UNIVERSITY OF MINNESOTA

SIGNALS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SPRING 2004

The Future is Now!

By Chuck Benda

All five of the ECE Department's assistant professors have landed the prestigious NSF Career Award, testifying to the current strength of the department—and hinting at an even more robust future.

Making the transition from graduate student to professor can be quite a challenge. Although the workload and the pressure to succeed can be pretty substantial even for Ph.D. students, they pale in comparison to what a typical new faculty member at a major research institution must face early in his or her career.

"It was a huge shock when I first got my feet wet," says Assistant Professor Rhonda Franklin Drayton. "When I completed grad school, I felt I was ready for primetime. I had been looking forward to taking my research to the next level. Instead, I discovered I that as an experimentalist, I would need to build from scratch and then resume my research."

Starting all over meant building a research team and raising the funding to continue her research, tasks that were compounded, according to Drayton, by the fact that she now also had other hats to wear, as well: those of teacher, manager, team leader. "You have to keep a lot of balls in the air at once," she says.

Assistant Professor Kiarash Bazargan, agrees. "It's very difficult to figure out how to balance all the demands on your time," he says. "Preparing to begin teaching new classes for the first time can be enormously time consuming, let alone seeking out and securing research funding."

Many tasks await new faculty members: identifying and recruiting good students to your research group and then teaching and mentoring those students, choosing research projects that are fundable, preparing funding proposals (and waiting six to eight months for a response)—the list goes on. The other assistant professors in the department—Heiko Jacobs, Beth Stadler, and Babak Ziaie—agree with Drayton and Bazargan that the challenges can be intimidating at first. And, like Drayton and Bazargan, they'll tell you that receiving the prestigious National Science Foundation (NSF) Career Award was just the jumpstart their careers needed.

"The prestige alone gives you a pretty good psychological boost," says Ziaie. "And the monetary award—$75,000 a year for five years—provides seed money you can use to hire students, buy supplies, and explore some of your research ideas in order to apply for the funding you need to do the real research."

Having received their awards from 2 to 6 years ago, the seeds these bright young faculty members have planted have already turned into some pretty amazing "real" research. See for yourself in the stories that follow.

KIARASH BAZARGAN

VLSI-CAD

Since joining the ECE faculty as an assistant professor in the fall of 2000, Bazargan has come to greatly appreciate the support the ECE department affords its faculty.

"For starters, in this department, junior faculty members are given a very manageable teaching load," says Bazargan. A native of Tehran, Iran, Bazargan earned his undergraduate degree in computer science at Sharif University of Technology in Tehran and his master's (1998) and Ph.D. (2000) degrees in electrical and computer engineering at Northwestern University. "This gives us a tremendous opportunity to invest the necessary time in gearing up our research programs to begin to get known within the research community."

Kiarash Bazargan

When it comes to teaching, "manageable" is a relative term. The first time one teaches a new course, according to Bazargan, it takes roughly eight hours to prepare for a one and one-half hour lecture. Given those numbers, it's not hard to understand how a heavy teaching load could eat up just about every

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INSIDE OUT

During a year of budget cuts, a major blackout, and global strife, the Electrical and Computer Engineering Department has continued to move forward with remarkable resiliency. This is very much due to the dedication and the outstanding work of our faculty, staff, and students, and the tremendous support of our alumni and friends. I wish to take this opportunity to highlight some of our accomplishments, and to summarize important developments of the past year. More information on these developments is given elsewhere in the newsletter.

The generosity of our alumni and friends has continued unabated during these difficult economic times, with the Department's Hartig Fund receiving over $60,000 in new contributions during the past year. Income from this fund is primarily used for scholarships and to provide support for our academic programs and initiatives. Last summer, David and Joan Henle made a generous commitment to the Department in memory of David's parents, Robert (1949 B.E.E, 1951 M.S.) and Marjorie, in the form of the endowed Robert and Marjorie Henle Chair in Electrical Engineering. Professor Sachin Sapatnekar is the first holder of this chair. Recently, Professor Gary Glover (1964 B.E.E., 1965 M.S., 1969 Ph.D.) of Stanford University endowed a fellowship in ECE. These and other monetary contributions are critical to enabling us reach greater heights in our educational and scholarly endeavors.

One of the initiatives of the past year was the establishment of undergraduate central advising. Surveys of our undergraduates have consistently pointed to the desire on the part of students for more informed and up to date advising help. We felt that such a service could best be provided by a group of faculty central advisors, who are well-informed on the latest curricular issues and graduation requirements, with faculty as a whole available for professional advising help. Without any additional resources, this service was successfully implemented and well received by students during the 2003-04 academic year. An interesting example of educational outreach was the internet delivery of a three-day short course, by Professor Mohan and his colleagues, to power engineering educators on new ways of teaching electric drives. This short course resulted from a grant in support of new approaches to power engineering education and the dissemination of the results. Hundreds of educators and engineers from around the globe "attended" this short course, free of charge, over the web. This is clearly a very successful example of the use of technology for education and training.

Another major undertaking has been the development of a departmental history book. Professor James Leger has spearheaded this project, building on a historical document compiled in the late 1980s by Professor Emeritus Paul Cartwright. We hope to have this project completed by fall 2004.

The accomplishments of our faculty and students have been recognized inside and outside the university. Professor Guillermo Sapiro received a coveted Distinguished University McKnight Professorship, while Professor Heiko Jacobs' outstanding work in research and teaching was recognized through a McKnight Land Grant Professorship. Professor Georgios Giannakis received one of two 2004 George Taylor Distinguished Research Awards from IT, and Professor Keshab Parhi was selected the recipient of the 2004 Frederick Emmons Terman Award of the American Society of Engineering Education. A project developed by Graduate students Byunghoo Jung and Jaewon Kim, consultant Philip Cheung, and Professor Ramesh Harjani won the SiGe Design Challenge sponsored by the Semiconductor Research Corporation (SRC). The title of the design was "20 GHz Wide Tuning Range Low Noise VCO and Monolithic CDR Circuit". Fifty-nine design teams from around the world participated in the two-phase competition. Professor Giannakis and students, and Professor Georgiou and collaborators received best paper awards from three different IEEE societies. The views and expertise of Professors Massoud Amin and Bruce Wollenberg have been in high demand by industry and government following the great blackout this past year. The University is a member of the multi-university National Nano-Infrastructure Network (NNIN). Funded by the National Science Foundation, the NNIN's goal is to provide researchers across the country low cost access to nano capabilities. NNIN funding will be used to support the operation of multi-user facilities and to open up those facilities to subsidized usage by academics from outside the node institutions. Further information on these awards and other recognitions and newsworthy items can be found on the Department's web site (www.ece.umn.edu).

We congratulate and give our best wishes to three colleagues who have

SIGNALS

M. Kaveh
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Associate Head & Director of Undergraduate Studies

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PRODUCTION

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retired this year from the Department. They are Professor Marshall Nathan, Executive Assistant Betty Lou Viskocil and Shop Foreman John Marchetti. We thank them for their many outstanding contributions to the Department and the University. We welcome three new colleagues. They are Assistant Professors Nihar Jindal, Chris Kim and Mihailo Jovanovic. Nihar has received his Ph.D. degree from Stanford and works on information theory and wireless communications. Chris' Ph.D. degree is from Purdue, and his areas of interest include circuit design and architectures for nano-scale VLSI systems. Mihailo received his Ph.D. degree from the University of California at Santa Barbara and works on modeling and control of distributed systems. We'll provide more background and news about these new colleagues in the next issue of *Signals*.

After nine years at the helm of the Institute of Technology, Dean H. Ted Davis will return to teaching and research in fall 2004. The search for a new dean of the college is underway. Another major change is the resignation and departure of Senior Vice President and Provost Christine Maziar. Dr. Maziar, who is also a professor of ECE, will be moving to Notre Dame University as a Vice President and Associate Provost. We wish Dean Davis and Provost Maziar all the best in their new endeavors.

In closing, I wish to once again take this opportunity to thank our alumni and friends of ECE for generously supporting our students and programs. We'd appreciate hearing from you.

With my best wishes,
M. Kaveh
Centennial Professor and Head

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"I've developed multiple mentor-like relationships with my colleagues. Daily conversations with these fellow faculty members have really accelerated the development of my research program."

—KIARASH BAZARGAN

hour in the day for new faculty members. Along with reasonable teaching loads, new faculty members at the ECE department soon discover a wealth of support from their colleagues.

"We don't have an official mentoring program in the department—but my colleagues have proven themselves extremely willing to help," says Bazargan. "I've developed multiple mentor-like relationships with my colleagues. Daily conversations with these fellow faculty members have really accelerated the development of my research program."

A specialist in computer-aided design (CAD) for very large-scale integrated circuits (VLSI), Bazargan has zeroed in on reconfigurable computing, hardware/software co-design, Field Programmable Gate Array (FPGA) physical design, and fast ASIC floorplanning as his primary areas of focus.

Bazargan landed his NSF Career Award in the summer of 2003. He had already gotten a good start on funding his research prior to the award. Recently, he and his research group have achieved some noteworthy success, including the work done on a research project to develop new algorithms for the placement of FPGAs and a project to implement a hard disk read-back signal generator on an FPGA platform to be used in simulations (in collaboration with ECE Professor Jay Moon).

Chip design these days is an incredibly complicated process. With thousands upon thousands of devices incorporated onto single chips, even using the latest CAD tools, the design process has become almost untenably time consuming. When it comes to the placement of FPGAs and other devices, one of the best algorithms used in the design process to date has been one that simulates the annealing process (the cooling and solidifying of molten metal).

"The goals of placement are to minimize circuit delays, minimize the total area, and minimize power consumption," says Bazargan. "Traditionally, placement solutions have been slow to come by; good solutions, even slower."

Others tried different methods of improving on the performance of the so-called annealing algorithms without much success. According to Bazargan, these researchers found that to make their methods work, they had to be willing to accept tradeoffs in terms of either time or quality.

"For example, some were able to speed up the placement process by an order of magnitude, but achieve solution qualities that are much worse than annealing," he says. "We developed what we call heuristic or greedy algorithms. Our placement is partitioning based, which has allowed us to achieve three to four times speedup, while maintaining the same quality as annealing."

Bazargan's research group is the first to achieve such results and the paper they published describing their work was nominated for the Best Paper Award at the annual Design Automation Conference. The next step for this project, according to Bazargan, is to begin to examine placement methods for three-dimensional chip design. "If we can develop a fast placement tool, it will enable us to reap some of the inherent benefits of 3-D design," he says.

In his research on the signal generator, Bazargan teamed up with ECE Professor Jay Moon. They were looking for ways to develop a signal generator that simulates different sources of noise that are added to a hard disk read head.

"People developing hard disks need to be able to develop very high quality filters to eliminate the noise that leads to signal errors," says Bazargan. "The necessary simulations can take several days. We did it on an FPGA chip and

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were able to reduce the amount of time to a matter of hours."

Bazargan and Moon were also able to offer a signal generator with greater flexibility. In simulations, the parameters change as the hard disk read-head moves from one track to another. With FPGAs, it's possible to quickly plug in the new hardware blocks that correspond to various factors, and generate the new, appropriate signal, according to Bazargan.

"We were able to achieve the speed-up through the use of a heavily pipelined design that allows us to do a lot of the computing in parallel," he says. "With our approach, one can also reconfigure the FPGAs much quicker and more economically than can be done with traditional ASIC chips."

Results like these would seem to suggest that the NSF was very astute in awarding Bazargan his Career Award.

RHONDA FRANKLIN DRAYTON

High Speed Electronic and Opto-electronic Packaging

The first of the department's junior faculty members to receive an NSF Career Award (1999), Drayton also received the more prestigious version of it: The Presidential Early Career Award, which comes with a five-year, $100,000-per-year stipend, rather than $75,000 per year. Like everyone else, Drayton has been able to put that money to good use as she ramped up her research program, but she also believes that the process of applying and competing for the award was a critical factor in shaping her career.

Rhonda Drayton

"The application process itself was extremely helpful to me," says Drayton. "Going in, you know the competition will be stiff. Typically, all the applicants are very, very bright—and very excited about what they'd like to do with their careers. Knowing that forces you to formulate a career/business plan—something I never considered as a grad student—and it forces you to think very, very carefully about where it is you want to go, and how you plan to get there."

Academicians need such a plan, according to Drayton, in order to efficiently make the transition from graduate student to faculty member. She compares the way she thought about her career during her student days to an athlete training for the Olympics. As a student, she thought she was ready for the big show, only to discover that when she got there, she was now expected to be a coach to good athletes with great potential as well as be an athlete herself.

"As a student, your research often begins with someone else's idea, and you end up contributing to a foundation that has already been laid," she explains. "As a faculty member, you have to expand your horizons. You become the idea creator and the person who delegates the responsibility. You have to examine and understand the big picture, and then identify areas and problems where you and your research team can make a contribution."

Drayton, who joined the ECE Department in 1998, is a native of Houston, Texas. Prior to coming to Minnesota, Drayton had been a Visiting Faculty Scholar at the Lawrence Livermore National Laboratory and an assistant professor in the electrical engineering and computer science department at the University of Illinois at Chicago. The primary focus of her research is on development of packaging concepts that enable integration of the next generation of high speed circuit designs (i.e.radio frequency and microwave circuits) used in wireless, mobile and satellite communication systems into more complex, yet compact systems.

"When you're working with high frequency circuits, there are a number of subtle design challenges that can be ignored when you're working with lower frequency applications," says Drayton. "We're attempting to tailor the packaging so that it will enable diverse integration of complex, dissimilar technologies."

The research that Drayton does is aimed at higher level applications within the infrastructure of communications systems. But even there, the direct tie to applications is tenuous because their research is more fundamental by nature. "Our efforts are very contemporary for packaging of optoelectronic and/or microwave designs, " she says.

Her research involves concept development for three general areas: packaging, integration, and GHz material characterization used in high frequency circuit design. In one branch of her research, Drayton and her colleagues have been examining various integrated packaging concepts that will allow them to develop viable packaging and interconnect solutions for small array features sizes like those common to opto-electronic applications. They have chosen to work on a silicon substrate, because of the flexibility and ease of design that it offers. To enable improved performance of designs working at either high or low GHz frequency operation, they're investigating a form of silicon known as porous silicon in order to improve the electrical properties of the substrate for high speed applications. To date, they have been able to achieve as much as a 65 percent reduction of signal loss in the silicon substrates commonly used in technologies like CMOS and BiCMOS.

In a related packaging and integration problem, they are developing compact, three-dimensional high-frequency package and interconnect architectures that are needed to integrate GHz electronic circuits and/or optoelectronic devices from other different material systems. This approach will permit three-dimensional integration in so-called "wafer-level" architectures consisting of digital and analog design using electronic and photonic approaches.

"Going in three dimensions—stacking the wafers—offers a number of opportunities," says Drayton. "You can make smaller systems. You can use the design to isolate sensitive components. You can enhance performance. Current technologies don't typically route microwave signals in that manner, however. They usually keep them in planes, in order to control the performance."

It will most likely be years before Drayton's research finds its way into the real world infrastructure of our communications systems, but Drayton seems to like staying ahead of the curve. The next logical step, from her perspective,

is to become involved in more collaborative research efforts.

Along with collaborating with other researchers at Honeywell and Lawrence Livermore Natinoal Laboratory on packaging problems, Drayton would also like to expand her efforts to include research on antenna-related problems and the application of new materials to high frequency design.

"I've been working to bring our new antenna lab on-line," she says. " We've already initiated some projects in this area as well. As we develop new compact packaged systems, we also need to develop better ways to get our signals in and out of the various devices by means of wireless free space propagation. We aim to develop these systems to be seamless.

"In our final research area, materials characterization, we're working with DuPont to develop techniques and models to characterize ceramic materials for GHz applications. This has been a good collaboration since we do not develop ceramic materials ourselves in house. Through industrial collaborations, we can really expand our horizons."

Which is, after all, just the sort of attitude the NSF hopes to promote with its Career Awards.

"As a faculty member, you become the idea creator and the person who delegates the responsibility. You have to examine and understand the big picture, and then identify areas and problems where you and your research team can make a contribution."

—RHONDA FRANKLIN DRAYTON

HEIKO JACOBS

Nano-technology

As semiconductor devices, circuits, and chips become smaller and ever smaller, those researchers who wish to keep advancing their discipline must become more and ever more creative as they seek out ways to transcend the physical limits of traditional technologies. At these dimensions, once benign physics phenomena become insurmountable barriers. For example, current manufacturing processes rely on robots to "pick" components from their fabrication template and "place" them onto the appropriate site in the circuit. But that technology won't work for Assistant Professor Heiko Jacobs.

Heiko Jacobs

"You can no longer assemble these devices using pick and place," says Jacobs. "The robots can pick the components up, but they can't place them. At these sizes, ordinary surface forces prevent their release."

What can you do when the size of the components has shrunk so much it's impossible to assemble the final product? Get them to assemble themselves, which, as fantastic as it might sound, is the primary focus of Jacobs' research.

"We're working in three primary areas, each of which feed into developing the technology known as directed self assembly," says Jacobs. "So far our progress has been pretty good in each of these areas."

Pretty good might be an understatement given the fact that Jacobs and his research team are among the best in the world, but Jacobs' success at the University isn't surprising, given his graduate school training and a productive post-doctoral stint at Harvard University with renowned Chemistry Professor George M. Whitesides. Some of the work he did there (developing a stamp to form nanometer-sized contacts) was a precursor to his current research. An electrical engineer working with a chemist wasn't unusual at all, given the nature of his research interest, according to Jacobs. In fact, when working in these dimensions, it's almost a prerequisite to blend disciplines such as chemistry, applied physics, and mechanical engineering with electrical engineering. Jacobs, a native of Cologne, Germany, is well suited for these multidisciplinary efforts. He earned his bachelor's and master's degrees in electrical engineering at the University of Wuppertal, Germany. Then he earned a Dr. Sc. Techn. Degree in mechanical engineering in the area of nanotechnology at the Swiss Federal Institute of Technology.

The first step to directed self-assembly is to figure out how to get the components to "assemble" themselves in the proper location. In one project, Jacobs and his research team are developing techniques that use electrical charges to attract the components to precise locations.

"Essentially, you're programming the surface of the substrate to direct the self assembly through the use of electrical charges," says Jacobs. "We started out using an atomic force microscope with multiple points and a scanning probe technique to create high-resolution patterns of charges. Since then, we have developed a parallel concept to overcome the speed limitations involved with the scanning probe technique. We call this technique Electric Nanocontact Lithography."

Electric Nanocontact Lithography is based on the same principles as scanning probe lithography, according to Jacobs, but relies on a completely parallel approach. He expects this approach to lead to the development of a reconfigurable exposure tool that can be used to form a variety of different patterns on surfaces, including patterns of oxide, electron resists, and charge. This could enable the mass production of such devices as single electron transistors, quantum-effect-based lasers, and photonic bandgap optical filters.

In a second research project, Jacobs is developing techniques to position very small components—measuring five nanometers—in precise locations. The approach uses electrostatic forces to direct the components into position. The developed apparatus, a "Nanoxerographic Printer," has already allowed the research group to integrate nanoparticles ranging in size from 5 to 100 nanometers onto surfaces with a resolution of 50 nanometers. To date, the group has been able to demonstrate a 2000-fold increase in precision over what anyone else has been able to accomplish. "Ultimately we would

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like to develop techniques to enable the fabrication of hybrid micro- and nano-scale systems that are based on novel device prototypes such as single electron transistors and nanowire based lasers," says Jacobs. Conventional semiconductor devices out of silicon, gallium arsenate, gallium nitrate, indium phosphide, and other materials are incompatible using current technologies and must be assembled into systems on separate substrates using long interconnects. Jacobs aims to use various approaches to enable the integration of novel device prototypes to form hybrid systems on a single substrate.

In one approach, Jacobs teamed up with ECE Professor Steve Campbell and mechanical engineering Professor Uwe Kortshagen to fabricate electronic (first) and optoelectronic systems from single crystal semiconductor nanoparticles.

In a second approach, Jacobs and his research team focus on integrating nanowires to form nanowire-based devices and systems. They are developing the technology to "grow" nanowires with precise diameters in precise locations.

In a third research project, Jacobs and his research team are attempting to develop self-assembly techniques on a much larger scale to form multicomponent microsystems. This project focuses on assembling components that measure 100 by 100 micrometers. They are working on a technique that uses patterned three-dimensional objects and relies on surface tension to drive the assembly process.

"Our goal is to develop a programmable technique that will enable the fabrication of multicomponent microsystems with electrical three-dimensional interconnects between individual building blocks," says Jacobs.

With time, the right combination of disciplines, and a good deal of creativity, it would seem that almost anything is possible in the realm of nanotechnology.

BETH STADLER

Materials Integration

Like her colleagues, Assistant Professor Beth Stadler appreciated the prestige that accompanies the NSF Career Award. More importantly, however, she too discovered that the funding that accompany the award serve as a pretty good launching pad when it comes to securing additional funds.

"The funding that comes with the award doesn't really go all that far in terms of financing research," Stadler says. "It pays overhead, stipend for one student on your research team, and a little is left for materials and supplies."

Beth Stadler

However, it is a good start to the research effort and makes it easier to secure additional funding. A growing list of research sponsors, both public and private, attest to Stadler's belief. The list includes several other awards by the National Science Foundation, research and equipment awards from the Office of Naval Research, a collaborative award from the National Space and Aeronautics Administration's Small Business Technology Transfer division, and collaborative work with Boston Applied Technologies. The Materials Research Science and Engineering Center (MRSEC) at the U was also helpful in providing a launching pad for Stadler's work in nanowires.

Stadler has given her research group a name—Advancing the Integration of Materials and Devices—replete with its own acronym (AIMD) that pretty well describes the scope of her research. As you might expect, her education fits her research specialties quite well. A native of Chardon, Ohio, Stadler earned her bachelor's degree (1990 Case Western Reserve University) and Ph.D. degree (1994 Massachusetts Institute of Technology), both in materials science.

Stadler's research is focused on developing, optimizing, and integrating photonic and magnetic materials and devices that are not typically considered to be compatible. Her research covers three major areas. One area is the integration of magneto-optic devices onto semiconductor substrates using thin-film technology. This includes developing integrated thin film permanent magnets for biasing and growing self-organizing nanostructures in aluminum oxide for novel photonic crystal applications. The second area also uses these nanostructures in aluminum oxide, but this time they are templates for growing arrays of magnetic nanowires. These nanowires are useful for current-perpendicular-to-the-plane (CPP) magnetoelectronics, fundamental studies of one dimensional magnetism, and resonant sensors for acoustics, flow, chemical, and other applications. Finally, Stadler is integrating materials science and electrical engineering in the fabrication of world-class perpendicular recording media through novel seedlayers and dopants.

An example of the novel integration being performed in Stadler's group is their work in garnet thin film waveguides.

"Garnet is a useful magneto-optic material," says Stadler. "It has the capacity to rotate light, which makes it useful in applications such as the isolators that are used to protect lasers from any back-reflected light that might impinge on them. Up until now, these devices were only available in discrete components, so they are bulky and have realignment issues."

Stadler's group is also using garnet to fabricate photonic band gap structures (PBGs), which enable device designers to manipulate light in ways much like atomic bandgaps can be designed to manipulate electrons. Most designers of PBGs use semiconductor/air structures in order to obtain the largest possible differences in the dielectric constants. Stadler's group has used advanced simulation techniques to design PBGs using garnet/air structures, which will enable lower insertion losses for integrated isolators and magneto-optic functionality. The problem is, garnet isn't particularly compatible with semiconductor materials, such as silicon, indium phosphide and gallium arsenide, which are common substrates for photonic integrated circuits.

"We've developed a technique to grow garnet using semiconductor compatible processes says Stadler. "This is difficult because a complex oxide like garnet typically requires high energy processing to form. Semiconductors, however, require low temperature processing to prevent damage. We

finally have prototype waveguide isolators that will greatly aid in the realization of fully integrated photonic integrated circuits because the laser can now be included on the chip."

As she has developed her research program, Stadler has continued to try to develop innovative ways to motivate and inspire students in her classes as well. One method has been a team-based lab that is part of a graduate class called Principles of Thin Film Technology. One year, the teams competed in making resistive mirrors.

"One group used a silicon overcoat —which typically isn't as reflective as the metals being used—but the layer they deposited happened to be as thick as a half wavelength for the light being used, so they lucked out because it gave them better reflection along with the resistance they'd wanted," Stadler says. "It's been a fun addition to their coursework, and more importantly, they get hands-on experience with vacuum equipment before they are responsible for their own research tools."

BABAK ZIAIE

Biomedical micro-machines

One of the things Assistant Professor Babak Ziaie appreciated most about the NSF Career Award was the flexibility the award allows recipients in terms of how to use the funds. He was able to use some of the monies to support his research by funding lab supplies, and student researchers and so on. But he was also able to use some of the monies to finance some curriculum improvements.

Babak Ziaie

"It's difficult to get good students these days," he says. "I used part of my NSF Career Award to develop some new classes; at the junior microelectronics level students examine and work on biomedical engineering-related design problems. This will help them connect what they learn to real, practical problems in biomedical instrumentation. I am also developing a freshman seminar on biomedical engineering. I wanted to reach out to the students, show them that it's a fun field, and get them excited about the possibilities of becoming involved in research."

"I used part of my NSF Career Award to develop some new classes. I wanted to reach out to the students, show them that it's a fun field, and get them excited about the possibilities of becoming involved in research."

—BABAK ZIAIE

Ziaie's passion for his research is strong. And, while it clearly spills over into his classrooms (hopefully inspiring the next generation of researchers), it also has moved him quickly down the path toward success. His research interests are focused on solid-state sensors and actuators and micro-machining technologies for biomedical research. In particular, he has zeroed in on diagnostic, therapeutic, and rehabilitative microsystems such as implantable drug delivery systems and neural prosthetic devices.

One project makes use of energy supplied through hydro-gels to power an implantable device that can sense changes in glucose levels. Because the "power" comes from the hydro-gels, no batteries or external wires are required.

"It's a chemical-mechanical device that is used in conjunction with an insulin pump," says Ziaie. "When the hydro-gel swells, it activates a transponder that can deliver a signal to the drug delivery pump."

It sounds simple enough, but, as you might guess, it isn't quite as easy as it might sound. According to Ziaie, the biggest challenge has been integrating the hydro-gel with the micro-machined structure. Hydro-gels, which are polymeric materials that swell when they come in contact with water, were developed by pharmaceutical companies. There are many different kinds, some sensitive to Ph, some sensitive to glucose, and so on. Typically, they are very soft. When they swell, they don't exert very much pressure, which means the system must be both precise and sensitive.

"We've been very successful, so far," says Ziaie. "We've already demonstrated the ability to sense glucose levels remotely, measure glucose, and modulate the flow of insulin. When it comes to hydro-gels and drug delivery, we are the cutting edge."

In a second project—which has also achieved a substantial measure of success already—Ziaie and his research team are developing a micro-system for diagnosis and management of glaucoma.

The heart and soul of the system on the diagnostic side is an implantable wireless pressure sensor that would allow physicians to monitor eye pressure over the long term. On the treatment side, Ziaie hopes to be able to develop a micro-fluidic valve that would allow physicians to drain fluid and lower the intra-ocular pressure as needed to manage the patient's glaucoma.

Currently, the technology for managing the pressure within the eye of a glaucoma patient is relatively primitive. According to Ziaie, physicians implant a crude, pressure sensitive valve connected to a tube. When the pressure rises, the valve opens, allowing some fluid to drain off to reduce the pressure. Typically, the valves only work for a couple of months, however. Ziaie would like to develop a more robust micro-system that could do the job better and longer.

"We have developed some novel ways of controlling micro valves that we believe would work in this and other applications—such as with brain fluids," he says. "To be successful, such a system would have to successfully monitor pressure and have wireless control."

Ziaie and his research group have already developed several successful micro-valves. And they developed the capacity to offer remote wireless control, novel packaging techniques, and the microchips needed for data processing. The rest may be merely a matter of time.

"Glaucoma treatment hasn't changed in the past 40 years," says Ziaie. "People still go blind from it on a regular basis. The devices we're developing can have a major impact on this problem."

Small wonder Ziaie is as passionate as he is about the work he does.

Chair Honors a Father's Passion for Engineering

By Chuck Benda

Semiconductor pioneer Robert A. Henle didn't convince his son to become an engineer—but clearly he convinced him of the value of engineering.

A Hatful of Feathers

Robert A. Henle's professional success and reputation reached far beyond the confines of IBM. He is recognized throughout the industry as a pioneer in the development of all-transistor computers and the monolithic memory technology. Henle was well respected as a teacher, a groundbreaking research scientist, and a prolific inventor and writer. His professional accomplishments and honors are too many to list in their entirety, but here is a sampling.

48 patents

More than 25 technical papers

IBM Fellow

Member, National Academy of Engineering

Fellow, Institute of Electrical and Electronics Engineers (IEEE)

IEEE Edison Medal

Department of Defense Citation for "Exceptionally Meritorious Civilian Service"

University of Minnesota Outstanding Achievement Award

Like many young men growing up, David Henle tried to follow in his father's footsteps. He even went so far as to begin his college education in engineering. It didn't take long, however, to realize he was trying to pound a round peg into a square hole and change his major. David has never forgotten, however, the enormous passion his father, Robert A. Henle (B.S. 1949, M.S. 1951), showed for engineering.

"My father had a keen mind for math and an ever-present passion for engineering," says Henle. "It showed whether we were sitting around home on a Saturday afternoon—when my father spent countless hours reading *American Scientist* and all sorts of trade journals from the IEEE—or on the ski slopes, where he'd challenge us to figure out the number of chairs on the lifts and then calculate the exact center of the lift. There were hundreds of such games he played with us."

To honor his father's passion for engineering, David Henle and his wife Joan recently presented the University of Minnesota with a gift to endow the Robert and Marjorie Henle Chair in Electrical Engineering.

"I don't have any close personal ties to the University of Minnesota, but my wife and I wanted to do something to support the intellectual pursuit of the sciences—especially engineering," says Henle. "It seemed to make sense to do that at the institution where both of my parents sort of 'grew up.'"

Although it didn't turn David Henle or his siblings into engineers, Robert Henle's passion for engineering did help them develop their minds. Instead of engineering, Henle earned an undergraduate degree in economics from Union College, in Schenectady, New York, and an M.B.A. degree from New York University. Today, he is managing director and global head of Private Wealth Management at Goldman Sachs,

From left to right: IT Dean Ted Davis, University of Minnesota Foundation Assistant Vice President for Development Judy Kirk, ECE Department Head Mos Kaveh, David Henle, University of Minnesota President Bob Bruininks, and University of Minnesota Senior Vice President Christine Maziar

"My father had a keen mind for math and an ever-present passion for engineering. It showed whether we were sitting around home on a Saturday afternoon—or on the ski slopes, where he'd challenge us to figure out the number of chairs on the lifts and then calculate the exact center of the lift.

—DAVID HENLE

in New York. Goldman Sachs, founded in 1869, is one of the world's oldest and largest investment banking firms. Henle is in charge of private banking services, which includes tax planning, estate planning, and asset allocation planning.

Robert Henle, who passed away in 1989, began and ended his career working for IBM. Shortly after completing his master's degree at the University of Minnesota in 1951, he accepted a job with IBM in Poughkeepsie, New York. He and his wife Marjorie (whom he met at the University) moved to nearby Hyde Park.

Henle flourished at IBM. In his master's work at the University of Minnesota Electrical Engineering Department, he had studied transistor circuits. At IBM, he joined a research group studying the application of semiconductor devices to computers. Their work led to the development of IBM's first all-transistor computer. He followed those efforts with developmental work on high-speed circuits for a series of IBM computers that were considered to be the cutting edge of computer design in the late 1950s. Subsequently, Robert Henle developed monolithic memory technology. Among many other accomplishments at IBM, Henle played a primary role in developing techniques that became the foundation of all IBM semiconductor main memories. In 1975, he was named manager of Advanced Technology for IBM's Components Laboratory, and in 1980, he was appointed director of the Advanced Silicon Technology Laboratory in the IBM Thomas J. Watson Research Center, position he filled for the remainder of his career.

Henle's professional success gave him an opportunity to indulge another one of his passions—a love of the great outdoors. A native of Virginia, Minnesota, Henle spent much of his free time in his youth roaming the wilds of the Iron Range. It was another passion he tried to pass on.

"He was a great outdoorsman," says David. "He loved to water-ski and sail. And snow-ski. As soon as he was able, he bought a place in the Adirondacks, because it reminded him of home. I remember skiing with him as young as six—on wooden skis with metal edges and old-fashioned leather boots."

Trips back to the range were infrequent, but Henle's escapades in the Adirondacks clearly created a reservoir of memories that will never fade for his children. Now, thanks to the generosity of David and Joan, Robert A. Henle's memory will live on at the University of Minnesota, as well.

RECENT GIFTS

We would like to thank the following companies for their support during the past academic year.

Cadence
Ciprico
Cymer Inc.
Fujitsu
Grandis Inc.
Guidant
Heraeus Corporation
Honeywell, Inc.
IBM
Information Storage Industry Consortium (INSIC)
Lockheed Martin
LSI Logic
Micro Control Co.
Micron
Minnesota Mining & Manufacturing
NIST
Omron Electronics
Samsung
Seagate Technology
Semiconductor Research Corporation

Sapatnekar First to Hold Henle Chair

Professor Sachin Sapatnekar has been appointed as the first holder of the Robert and Marjorie Henle Chair in Electrical Engineering.

"I feel very honored and lucky to be named to this professorship," says Sapatnekar, who—like Henle—is a Fellow of the Institute of Electrical and Electronics Engineers. "Bob Henle was a pioneer in the semiconductor industry; his research brought my field where it is today. In some ways, the work that I do is a continuation of the work he did a few decades ago."

Sapatnekar received the 2003 Technical Excellence Award from the Semiconductor Research Corporation. He and his co-authors also received the Best Paper Award from the 2003 Design Automation Conference.

"It is very prestigious to be appointed to a named professorship," says Sapatnekar, who also noted that the stipend that comes with the professorship allow him greater latitude in his research efforts. "Funds of this sort permit us to look at research topics that are in the early stages of research and would be otherwise difficult to fund."

Entrepreneur Extraordinaire

Gerald Timm (B.S. 1963, M.S. 1965, Ph.D. 1967) is the founder or co-founder of five medical device companies and—given his prolific output in terms of patents and publications—may just have the fodder for one or two more up his sleeves.

It didn't take long for Gerald Timm to decide for himself that going to college might be a pretty good idea. One of seven children, Timm grew up on a dairy farm near Alexandria, Minnesota. He loved the great outdoors and the rural life in West central Minnesota, but there was one thing he didn't like.

"I didn't like getting up at 5:00 a.m. seven days a week to do chores," Timm recalls. "There's no escaping chores on a dairy farm—so I determined rather early on I wanted to go to college."

Although he would become the first in his family to attend college, Timm had no doubts that it was the right thing to do when he left home for Moorhead State College in 1958. He was less certain, however, about what he wanted to do there.

"I liked math and physics, so I knew I wanted to do something that involved those subjects," he says, "but I wasn't sure what. Then, when the Russians launched Sputnik in the fall of '57, I decided I was going to rescue our lagging space program. In those days, kids thought they could go do these things all by themselves."

Although a career in the space program wasn't in the cards, Sputnik and Timm's love of math and physics steered him toward a career in engineering. After a year at Moorhead State, he transferred to the University of Minnesota and hooked up with Electrical Engineering Professor Aldert van der Ziel, who served as his adviser throughout his academic career. Van der Ziel hired him as an engineering assistant, and during his undergraduate years, Timm learned to blow glass, work with vacuum systems, and handle other laboratory equipment and procedures. He liked the environment and the people he worked with, but he encountered a problem he never anticipated.

"One year I discovered girls," Timm says, laughing. "It helped my social development a great deal, but it almost ruined by academic career."

Timm's grades suffered due to his "outside interests," and his grade point average dipped so low, he was in danger of not being admitted to graduate school. Van der Ziel went to bat for him, and he was admitted on very strict probation, with the condition that he get and maintain good grades.

During the course of his education, Timm explored a number of different areas of interest, including oceanography, control systems, and biomedical engineering. When the biomedical engineering won out, Timm briefly considered going to medical school, but opted instead to continue in electrical engineering and get the medical background he needed through supplementary studies.

After he completed his Ph.D. work, Timm joined the faculty of the University of Minnesota Medical School, in the Department of Neurology. There, he began researching problems of the pelvic organs resulting from spinal cord injury, stroke and other neurological disorders and assisted with the development of a Ph.D. Program in Biomedical Engineering. The research led to the conceptualization and development of a number of devices for diagnosing and treating urinary control and male erectile disorders. These devices—which include an electronic bladder pacemaker, an inflatable penile prosthesis, an artificial urinary sphincter, and a number of assessment tools—formed the basis for the companies he later founded.

"Returning to the faculty is kind of like placing bookends on my career... There's a great opportunity for collaboration with electrical engineering, mechanical engineering, and materials science."

"I got the opportunity to work with some great faculty members, who played an important role in helping to develop these devices," says Timm. Key among them, according to Timm, were two physicians who have since passed away: neurologist, William E. Bradley and urologist, F. Brantley Scott.

With the founding of his early companies, Mentor Corporation and American Medical Systems, Timm's time began being consumed by his entrepreneurial efforts and he left the faculty.

"American Medical is probably the best known of the companies I founded," says Timm, who since sold out the majority of his ownership interest, although he remains a minor

shareholder. "They currently have about 600 employees and their annual sales are in the neighborhood of $170 million."

Timm's other medical device companies are Dacomed Corporation, Timm Medical Technologies, and his latest undertaking; NovaTek Medical LLC. In addition to the companies he founded, Timm has established a very impressive research and development track record. He is the inventor or co-inventor on 20 U.S. patents plus their multiple international counterparts. He has published 66 scientific papers as author or co-author.

In 2001, the University of Minnesota honored Timm with its Outstanding Achievement Award, the highest honor the University bestows on its alumni. Among other things, the Award cited Timm for his "pioneering research on electrical bladder stimulation and fluid transfer systems."

These days, Timm is trying to make a little more time for a couple of his passions: travel and golf. In fact, he recently took a trip to Scotland that allowed him to indulge both passions at once. Nonetheless, he still keeps a busy work schedule. Along with running NovaTek on a daily basis, Timm has returned to the medical school faculty at the University of Minnesota as a Professor of Urological Surgery.

"Returning to the faculty is kind of like placing bookends on my career," he says. "But this time, it's just a part-time appointment. I want the freedom to help build the school's research capabilities in the area of technological applications to urological disorders. There's a great opportunity for collaboration with electrical engineering, mechanical engineering, and materials science. And, I don't want to have worry about the time clock."

For a man who's had such a prolific career, this seems an appropriate way to put that final bookend in place.

ALUMNI NEWS

1964

Gary Glover (1966 M.S., 1969 Ph.D.) made a gift of $25,000 to the department to establish an endowment for a fellowship in electrical engineering. Glover is a Professor at Stanford University.

1966

Phillip W. Arneson wrote to pass along some news with the hope it might spur an old classmate or two to get in touch. Arneson is chairman and chief executive officer of Sorrento Networks Corporation (ticker symbol FIBR on NASDAQ), in San Diego. Sorrento is a leader in electro-optical devices that increase traffic in transmissions over metro fiber optic lines, according to Sorrento. Previously, Sorrento was executive vice president of the electronics sector for Allied Signal and group vice president for Control Data.

"I'm proud to have been educated at the University of Minnesota," says Arneson, who notes that although he passed through commencement in 1966, due to a delay in the receipt of several credits, he wasn't officially awarded his degree until 1985. "I fondly remember Dr. Hartig, Dr. Haxby, and many others from my time at the U."

1967

Recent stories in *Signals* regarding alumni entrepreneurs prompted **Herman Held** (1968 M.S.) to write and let us know that he is the founder of Quest Engineering Solutions, Inc. The company, based in New Billerica, Massachusetts, specializes in test services and related consulting services. Quest helps customers meet worldwide regulatory requirements and achieve world-class levels of product quality and reliability.

1971

Frederick T. Strobl, who also holds an M.D. degree, is a co-founder of two companies, CNS and AcuBead. CNS is best known as the maker of Breathe Right® nasal strips. AcuBead designs, manufactures, and distributes disposable, over-the-counter ear acupressure strips. These strips are used to create acupressure as a treatment for headaches, neck pain, and back pain, among other applications.

1977

Al Clark joins the ever-growing list of ECE entrepreneurs, too. The founder of several companies, Clark's most recent effort is Danville Signal Processing, Inc. This Cannon Falls, Minnesota, company develops and manufactures digital signal processing products for the communications, audio and instrumentation markets. Prior to that, Clark founded Timewave Technology, Inc.

1981

Ronald Indeck (1984 M.S., 1987 Ph.D.) is serving as president of the IEEE Magnetics Society. Indeck is the Das Family Distinguished Professor of Electrical Engineering at Washington University in St. Louis.

Jeffrey Schoess also can lay claim to a spot on the list of ECE entrepreneurs. He founded Korosensor.com, Inc. in 2000. The Buffalo, Minnesota-based company focuses on sensor innovations for healthcare.

1982

Finally, even though **Jim Hagerman** reports his is just a small company ("We like to call them 'micro-companies,'" he says) he too, is a company founder. Located in Honolulu, Hawaii, Hagerman's company focuses on the design and manufacture of audiophile-grade electronics.

News By Email!

ECE Signals **can now take "News About You!" via email. If you recently got a promotion, a new job, or have any other news to share with your classmates, send it to Melissa@ece.umn.edu and we'll make sure it gets into the next issue of your newsletter.**

High School Mentor Program Yields Amazing Results

When he agreed to serve as a mentor for high school student Scott McDonald during the past academic year, Assistant Professor Babak Ziaie was intrigued. It was to be his second such experience.

"High school students are fun to work with," says Ziaie. "They're excited and want to learn new things. If they're bright and motivated, you can really influence their lives."

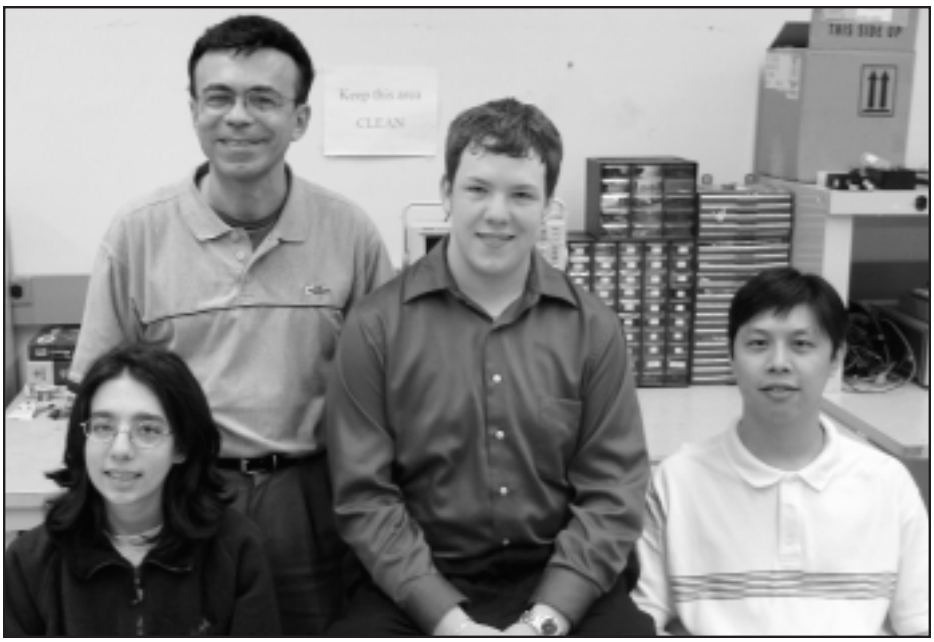
Although Ziaie relished the opportunity to inspire a bright young mind, he didn't really anticipate the program would be as successful as it turned out to be. The first mentor program in which he participated didn't offer enough time for the student to really get involved, in Ziaie's opinion.

"This program is much better," he says. "The students are required to come to the lab three times a week and spend the afternoon. In the other program, they came once or twice a month."

The program—called Mentor Connection—gives Twin Cities high school students (juniors and seniors) an opportunity to seek out and partner with mentors in just about any field imaginable. It also offers a speaker program that brings established professionals in to speak to program participants.

"I've always liked science and mathematics," says McDonald, explaining how he zeroed in on Ziaie as a potential mentor. "I checked with people in the Institute of Technology Honors program to get some ideas about faculty members at the cutting edge of research in either electrical or biomedical engineering, and they suggested Professor Ziaie."

Who, coincidentally, is an electrical engineer at the cutting edge in biomedical engineering. Ziaie is developing a variety of implantable biomedical micromachines (see cover story: The Future is Now.) and when he and McDonald teamed up in the mentor program, good things began happening almost immediately.



From left to right: Eleanor Kai, Assistant Professor Babak Ziaie, Scott McDonald, and Tingrui Pan

"Scott is pretty amazing," says Ziaie. "I gave him some direction, suggested a long list of papers he ought to read, and he just really went to it. I know some of the papers were over his head, but he was very motivated, and worked very hard."

"At first, I spent as much as 40 hours a week on background research," says McDonald. "Then I started following some of the grad students around, watching them. Once I learned some of the basics, I tried to do some of the simple tasks—like making small molds—myself."

Before long, McDonald was ready to tackle his own research project. Ziaie made a couple of suggestions about possible projects, and paired McDonald with graduate students Tingrui Pan and Eleanor Kai. Together, they designed, fabricated, and tested a magnetically driven micro-pump—but not just any old micro-pump.

"The pump—which could be used for micro fluidic applications such as drug delivery—is powered by a small battery," says Ziaie. "The power consumption for this pump is the lowest of any recorded in the literature."

Not bad for a high school student. And although he worked with Pan and Kai, according to Ziaie, this is McDonald's project; he was the "lead scientist" for the research group. He came up with his own ideas and got things done. And he is the lead author on the paper describing the research project. He will present that paper in San Francisco at the fall meeting of the IEEE's Engineering in Medicine and Biology Society.

"Not many high school students are the first author on an international conference paper," says Ziaie. "He really added to the ideas we gave him and made this project his own."

McDonald is quick to reflect the credit back to Ziaie and his graduate student partners.

"I was kind of overwhelmed by the whole experience," he says. "Professor Ziaie was very helpful. He came up with some basic ideas to explore and

"This program gives us a great opportunity to attract some of the brightest young minds in the country to science and engineering."

Tingrui and Eleanor and I jointly designed the pump and spent a couple of months tweaking the design and testing it."

No matter how one divvies up the credit, however, the results are still impressive. What's more, the entire process was rewarding to both Ziaie and McDonald.

"I would encourage other faculty members to get involved in this program," says Ziaie. "I'm sure not everyone is going to do as well as Scott did, but I had the opportunity to see poster presentations by about 100 students and I was very impressed. This program gives us a great opportunity to attract some of the brightest young minds in the country to science and engineering."

For McDonald, the experience was invaluable and very enjoyable. He's going to continue to work with Ziaie over the summer as an intern. And he's a little more certain he would like to pursue an education in engineering. Although he hasn't yet settled on a major, he is planning to enter the IT Honors Program at the University of Minnesota this fall. Perhaps more importantly, his time with Ziaie gave him a big boost of something every teenager could use a little more of: confidence.

"Professor Ziaie was much more open to my ideas than I thought he would be," says McDonald. "He gave me more responsibility than I expected. And, he showed me a level of respect that I never got from my high school teachers."

Assistant Professor **Mohamed-Slim Alouini** received the George Taylor Career Development Award from the University of Minnesota Institute of Technology. The award recognizes exceptional contributions to teaching by a candidate for tenure during the candidate's probationary period.

Professor **Massoud Amin** received the 2002 Chauncey Award from the Electric Power Research Institute (EPRI) in March 2003. The award, which is the highest annual award presented by EPRI, was given in recognition of leadership in creation and execution of the Infrastructure Security Initiative to secure the Nation's energy infrastructure. Amin, who is the director of the University of Minnesota's Center for the Development of Technological Leadership and holder of the H. W. Sweatt Chair in Technological Leadership, has been in much demand by the press and by technical and government organizations of late. He has been asked to speak on the security of large-scale infrastructures and power delivery systems. Recent media interviews have included *The New York Times*, *The Chicago Tribune*, and *Scientific American*. He has given invited talks on these subjects before The Santa Fe Institute, the Us Department of Energy 2003 Conference, and a Congressional Staff Briefing, to name a few.

Professor **Steve Campbell** will head up the University of Minnesota node of a five-year, $70 million, multi-university effort to provide researchers across the country with low-cost access to nano capabilities. In addition to Minnesota, the program—which is known as the Nano Infrastructure Network or NNIN—includes lead institution Cornell, Stanford, the University of California at Santa Barbara, Harvard, the University of Texas at Austin, the University of New Mexico, Howard, and, in an affiliate role, North Carolina Sate University. The Minnesota node will concentrate on attracting usage from nano researchers in the upper Midwest and will specialize in nano characterization and on nano-particle and aerosol capabilities. Funding will be used to strengthen operations at Minnesota's Nanofabrication Center and Characterization Facility, and to support staff affiliated with the Particle Technology Lab.

Assistant Professor **Rhonda Drayton** received a 3M Non-tenured Faculty Award. The $15,000 unrestricted award is intended to support excellence in research by new faculty members in physical and/or biological sciences.

Associate Professor **Emad Ebbini's** research on time-reversed ultrasound for medical applications received coverage in an article titled "On the Rebound" in the March 15, 2003 issue of *Science News.*

Professor **Tryphon Georgiou** received the 2003 George S. Axelby Outstanding Paper Award from the IEEE Control Systems Society for a paper titled "A Generalized Entropy Criterion for Nevanlinna-Pick Interpolation with Degree Constraint." The paper, which was published in June 2001, was co-authored by Professor Christopher I. Byrnes of Washington University and Professor Anders Lindquist, of KTH, Sweden. Georgiou received the Axelby Award twice before, in 1992 and 1999, for papers co-authored with Malcolm Smith of the University of Cambridge. Georgiou is the only person to have won the award three times.

Former Ph.D. student Z. Wang (now a faculty member at Iowa State University) and Professor **Georgios Giannakis** received the IEEE Signal Processing Magazine Best Paper Award for 2003. The award, which recognizes an outstanding tutorial paper published in the Signal Processing Society's monthly magazine, was presented for the paper "Wireless Multicarrier Communications: Where Fourier Meets Shannon." The paper was published in May 2000 in Vol. 17, No. 3, pp. 29-48.

A Minnesota team under the direction of Professor **Ramesh Harjani** won the Semiconductor Research Association's (SRC) SiGe Design Challenge. Fifty-nine university teams from around the world

participated in the contest. The Minnesota team, which consisted of graduate students Byunghoo Jung and Jaewon Kim, consultant Philip Cheung, and Harjani, took second place in the initial phase of the competition. IBM then fabricated the designs of the top 15 entrants. After fabrication, the Minnesota team was awarded first place overall for its design: "20 GHz Wide Tuning Range Low Noise VCO and Monolithic CDR Circuit."

Adjunct Professor **Paul Imbertson** was selected by the IT Student Board as the Best Professor in Electrical and Computer Engineering in 2003.

Assistant Professor **Heiko Jacobs** was named a McKnight Land-Grant University Professor for 2004-06. The award, which recognized Jacobs for his groundbreaking research in non-traditional micro- and nano-technologies to enable the manufacture of novel devices, includes two years worth of research support and the possibility of a fully-supported sabbatical research leave.

Professor **Richard Kiehl**, and his collaborators—Nadrian Seeman of the Chemistry Department at New York University and University of Minnesota Chemistry Professor Karin Musier-Forsyth—are the first researchers to demonstrate the ability to use DNA crystals in directed self-assembly to fabricate nanoscale components. The components, in the prototype, are small gold clusters that have the ability to act as single-electron memory cells. "This is the first time DNA crystals have been used to assemble nanocomponents, but it is really just the first step toward a nanoscale manufacturing scheme that can be used for electronic circuits, memories, regular periodic arrays and other things," says Kiehl.

The IEEE Board of Governors selected Professor **Keshab Parhi** to receive the 2003 Kiyo Tomiyasu Award for pioneering contributions to high-speed and low-power digital signal processing architectures for broadband communications systems.

Professor **Sachin Sapatnekar** received the 2003 Technical Excellence award from the Semiconductor Research Corporation (SRC). The award is given annually to researchers who, over a period of years, have demonstrated creative, consistent contributions to the field of semiconductor research, who are groundbreakers and leaders in their fields, and who are regarded as model collaborators with their colleagues in the SRC member community. In giving him the award, SRC cited Sapatnekar as work in the area of Analysis and Optimization of Signal and Supply Networks that has significantly enhanced the productivity of the U.S. semiconductor industry. Sapatnekar, along with

IN MEMORIUM

William "Jerry" Shepherd, 1911-2003

Professor Emeritus William Gerald Shepherd died on September 5, 2003. During his 32-year career at the University of Minnesota, Shepherd served as a professor, associate dean of the Institute of Technology (1954-56), head of the Department of Electrical Engineering (1956-63), vice president for Academic Affairs (1963-73), and director of the Space Science Center—now known as Shepherd Labs (1973-79). Shepherd, who lived in Falcon Heights, Minnesota, was 92.

Known to his friends and colleagues as "Jerry," Shepherd was born in Ontario, Canada. He moved to Minnesota with his family in 1914 and became a U.S. citizen in 1922. His first exposure to the University of Minnesota came when he enrolled in the electrical engineering program. He earned his bachelor's degree in 1933 and a Ph.D. degree in physics (also from the University of Minnesota) in 1937.

Shepherd went to work for Bell Telephone Laboratories in New York after he completed his doctoral studies. There, in collaboration with John Pierce, he invented a device known as the Reflex Klystron or the Pierce-Shepherd tube. The device helped solve a problem encountered during the early development of radar. After 10 years at Bell Labs, Shepherd opted for a return to academia, accepting a position as a professor of electrical engineering at the University of Minnesota.

In addition to being a strong teacher, research scientist, and administrator, Shepherd was somewhat of a political activist. In 1965, he spoke out against a legislative attempt to make university employees take an oath of allegiance to the United States, calling it an affront to the academic profession. During the 1969 student strikes at the University, Shepherd suggested that—as long appropriate make-up instruction was provided—it would be appropriate for professors to skip classes as an act of solidarity affirming that "a student has freedom of choice with respect to his right to learn." In 1973, when former University of Minnesota President Malcolm Moos initiated policies that diminished the authority of the academic division, Shepherd resigned in protest, along with a number of other faculty members.

Shepherd served as president of the Institute for Electrical and Electronics Engineers (1965-66). He was elected a Fellow of the Institute of Radio Engineers in 1952 and a member of the National Academy of Engineering in 1969. Throughout his life he was active in the Minnesota arts community, serving on the Board of Directors for both the Walker Art Center and the Minnesota Orchestral Association. One of Shepherd's pet projects after he retired in 1979 was fundraising for the University of Minnesota's Weisman Art Museum, which has a room named in his honor.

Fittingly, family, friends, and colleagues held a memorial service for Shepherd at the Weisman Museum on September 13, 2003.

co-authors Haifena Qian and Sani R. Nassif, also recently received the Best Paper Award from the 2003 Design Automation Conference, for a paper titled "Random Walks in a Supply Network." Qian is one of Sapatnekar's graduate students and Nassif is with the IBM Austin Research Lab.

Professor **Guillermo Sapiro** helped develop the image compression technology (algorithm) being used by the Mars Exploration Rovers recently deployed on the surface of the Red Planet. Sapiro and his colleagues, Marcelo Weinberger, Ph.D. and Gadiel Seroussi, Ph.D., from Hewlett-Packard Laboratories developed and patented the LOCO technology, one of two primary compression technologies used on the rovers. LOCO is also the core of the international standard JPEG-LS for the loss-less and near loss-less compression of still images. In another area, Sapiro and his research group have received considerable media exposure for their work on a process known as image in-painting. The process, which uses sophisticated algorithms to "recreate" missing portions of images such as paintings or photographs, has applications in areas ranging from art restoration to military espionage to movie making. Stories about Sapiro's research have appeared recently in publications such as *Science News*, *National Geographic*, and *Discover Magazine*.

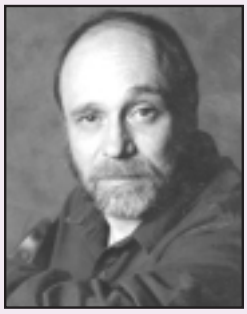
Assistant Professor **Joseph Talghader** recently received the 3M Non-tenured Faculty Award.

Profesor Emeritus **Ray Warner** recently received the Paul Rappaport Award for his paper titled "Microelectronics: Its Unusual Origin and Personality." The paper was first published in the November 2001 issue of the *IEEE Transactions on Electron Devices*.

Professor **Bruce Wollenberg** received the 2002-03 Eta Kappa Nu Outstanding Teaching Professor Award. This award is presented annually by the University of Minnesota Chapter of Eta Kappa Nu and is based on nominations submitted by undergraduate students.

Retiring Trio Gave Nearly 100 Years of Service to U

Three Electrical and Computer Engineering (ECE) Department faculty and staff members were honored at a recent retirement dinner. They are John Marchetti, ECE managing research engineer, Marshall Nathan, Professor of Electrical and Computer Engineering, and BettyLou Viskocil, ECE executive assistant. Between them they compiled nearly 100 years of service to the University of Minnesota, including about 64 years of service to the ECE department.



John Marchetti, who was born and raised near Virginia, Minnesota, first began working at the University in the Physics Department's machine shop. He transferred to the ECE department in 1979 and became machine shop foreman two years later. "Unofficially," Marchetti has served as the "official" ECE department photographer for much of his career with the department. Most of the photos that appear in *Signals*—including all the photos in this issue's cover story—are John's handiwork. John plans to work part-time for a private company during his "retirement."

Marshall Nathan joined the ECE faculty in 1987 as a professor of electrical engineering. He held the department's Centennial Chair in Electrical Engineering from 1990 to 2001. Prior to coming to the University, Nathan compiled a productive career in private industry and served a brief stint as a visiting professor at Cornell University. He completed his undergraduate studies at the Massachusetts Institute of Technology, receiving his B.S. degree in 1954. He earned a master's degree in physics (1955) and a Ph.D. degree in applied physics (1958), both from Harvard University. After completing his education, he went to work for IBM in their research division. His work there included studies of the electronic properties of semiconductors and semiconductor devices, as well as the study of the optical properties of semiconductors and insulators. He played an integral role in the development of the semiconductor laser. Among his many career achievements and awards, Nathan received the IBM Outstanding Innovation Award (1963), the IEEE David Sarnoff Award (1980), and the IEEE/LEOS recognition (1988). Nathan is a Fellow of the American Physical Society, a Fellow of the IEEE, and a member of the National Academy of Engineering.

By the time **BettyLou Viskocil** joined the ECE Department in 1981 as executive assistant to the department head, she had already accumulated 18 years of service to the University. She began her career at the University in 1963 in the Office of the Vice President for Development. Later, she worked for the University of Minnesota Foundation and the Office of the Vice President for Administration. BettyLou has continued as executive assistant to the department head since joining the department. Among numerous other duties, she has played an instrumental role in providing news about alumni and students to *Signals*. Although she's looking forward to more leisure time and travel, BettyLou plans to continue to pursue her interests in care counseling and life coaching.

2003-2004

SCHOLARSHIPS

3M Scholarship
Anwer, Bilal

Erlyn E. Christianson Undergraduate Scholarship
Noorbaloochi, Sharareh

Chauncy L. Greene Fund Scholarship
Daali, Amy W.
De la Fuente-Vornbrock, Alejandro
Engebretson Andrew Ray
Lodermeier, Mark
McKeen, John Charles
Tewoldebrhan, Minassie
Triebwasser, Christa Marie
Yilma, Dereje Ghizaw

Gordon and Marie Hackborn I.T. Scholarship
Yilma, Dereje Ghizaw
Tewoldebrhan, Minassie

Hartig Fund Scholarship
Calgaro, Thomas Henry
Chau, Yiteen
Cheng, Yang Paul
Crum, Kyle
Engebretson, Andrew Ray
Hawkinson, Jared Lee
(Hartig/Noel Schulz/IEE PES Walter Fee Scholarship)
Jepson, Amanda
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