set from the patients. And we had information on whether or not each patient survived his or her leukemia. The way it works is that you try to find patterns in the genes that correlate with long-term survival," explains Helman.

After the team tested the network and standardized the data from the microarrays, Helman and Veroff ran the data through the Bayesian net on a number of computers in the Center for High Performance Computing (HPC).

Finding A Pattern

By the summer of 2002, the process found a pattern — and a medical discovery. "Amazingly, our Bayesian net revealed that there was one particular gene that was extremely predictive of whether or not someone would survive their leukemia. When that gene was 'expressed' — or turned on — the patient had an extremely high probability of surviving their leukemia. When it was low, the probability wasn't as good," explains Helman.

The gene is named Outcome Predictor for Acute Leukemia 1 or OPAL1 and its discovery is making waves in the cancer research field. The team first presented their findings at a meeting of the American Society of Hematology in late 2003. The group has been invited to submit their research for publication in the New England Journal of Medicine.

OPAL1 has also been submitted for patenting. But most importantly, the discovery has important implications for determining appropriate treatment for leukemia and may some day lead to new treatment protocols for patients with ALL based on their OPAL1 gene expression.

As with most important finds, the OPAL1 discovery depended on collaboration. "It took quite a lot of time and commitment trying to understand the things the medical school was doing, and for them to understand the kinds of things we were talking about," says Veroff.

Dr. Joseph L. Cecchi, dean of the School of Engineering, agrees. "This collaboration between the Computer Science Department in the School of Engineering and the Cancer Research and Treatment Center in the School of Medicine was so successful because the faculty from each school took the time to learn about each other's 'culture,' to bridge the gaps and solve this important problem."

Unique Analysis Approach

Helman's and Veroff's blending of classical mathematical theories and computer science is unique. While many researchers are looking at microarrays, few are applying Bayesian nets to analyze data like the UNM team does. Helman says, "The new computer science aspect that Bob and I developed and applied for the gene work is: A) how do you know which of the patterns to pursue most rigorously when you can only pursue a small number of them because of the sheer enormity of the number? And, B) how do you allow for the fact that there are so many patterns and you don't want to be fooled by ones that are just random associations? And how confident can you be that the ones that look good are actually meaningful? Those are the kinds of new computer science techniques that we have to apply to these kinds of problems."

The potential for combining Bayesian nets and computer science is wide ranging. The team has already customized the networks for a variety of applications. They have looked for the usage patterns of people trying to hack computers and are attempting to analyze export patterns to detect proliferation activities. Currently, they are working on a defense-related application that evaluates biosignatures of toxins like anthrax. The hope is that the research could lead to rapid field assessment to determine if people have been infected with toxins, viruses or bacteria. They are also funded by the National Science Foundation to study DNA damage response mechanisms.

Classical mathematic theories, algorithms and computer science all seem removed from the human condition. They are not, says Helman. "What we learn here is all transferable to humans." OPAL1 is perfect proof. ✦

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Alumni Profile

Dr. Delores Etter

Engineering a Distinguished Career

When opportunity knocks, Dr. Delores Etter, a UNM alumna and former faculty member, opens the door. In doing so, she's transformed a love of math into a distinguished career in electrical engineering.

"I believe that you never know what opportunities you're going to have. So when you have the chance to do something really neat, you need to think seriously about it, because that opportunity won't come around again," explains Etter.

Currently, Etter is a faculty member in electrical engineering at the United States Naval Academy in Annapolis and holds the Distinguished Chair in Science and Technology provided by the Office of Naval Research. She is also conducting research on biometric signal processing. In addition, Etter is a member of many national and professional advisory committees, including the National Science Board and the Defense Science Board.

A Different Course

But engineering was not Etter's first interest when she started college at Oklahoma State University (OSU). She loved math but says, "Engineering never crossed my mind. There were no role models and none of the high school counselors were suggesting engineering for young women. So I started in math."

Etter met her husband, an aerospace engineer and member of the Air Force, at OSU. His postings took them to Texas and then to Wright-Patterson Air Force Base in Ohio. Etter worked as a teaching assistant at Wright State University while completing her B.S. and M.S. degrees in mathematics.

Then they moved to Kirtland Air Force Base in Albuquerque. Opportunity knocked again, when Etter started teaching computer science courses at UNM. "Just for fun, I decided that I would enroll in the first electrical engineering course to see what kind of problems my students were solving, so that I could use those problems as examples in my teaching," explains Etter. That course sparked her interest in electrical engineering and led her to earn a Ph.D. in the field. "If the computer courses hadn't been in the electrical engineering department at UNM, there's probably a very small chance that I would have gotten into electrical engineering," says Etter.

An Opportunity to Serve

After UNM, Etter taught at the University of Colorado at Boulder for eight years. At the same time, she served on Department of Defense advisory committees. In 1998, she had the opportunity to serve as Deputy Under Secretary of Defense for Science and Technology. She was responsible for planning, program execution and budget allocation for the $9 billion Department of Defense Science and Technology Program. "It was an incredible adventure for an academic," says Etter.

In 2001, she took up her current post. "I feel like I have a foot in both worlds now. I'm playing a role in training the next generation of our nation's Navy and Marine Corps leaders. I'm still on a number of advisory committees and continue to be involved in things related to national security," says Etter.

She has earned numerous awards for her outstanding accomplishments and dedication, including the Department of the Navy Distinguished Public Service Award and the Federal Women in Science and Engineering Lifetime Achievement Award. In 2002, Etter was honored with the UNM Distinguished Engineering Alumnus Award. She has also been elected to the National Academy of Engineering, and is a Fellow of the Institute of Electrical and Electronic Engineers and the American Association for the Advancement of Science.

Etter attributes much of her success to her education in the nation's state universities. "I got such a wonderful educational background in my course work at public universities… I'm really proud of that background." says Etter.

She notes that UNM's department structure and culture led her into engineering and shaped her interests. "UNM gave me, and faculty members in general, the opportunity to do the things we wanted to do in terms of research and academic interest. As long as you worked hard, you had a lot of flexibility to learn new things, bring new areas into the classroom and start new topics," says Etter. ✦

Chemical and Nuclear Engineering

Department Installs New Scanning Electron Microscope

A new, high-powered microscope was installed in the Farris Engineering Center's Scanning Electron Microscope Laboratory in April. The **Hitachi S-5200** is the highest resolution microscope of its kind available today. It will give researchers at UNM and other state universities the ability to study nanomaterials at unprecedented resolution.

Abhaya Datye, director of the Center for Micro-Engineered Materials and UNM professor of Chemical and Nuclear Engineering, says that UNM is the first U.S. university to have the $800,000 microscope.

The new instrument allows scientists and researchers to look at the surface of complex materials to understand their structure. It also lets users design novel materials on a nanoscale and tailor their properties for superior performance. Off-site users can download data in real time to their personal computer at the full resolution, allowing researchers at other universities access to the facility as if it were located on their own campus.

A grant from the Experimental Program to Stimulate Competitive Research at the National Science Foundation made the purchase possible. The National Nanotechnology Infrastructure Network, a prestigious collaboration of top academic nanotechnology programs to which UNM was admitted last November, provided additional funds. The State of New Mexico and UNM provided matching funds.

Chair: Julia E. Fulghum
505-277-8670
chne@unm.edu
Faculty: 18
Graduate students: 89
Undergraduate students: 81
Annual research expenditures: $4,482,540

Civil Engineering

Mahmoud Reda Taha, Ph.D., P.Eng., joined the Civil Engineering Department in December of 2003 as an assistant professor of structural engineering. He is also researching smart structures and biomechanics. Taha received his Ph.D. from the University of Calgary in Canada and earned his B.S. and M.S. in structural engineering from Ain Shams University in Egypt.

Taha is one of 25 recipients of Oak Ridge Associated Universities' (ORAU) Ralph E. Powe Junior Faculty Enhancement Awards for the 2004–2005 academic year. ORAU is affiliated with the Department of Energy. Taha won the grant in the category of engineering or applied science for his research project titled "Integrating Structural Modeling and Artificial Intelligence Techniques for Modeling Knee Ligaments."

The $5,000 grant is intended to provide "seed money" to allow faculty members in their first two years of tenure track to enhance their research during the early stages of their careers. Each recipient's institution matches the ORAU award with an additional $5,000.

Chair: Timothy J. Ward
505-277-2328
civil@unm.edu
Faculty: 16
Graduate students: 68
Undergraduate students: 98
Annual research expenditures: $1,181,121

Computer Science

Shuang (Sean) Luan, Ph.D., will be joining the Computer Science Department this fall. Luan earned his Ph.D. in computer science from the University of Notre Dame. He also earned his M.S. in computer science from the University of Notre Dame and his B.S. from Harbin Institute of Technology in Harbin, China. Dr. Luan's research interests include computational medicine, algorithm design, analysis and implementation, and computational geometry. He plans to collaborate on research efforts with the Department of Radiology and Radiation Oncology in the School of Medicine.

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

Electrical and Computer Engineering

Jingkuang Chen, Ph.D., will join the Electrical and Computer Engineering Department this fall. He will work in the department's Microelectromechanical Systems (MEMS) program. Chen earned his Ph.D. in electrical engineering from the University of Michigan in Ann Arbor. He earned his B.S. and M.S. in electrical engineering from National Taiwan University in Taipei, Taiwan. Dr. Chen's research interests include the study of MEMS-based ultrasonic transducers and developing smart microfluidic systems for biomedical applications.

Chair: Christos Christodoulou
505-277-6580
info@ece.unm.edu
Faculty: 32
Graduate students: 285
Undergraduate students: 260
Annual research expenditures: $10,977,000

Mechanical Engineering

Juan C. Heinrich has been appointed as the new chairperson for the Mechanical Engineering Department. Heinrich joined the School of Engineering on August 16. He leads a department of 300 students and 17 faculty members.

"Professor Heinrich brings a vision and leadership style that will move the department and school forward at a time of great opportunity in engineering," said Joseph L. Cecchi, dean of the School of Engineering. "I'm extremely pleased that such an outstanding, accomplished faculty member will be leading the Department of Mechanical Engineering."

Previously, Heinrich was professor of Aerospace and Mechanical Engineering at the University of Arizona. His teaching experience spans a broad array of courses at both undergraduate and graduate levels. He has conducted research on the analysis of materials and the modeling of solids and fluid flow.

Heinrich received his Ph.D. in Mathematics/Numerical Analysis from the University of Pittsburgh in 1975. He then was a senior research assistant in the department of Civil Engineering at the University of Wales in Great Britain. From 1978-1980, Heinrich was a senior research associate in the department of Earth Sciences at Case Western Reserve University in Cleveland, Ohio. He joined the University of Arizona in 1980 as assistant professor and was promoted to full professor in 1990.

Chair: Juan C. Heinrich
505-277-6277
lsandve@unm.edu
Faculty: 17
Graduate students: 119
Undergraduate students: 189
Annual research expenditures: $1,864,021

"We're charging forward to raise awareness at UNM about women in engineering and the sciences."

Elaine Borrelli

Director of Engineering Student Programs and the Women in Science and Engineering Program

On the Road to Change

ANNUAL WEPAN CONFERENCE IS HELD IN ALBUQUERQUE

Women make up 50 percent of the population and almost half the workforce, but they comprise only 12 percent of engineering professionals. The Women in Engineering Programs & Advocates Network (WEPAN) is working to improve that number. WEPAN is a national, nonprofit organization focused on increasing the number of women engineering students and women in engineering careers, as well as increasing their overall success in the field.

The road to reaching those goals went right through Albuquerque when WEPAN held its annual conference in the city this summer. The conference, themed "Route 50/50: Shifting Gears for Inclusion," was held June 6–9. Elaine Borrelli, director of Engineering Student Programs and the Women in Science and Engineering Program at the University of New Mexico, was the event chairperson. UNM co-hosted the event along with New Mexico State University.

More than 200 women from around the world attended presentations, workshops and panels during the three-day event. Topics included program assessment, classroom climate research studies, career trajectories for women engineers, successful pre-college initiatives, and a symposium on outreach, retention, and organizational change.

One of the keynote speakers was Sandra Begay-Campbell, a principal member of the technical staff at Sandia National Laboratories, alumna of the School of Engineering's Department of Civil Engineering, and currently a member of the UNM Board of Regents. Begay-Campbell spoke about her experiences as a Navajo woman in engineering within the framework of a Navajo concept called "walking in beauty" which takes a holistic approach to the world. "I was very excited to have the WEPAN conference in Albuquerque and to have attendees see the Land of Enchantment," says Begay-Campbell.

Borrelli says the conference was a great success for women in engineering and for UNM. "We're charging forward to raise awareness at UNM about women in engineering and the sciences. Dean Cecchi and the department chairs have been tremendously enthusiastic and supportive about creating an environment that welcomes women students and, in doing so, enriches the learning experience for all students," says Borrelli. She adds, "We're doing well, but we have more opportunities ahead." The number of women students in engineering at the nation's universities is about 20 percent. UNM is just above the national average at 21 percent.

Borrelli says the WEPAN conference helped boost the profiles of the city and university. She sums up the event saying, "We want people outside of New Mexico to understand that we have wonderful engineering and technical resources here. We also want them to see that UNM is an exemplary place for students to attend school. The conference participants enjoyed Albuquerque and felt that New Mexico, and UNM, are at the forefront of technology and engineering." ✦

www.wepan.org
www.unm.edu/~unmwise/

Greg Johnston

UNM Provost Brian Foster, left, and Colonel Eidsuane of the U.S. Air Force sign a memorandum of understanding to allow Air Force officers and civilians to earn advanced degrees.

A Productive Partnership

UNM partners with the Air Force in new distance learning program

This fall, four college courses are being taught at Kirtland Air Force Base through an agreement between the University of New Mexico and the U.S. Air Force. The courses are part of a new distance education program, teleconferenced from the Air Force Institute of Technology (AFIT) headquarters at Wright-Patterson Air Force Base in Dayton, Ohio.

The agreement between UNM and AFIT, which was signed in March, allows Air Force officers and civilians to earn advanced degrees in science, technology and management by combining credits from UNM and AFIT. The plan provides a framework for the two institutions to jointly offer part-time graduate programs primarily to Air Force officers and civilians, to share distance education offerings and to encourage research applications. UNM will further benefit by allowing students access to advanced courses and research opportunities, previously available only to Air Force personnel.

"This collaborative program will allow students in the School of Engineering to access high-quality systems engineering courses from AFIT," says Charles Fleddermann, professor of Electrical Engineering and associate dean. "It will also allow military and civilian employees at Kirtland Air Force base to easily transfer UNM courses to AFIT, or AFIT courses to UNM."

UNM has provided graduate-level education to Air Force officers and personnel for many years. For more than 50 years, AFIT has been the Air Force's primary source of graduate education in engineering, science and management. Air Force military personnel typically have three-year assignments, making it difficult to complete a part-time graduate program, which usually requires four or more years. UNM's agreement with AFIT will make their path to a graduate degree easier to negotiate. ✦

The University of New Mexico

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