EECS News

THE UNIVERSITY OF MICHIGAN

The Science
& Technology
of Antennas

Self-Healing Chips

In This Issue

A Message from the Chair

Exciting opportunities are on the horizon for EECS! We witnessed the dedication of our new Computer Science and Engineering Building—which has even surpassed expectations the faculty had for a congenial environment in which to collaborate and envision ways to use computer science to transform society for the better.

The renovation and expansion of the Michigan Nanofabrication Facility (MNF) is really taking shape! I recently toured the facility from the basement to the top of the roof and was truly impressed at how much thought has gone into each aspect of the design, from space and equipment needs, to air and water handling, to the showcase tour aisle. Building on more than 20 years of cleanroom experience, this $40M investment guarantees the position of the MNF now and in the future as one of the premier nanofabrication facilities in the world.

Construction crews are also on sight tearing apart large areas of the first floor atrium, while students are getting ready for finals and a variety of summer internships, coops, and research opportunities. When they return in the Fall, they'll be treated to a newly renovated atrium, showcase lab, and upgraded classrooms. We're all looking forward to the new commons area where students and faculty can come together and take a break from their work!

During the summer, some of our students will be gaining international experience as part of a study-abroad program. Our students have recently studied in Russia, Germany, and Australia. Kwan Chong Tan, whose story is featured in the student section, studied at Shanghai Jiao Tong University—which has a special partnership relationship with the College of Engineering. Recently the EECS Department signed a research partnership agreement with Seoul National University (see pg. 10) to facilitate graduate research between the two institutions. Providing opportunities for international experience will continue to be a focus for EECS.

In addition to international study, our students add to their Michigan education with extra-curricular interdisciplinary projects, such as U-M's well-known Solar Car team. Read about our students' involvement in the Solar Elevator Games (MClimber) and Formula SAE racing on pg. 13. These and other experiential practicums enrich the education of students in unique ways, and may even become integrated into the curriculum of the future.

Our faculty continue to be recognized for their remarkable achievements in all areas of research, which inevitably leads to new technology in the marketplace. Stephen Forrest, EECS faculty member and U-M Vice President for Research, has already made an impact throughout the University by initiating policy changes that will encourage and reward this transfer of technology. To formally recognize those who have transferred research innovations to the marketplace, Forrest's office initiated the Distinguished University Innovator Award. Prof. Mohammed Islam is the first to receive this award (see pg. 11).

Prof. Forrest brings with him a very strong research program as director of the Optoelectronic Components and Materials Group. His group is oriented toward the realization of practical optoelectronic devices. As a co-founder of Apogee Photonics, and with strong involvement in several other companies, he is naturally suited to enabling the entrepreneurial spirit to flourish at U-M.

U.S. Energy Secretary Samuel Bodman visited Forrest's ECE lab during his visit to U-M in February to deliver the keynote speech at the Michigan Memorial Phoenix Energy Institute Energy Symposium, called "Energy Science, Technology, and Policy: Facing the Challenge." EECS at Michigan will be involved in solving this challenge.

In the realm of technology advancements, Jessy Grizzle was listed as one of Scientific American's 50 top leaders in science and technology for his work in robotics, and the Advanced Computer Architecture Lab received a 2006 Microprocessor Report Analysts' Choice Award for Innovation, based on their work with ARM, Ltd. on a new chip technology called Razor.

Our students are contributing to research, participating in national and international competitions, and reaching out to others through leadership and service activities, as exemplified in the activities of three award-winning students (see pp.15-17).

You'll be interested to read about this year's alumni award winners, as well as the varied activities and accomplishments highlighted in the Alumni Notes. We welcome George Haddad, former department chair and internationally renowned researcher, into the hallowed halls of EECS alumni award winners, and look forward to the future accomplishments of Recent Graduate Award winner Rob Malan and his company, Arbor Networks.

As I reflect on the expanding facilities that house our people and equipment, and witness the incredible creativity, energy, and brilliance of our faculty and students—I can see that big things are at hand for EECS!

Brian E. Gilchrist
Interim Chair, EECS Department

Todd Austin and Valeria Bertacco

The Self-Healing Chip: Designing resilient, bulletproof, computing systems for the future

Todd Austin, associate professor, ACAL

Valeria Bertacco, assistant professor, ACAL

"When a transistor fails in one of today's chips, you get the blue screen of death," says Valeria Bertacco, assistant professor in the Advanced Computer Architecture Laboratory (ACAL). "But when a transistor fails in a chip using our technology, we repair it before you even know anything has happened, and you simply continue working," says Todd Austin, associate professor in ACAL. "Repair—it's one of the richest areas of this research."

The idea of a self-healing chip, while not new, is being taken to uncharted territory in the work of Austin and Bertacco. Their research is particularly applicable to the next generation of chip design, particularly 45nm and beyond, when the miniature nanoscale devices are expected to become subject to a wider variety of flaws and weaknesses at all stages of the chip's life—from design, to manufacture, and its ultimate use by the consumer.

The novelty of their solution, which achieves a high success rate with ultra-low costs, has attracted significant attention in the chip community, and has led to recent funding by the National Science Foundation in collaboration with the Semiconductor Research Corporation (SRC), and the Gigascale Systems Research Center. William Joyner, the SRC's director of Computer-Aided Design and Test for the Global Research Collaboration, stated, "The aim is for chips that won't fail. That will be a first for the industry. To continue the performance pace that billions of people have come to expect, we need more than technology advances. Sustained performance improvements require a critical coupling between technology and design."

Planning for Errors

The public has come to expect their consumer electronics, including laptops, desktop computers, digital cameras, PDAs, etc., to work until some external compulsion, such as a desire for hardware and software upgrades, faster speed, or more memory, motivates them to purchase a newer system. Most consumers don't have to worry about device breakdown.

Manufacturers ensure chip reliability through an aggressive post-manufacturing "burn-in" stage which virtually guarantees that those chips that survive will be stable over the expected lifetime of the devices. Chip designs also undergo extensive testing to ensure they will work as expected.

This method of designing and manufacturing chips has continued to be cost-effective and adequate even in today's 90nm devices, which have components that are only about 20 atoms thick. However, as that number falls to 10 atoms in the next realm of 45nm devices, which are already being developed by the major chip manufacturers (including Intel, AMD and Texas Instruments), detecting problems will become increasingly difficult, leading to cumbersome testing strategies and a higher potential for defects to escape undetected.

Even more important, as engineers seek cheaper and more efficient transistors at nanoscale sizes, they are finding that these atomic-size transistors seem to have new weaknesses that may lead to

post-production failures when the electronic gadgets are in the hands of the consumer, perhaps only weeks or even days later.

Todd and Valeria are preparing for these upcoming nanoscale devices through a novel approach to error-resilient design, called *BulletProof*, that protects against these future microchip breakdowns, and, in some cases, also protects against errors or "bugs" inherent to the design itself.

Self-healing chips

BulletProof is the name for a new approach to chip design that will detect and correct certain errors before they affect the outcome of the computation. The microprocessor will, in effect, heal itself. The entire process works in four stages:

STEP 1: Detection When components of the processor find themselves idle during program execution, they are thoroughly tested by Valeria's testing infrastructure to make sure they are operating correctly. If testing finds that something is broken, the system moves to Diagnosis.

STEP 2: Diagnosis The testing infrastructure determines exactly what is broken, and the program moves to Recovery.

STEP 3: Recovery A checkpoint and recovery mechanism designed by Todd takes over while the entire computation is held "speculatively" in the computer's cache memory, that is, before any computed result reaches the main memory and becomes permanent. The processor will then roll back the application's execution to an earlier point where all was working properly. At this point the system moves to Repair.

STEP 4: Repair The chip will heal what is broken, typically by re-routing the computation to a compatible component that is still functioning properly.

Computers today are already built with some redundancy (most often to allow parallel operations) so that the system can run efficiently and quickly. A computer may have four adders, for example. If one breaks, the entire computer will be incapacitated. But if *BulletProof* detects the break, it can re-route the computation to one of the remaining three adders; with just a minor loss in efficiency, the computer continues to operate.

As this silicon technology continues to scale in years to come, computers will need to be designed to better accommodate the repair of the more frequent transistor breaks. Todd describes this next hurdle: "If the industry gets to the position where

moving to the next smaller transistor requires a design that's three times the size, that's going to be the end of silicon scaling. It's too expensive. What you really need is something that's only 5-10% larger, and no one's hatched that idea yet. That's what we're doing."

One method is to design highly symmetric computers with multifunctional parts so that if a transistor breaks, many other transistors can take over. Austin's doctoral student Kypros Constantinides is working on designing just such a computer.

This technology is still brand new. "At the present time, we can take care of one transistor breaking, and any number of single event upsets," explains Valeria. That means one transistor amid the 100 million on today's chips. In the future, they expect to be able to tolerate many transistor defects. This
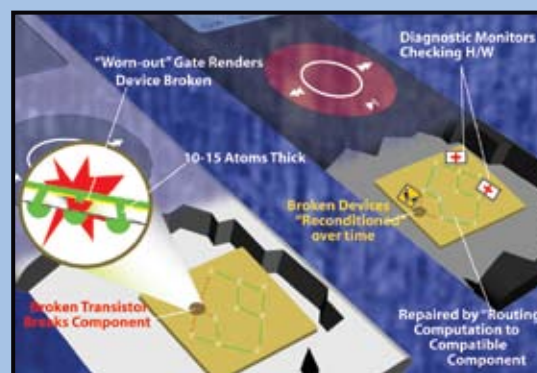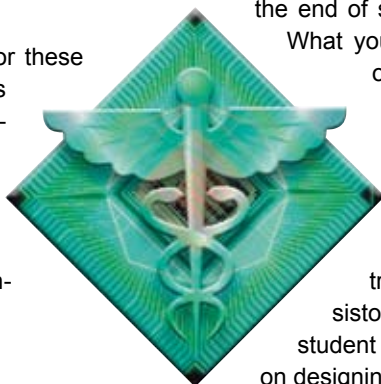
1. Detection *Discover that something broke*   **2. Diagnosis** *Find out exactly what broke*   **3. Recovery** *Fix any broken computation*   **4. Repair** *Heal the broken device*
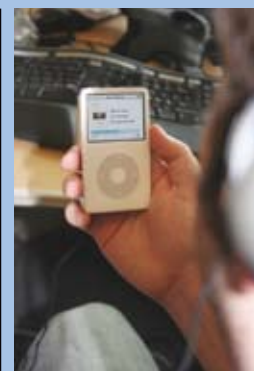
will seem to be essential for the next generation of nanoscale devices. Industry leaders such as Intel's Director of Circuit Research Shekhar Borkar have predicted that a decade down the road, transistor failures are to be expected, yet the chip has to work as if nothing has happened.

Single event upsets, or soft errors, can occur, for example, when a radiation particle evokes a charge as it randomly hits one of the very tiny oxide gates in a transistor—which may lead to a calculation misfire. Researchers have been addressing this issue for at least five years, and the problem is expected to be exacerbated with smaller technologies.

BulletProof will also be able to handle problems that arise from design complexity. "There is a big gap between how complex of a chip you can design, and how much of that chip you can verify," warns

"No one's hatched that idea yet. That's what we're doing."

Valeria, "and the gap is widening." With the number of transistors on a single chip expected to exceed eight billion by 2014, both design complexity and the number of broken and fragile transistors will continue to magnify.

Preliminary results using *BulletProof* are very encouraging. In one test case, the technology successfully covered 89% of the chip's silicon area with an increase in area of just 5.8%. After a repair, the system remained functional with a performance loss ranging from 4% to 18%.

RAMPing up to a prototype

Having proven the basic premise of *BulletProof*, Profs. Austin and Bertacco are looking forward to the next steps—which include expanding the scope of the repairs to virtually the entire chip, and applying their technique to a wider class of chips.

On the way toward building a complete prototype within the next two to three years, they are participating in a pilot program at Berkeley known as the RAMP (Research Accelerator for Multiple Processors) project. Using the "best-of-the-best technology," and cutting-edge chips from Xylinx, they will use hardware designs developed at Berkeley, add their own resiliency features to them, and then test their system by breaking transistors and devices in a way that mimics real life situations. "It'll be a fun project," says Austin.

Student Experience

Kypros Constantinides helped develop the physical prototype of a processor that was enhanced with the technology, which formed the basis of a recent paper delivered at ASPLOS XII (Architectural Support for Programming Languages and Operating Systems) this past October. He is gratified to meet those who recognize the importance of the research, despite the fact that it is still a technology for the future. "It is very exciting to work in a cutting-edge area of research," said Constantinides.

Smitha Shyam, a doctoral candidate also working on the project, has found that other researchers are beginning to look at their work more closely, especially as issues of reliability are becoming increasingly significant. She said, "people approach us all the time with questions as to how to extend our work to their domain and how to scale this to suit their requirements."

Beyond *BulletProof*

Professor Scott Mahlke was involved in the early stages of *BulletProof*. Grown from this early work, he and his group are currently investigating the design and construction of wearout-tolerant chip multiprocessors. The project, code-named StageNet, consists of a fabric of interconnected coarse-grain pipeline stages that can be configured to form

groups of processors. An array of sensors dispersed throughout the chip tracks the behavior of individual transistors. Just before critical breakdown, StageNet isolates potential faults and reorganizes itself to continue uninterrupted operation.

Similarly, other research projects of Austin and Bertacco are reaching into new directions. Valeria's work centers on the verification of chips at all stages of development: design, manufacture, and post-manufacture. She has published a book on the topic, *Scalable Hardware Verification with Symbolic Simulation.* Valeria came to U-M from Synopsys, where she was a Research Engineer in the Verification Group and the Advanced Technology Group. At Michigan, she has developed two main techniques to improve verification, called Guido and Inferno, and with Todd she is currently developing a technique called FRCL (Field Repairable Control Logic) to detect and correct design flaws after the chip is in use in the hands of the consumer. With nearly 70% of current effort in industry being devoted to chip verification rather than design, there is significant motivation to make this process efficient and effective.

Todd's primary research is in the areas of computer architecture, VLSI design, and error-resilient design. He came to U-M from Intel where he led microarchitecture research efforts for future-generation microprocessors. He is founder and president of SimpleScalar LLC, and co-founder and Chief Technology Officer of BitRaker Inc. Since coming to Michigan in 1999, he has collaborated on cutting-edge adaptive technologies such as Razor and DIVA (Dynamic Instruction Verification Architecture).

He is particularly excited about a project in low-power design with Prof. David Blaauw and their students called Subliminal Systems. Using solar cells to scavenge energy from the environment, they designed a sensor platform that consumes far less energy than any previously published sensor network processor. Building from this work, recent PhD graduate Leyla Nashandali, now at Virginia Tech, is collaborating with Austin and Blaauw in a project with the U-M Kellogg Eye Institute to build an intra-ocular eye pressure sensor that has the potential to help glaucoma patients extend their vision by providing continuous monitoring of the eye pressure.

The future of computing is in the hands of faculty such as Profs. Austin and Bertacco. With their colleagues and students in the Advanced Computer Architecture Lab, they are creating new technologies and methods of employing computer hardware and software that will ensure progress, and improve life.

"It'll be a fun project," says Austin.

"People approach us all the time with questions."

Kamal Sarabandi: Bridging the Divide of Fundamental Science and Technology

Kamal Sarabandi, Professor and Director of the Radiation Laboratory

Whether acquiring data from the furthest boundaries of the solar system, assessing global warming, seeing through walls, or assisting communication among city dwellers or soldiers in the field, Prof. Kamal Sarabandi is strongly grounded in the basics. "The reason we can do such vast areas of research is that we are doing the research at the fundamental level considering various interactions of wave and the objects of interest."

Prof. Sarabandi received his training among the best, here at Michigan. He now leads where he once trained, as director of the Radiation Laboratory, a position he has held since 2000. The RADLAB is composed of eight faculty, 4 research scientists, and nearly 50 graduate students who conduct research in areas as diverse as antennas, metamaterials, computational electromagetics, radio frequency (RF) propagation, microwave circuits, remote sensing, and plasma electrodynamics.

Prof. Sarabandi and his research group explore new avenues of research, such as the use of metamaterials, while they continue to expand knowledge in microwave and millimeter-wave radar remote sensing—an area he has worked in for more than twenty years. In recognition of his accomplishments, he received the 2005 Distinguished Achievement Award from the IEEE Geoscience and Remote Sensing Society.

Reaching into Space to Learn More about Earth

Prof. Sarabandi has been interpreting data from space for more than a decade—relating it to issues of global warming, and providing the data for scientists doing environmental research. "We need to protect our planet and understand what is really happening," stated Kamal.

NASA plans to establish a base station on the moon by 2020 to aid continued space exploration. Kamal is already planning the instrumentation that would be used on this lunar base station to observe processes occurring on the earth that would be impossible to do any other way. He predicts it could be possible to measure small relative motions of land masses, including earthquake activity, which could lead to an ability to predict earthquakes.

Meanwhile, NASA probes are being sent to the far reaches of the solar system—collecting data, and taking pictures, video, and radar images as they go. Getting the information back is a challenge, and the main stumbling block is the antenna—Kamal's specialty. The cost of an antenna large enough to transmit information efficiently is about $1B. Kamal has been working on a new technology that will emply a large array of smaller antennas, thousands of them, working together to create, in effect, a very large aperture.

Until there is a lunar base station, which would simplify the phase calibration of these antennas, the moon will be used as a calibration target using InSAR (Interferomatetric Satellite Aperture Radar) imaging techniques.

Keeping earth science as an important activity within NASA is a high priority for Kamal, who has been recently appointed to an advisory committee charged with planning the future activities of NASA. "There is really no other agency with the expertise to deal with all the components that are needed for observing earth as a system, including designing instruments, launching satellites, and interpreting and distributing data," he said. "Space exploration needs to incorporate continued remote sensing of the earth."

"We need to protect our planet and understand what is really happening."

(a)

Ant. 2   x (radar direction)   annulus of constant delay   semi-annulus of constant Doppler frequency shift
Ant. 1

(b)
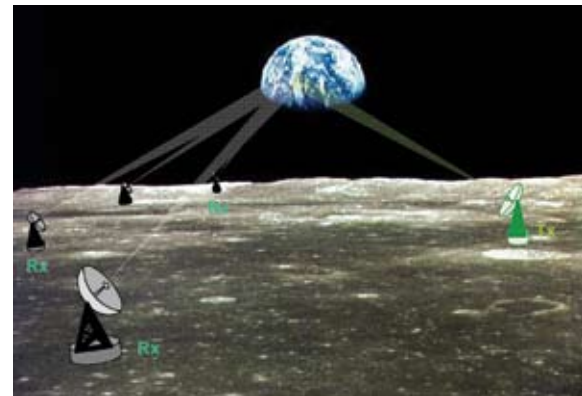
(a) Colossus reflector antennas with high radiated power for deep-space communication will be replaced with a large phased array of small reflectors and moderate radiated power. (b) The relative motion of the Earth and Moon wil be used to form Synthetic Aperture Radar (SAR) images of the Moon's surface. These images will be employed as calibration targets for the phased array.
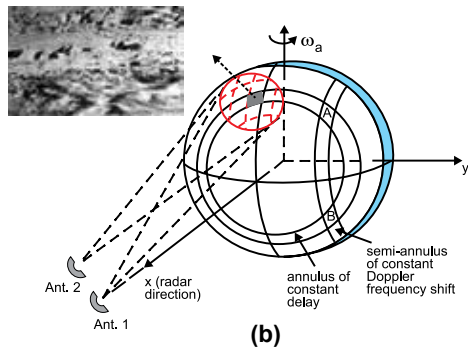
Remote Sensing for Safety and Security

Here on earth, Prof. Sarabandi has developed important tools and methods in the area of radar remote sensing to study complex systems such as carbon cycle, which affects global warming, and soil moisture and snow, which can reveal problems related to hydrology, ecology, and climate. Radar remote sensing also has a wide variety of applications related to security and safety.

One newly-funded project investigates the use of radar to penetrate through walls and create a map of the interior to see if there are people or weaponry inside. He is collaborating with Ohio State University and the company Science Applications International Corporation (SAIC) in this project. Based in California, SAIC recently opened an Ann Arbor office for their Reconnaissance and Surveillance Operation.

Kamal is also working on a related system that can scan a crowd and determine whether or not people are concealing weapons. This will enable quick, broad coverage of an area. Suspicious individuals may then be pulled aside and asked to stand in a device that will "see" through clothing, such as was recently implemented at the Phoenix airport.

Turning his attention to safety issues, Kamal is developing a millimeter-wave radar system that will be mounted on helicopters to map the terrain underneath. Pilots are subject to highly dangerous landing conditions when landing in either snow or dusty/sandy regions. It is also impossible for them to know what lies beneath the immediate surface, such as a ditch or a rock. The new technology will enable pilots to see through white-out or brown-out conditions, and to know on what kind of surface they are landing.

Prof. Sarabandi explains that his research can reach into such a wide variety of areas because applied electromagnetics is a highly successful disciplines with significant impact on a wide range of technologies. With the wall penetration project, for example, once he determines the science of what happens to a wave or signal as it penetrates a wall, he will undo what the wall did to the signal and reconstruct the image.

Communication through Waves and Sensors

With satellites in space and cell phones on the earth, the U.S. population is coming to expect near instant communication. Losing a connection with someone even for a moment becomes very frustrating. The situation becomes downright dangerous for troops communicating in the field.

Prof. Sarabandi has analyzed wave propagation in an urban environment for the purpose of wireless communication. His research, which has been commercialized, enables planners to establish base stations throughout a city to ensure coverage for an entire area. He is now turning his attention to providing our active troops with the same coverage, even when they are sent to unfamiliar territories.

To gather information about these areas, Kamal is developing miniature low-power unattended ground sensors to measure a variety of environmental variables, such as vibrations from vehicles and sound, as well as to transmit photos of the area and other information derived from radar. These electronic transceivers act as a network with each other, communicating information between nodes until the information is sent to a satellite, and ultimately to a base station. These sensors are only possible through the integration of miniature antennas developed by Prof. Sarabandi.

Antennas the bottleneck and key

"We can make microelectronics very, very small," explains Prof. Sarabandi, "but the bottleneck eventually becomes the antenna." It is extremely difficult to make antennas smaller without greatly sacrificing their performance, yet the growing number of wireless applications for low-cost, power-efficient, and miniature electronics makes this an important area for continued research. Perfecting antennas for a variety of uses has been a mainstay of Sarabandi's research; he has five patents in the area of antennas, and another six in the patent process.

When he was approached by Prof. Michael Flynn, a member of the Center for Wireless Integrated Microsystems, to collaborate on a project creating miniature environmental sensors, Kamal came up with a novel solution to the problem of integrating an on-chip antenna with a wireless transceiver on

A 0.3mm² Miniaturized X-Band On-Chip Slot Antenna in 0.13μm CMOS

9 GHz Miniaturized Antenna
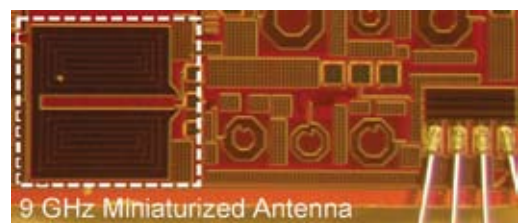
a CMOS IC with RF circuitry. The basis for his solution was an adaptation of the slot antenna. This tiny silicon-compatible antenna is capable of being mass-produced, and has potential applications in remote wireless environmental sensors, cell phones, and laptops. Sarabandi has already been talking with Intel about using the antenna design in wireless laptop computers. This breakthrough technology has been featured in *EE Times.*
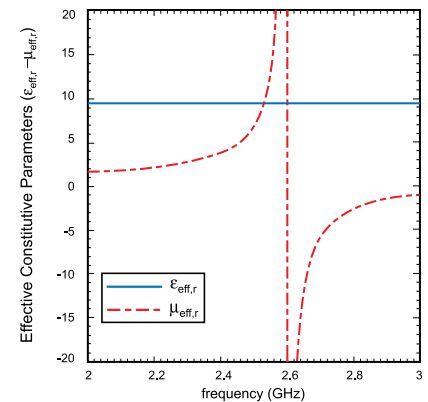
Metamaterials for Antennas

The ability to shrink the size of an antenna while maintaining high efficiency is a tremendous challenge, with high dividends in potential applications. About five years ago, Prof. Sarabandi began to consider the use of artificial materials, called metamaterials, to achieve this result.

Working in Prof. John Halloran's in the Materials Science Department, Prof. Sarabandi and his group took a rather simple ceramic material, similar to a coffee mug, and used ceramic stereolithography to construct a 3-D monolithic millimeter-wave antenna with a sophisticated computer-generated pattern. An important characteristic of this metamaterial is its property of having both artificial permeability (μ) and permittivity (ε), which presents significant potential for advancing RF/wireless front-ends. Kamal is able to control the index of refraction in different areas of this metamaterial and actually guide the wave and make it do what he wants.

Pictured to the right is the first Luneberg lens antenna constructed monolithically from this ceramic material. Potential consumer and military applications include use on an aircraft or on a military humvee, so that your laptop, or your soldier, can be in constant communication via satellite. This has already resulted in several patent disclosures. Prof. Sarabandi is working to reach the higher terahertz range of wavelengths with this technology, which would open an entirely new area of research effort.

Antenna size tends to be dictated by the frequency of the wave; the lower the frequency, the larger the antenna. However, it is not always feasible to have an antenna size that corresponds to the required frequency. For example, Army vehicles have extensive communications requirements with low frequency devices, yet it is not safe to outfit these vehicles with large, highly visual antennas. Prof. Sarabandi solved this problem by using a metamaterial known as Reactive Impedance Surface (RIS) permittivity substrate, which enables a significantly smaller antenna size on today's and tomorrow's Army vehicles. This work was recongnized with a Best Paper award at the 25th Army Science Conference this past November.

Embedded circuit metamaterial and its effective permittivity and permeability as a function of frequency.

## Educating Students to Lead the Way

Prof. Sarabandi supports a large number of graduate students to help him conduct research in a wide variety of areas, some of which have been outlined above. "Our students are critical to the work we do here," stated Kamal, "We are very fortunate at Michigan to have such high quality individuals."

The excellence of their work, combined with their focus on areas of high national interest, has resulted in a high number of student paper awards at recent conferences. Karl Brakora is a PhD candidate who has helped advance Kamal's work in metamaterials. Already a prize winner for a paper in the area of ceramic stereolithography, which is employed in the Luneberg lens described above, Brakora recently had his work published in the *IEEE Transactions on Antennas and Propagation.* He spent much of his time in the lab creating these completely novel structures. "It's really quite an accomplishment," said Brakora, who appreciated Prof. Sarabandi's patience through the extensive experimentation stage that goes into fabricating a completely new structure.

Prof. Sarabandi's commitment to his students was recognized early in his career when he received a U-M Henry Russel Award for excellence in teaching and scholarship. Amy Buerkle, a PhD student working with Kamal on acoustic and electromagnetic wave interaction, appreciates his dedication and zeal. She recalled that, "at one of our meetings, he presented a sketch of a new idea on the back of an airline napkin." As well as valuing his depth of knowledge and creative approach to solving problems, she stated, "he has demonstrated the importance of being well-rounded and using our ability as engineers to benefit society."

Prof. Sarabandi wants his students to begin to build their careers here at Michigan, with a strong foundation in the fundamentals. "All of the work that I do is fed by looking at the fundamental issue of how wave interacts with other material," stresses Kamal. "I want my students to have a solid foundation in order to move on to new areas once they leave Michigan. With a wide and deep knowledge of one field, you can do anything you want."
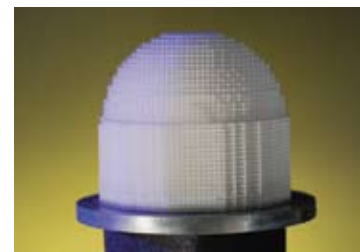
A millimeter-wave Luneberg lens fabricated monolithically using ceramic stereolithography.

William Gould Dow Distinguished Lecture

Sir John Pendry Brings us the Perfect Lens

L: Brian Gilchrist, Sir John Pendry, Duncan Steel, Roberto Merlin

Sir John Pendry, Chair in Theoretical Solid State Physics at Imperial College, London, delivered the 9th William Gould Dow Distinguished Lecture, "The Perfect Lens: Resolution Beyond the Limits of Wavelength." Pendry's theoretical work in the area of metamaterials, man-made materials that are specially created to evoke unique physical properties, and in particular metamaterials with a negative refractive index (NRI), has led to a prescription for an optical lens that will be able to focus on features significantly smaller than the wavelength of light.

An interdisciplinary team of faculty have recently received a $5M five-year grant from the Department of Defense to develop NRI metamaterials. They include the team's leader, Professor Roberto Merlin, Professor Stephen Forrest, and faculty from the Department of Materials Science & Engineering, as well as four other institutions. One of their goals is to create a superior metamaterial that will act as Pendry's superlens, replacing the traditional curved lens to image extremely small, even nanoscale objects. In addition, Prof. Tony Grbic of the Radiation Lab is investigating new approaches to developing NRI materials to broaden their application into areas such as improved medical imaging devices, new sensor technologies, wireless components, antennas, and microwave devices.

"These metamaterials promise to turn optics upside down by breaking through the limits on resolution imposed by conventional technology," said Pendry. NRI metamaterials are also predicted to have enormous potential in the field of optical data storage and lithography.

Partnership with Seoul National University

The U-M EECS Department and Seoul National University (SNU) School of Electrical Engineering and Computer Science have signed an agreement to collaborate on graduate education. SNU will send graduate students to work with EECS faculty for one year, and invite EECS students to work with SNU faculty. In addition, semi-annual workshops will be held alternatively at Michigan and at SNU. The first workshop was held at Michigan, February 21, 2007. Profs. Gilchrist, Hayes, Najafi, and Shin will visit SNU this May.
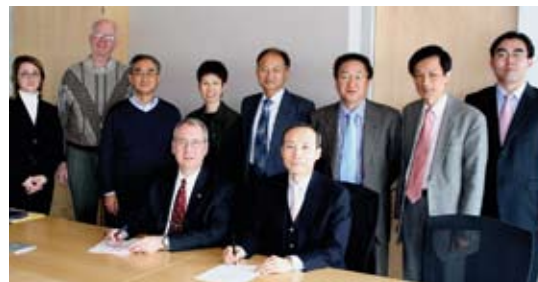
Brian Gilchrist and Jae Hong Lee (Director, School of Electrical Engineering) sign a partnership agreement between EECS and SNU. Standing: Amy Conger (CoE Int. Programs), EECS faculty John Hayes and Kang Shin, Stella Pang (Assoc. Dean, Graduate Education), SNU faculty Heonsik Shin, Song Wook Lee, and Byung Kook Park, and SNU graduate student, Seongjae Cho.

WIMS Plans for the Future

The Engineering Research Center for Wireless Integrated MicroSystems (WIMS ERC), funded by the National Science Foundation and now in its seventh year, is merging very low-power embedded computing and wireless technology with integrated sensors to realize devices capable of measuring a variety of physical parameters, interpreting them, and communicating wirelessly into larger distributed systems. During the next two decades, such microsystems are expected to become pervasive, sparking revolutionary progress in health care, environmental monitoring, homeland security, and other areas. The Center's Scientific Advisory Board met on March 20 at U-M to help plan for the future. Calling the WIMS ERC a tremendous success and a world leader, the Board is helping develop a bold vision that builds on existing strengths to take the Center to a whole new level, drawing on university-wide expertise and national and international alliances to tackle the critical problems of the 21st century. The ERC is led by U-M, partners with Michigan State and Michigan Tech, and is aided by the efforts of six outreach universities and 18 companies. With alliances in Asia and Europe, it includes 118 doctoral research projects involving 190 undergraduate and 174 graduate students.

The WIMS ERC Scientific Advisory Board at their meeting on March 20, 2007. From left: Ken Wise, Larry Burns (GM), Gil Herrera (Sandia National Labs.), Chih-Ming Ho (UCLA), Robert Nerem (GaTech), Sandip Tiwari (Cornell), and Khalil Najfai. Kurt Petersen (SiTime, LLC) attended by phone; Jim Patrick (Cochlear Corp.) could not attend due to previous commitments in Australia.

FACULTY HONORS AND AWARDS

EECS and CoE Awards

EECS Outstanding Achievement Award

Jim Freudenberg, Systems Lab Director, in recognition of his highly successful and long-standing course EECS 461: Embedded Control Systems.

Brian Noble, CSE professor, in recognition of his extensive revision and successful teaching of the course, EECS 280: Programming and Intro. Data Structures.

Jamie Phillips, ECE professor, in recognition of overall excellence in research, teaching, and service.

College of Engineering Education Excellence Award

David Kieras, CSE professor, for overall excellence in the education of EECS students. He is well-known for his demanding yet very popular undergraduate course, EECS 381: Object-Oriented and Advanced Programming. During interviews, recruiters have been known to ask our students whether they have taken this course.

University Awards

Peter Chen named Arthur F. Thurnau Professor

Prof. Peter Chen received a U-M Arthur F. Thurnau Professorship for his outstanding contributions to undergraduate education. In addition to receiving consistently outstanding student evaluations, his newly-created freshmen course, *Microprocessors and Music,* was an immediate hit with students. In this course, student teams build a music synthesizer in just one term. A member of both the Software Systems Lab and the Advanced Computer Architecture Lab, Prof.

Chen's current research uses virtual machines to provide security services.

Mohammed Islam receives 2007 Distinguished University Innovator Award

Prof. Mohammed Islam is the first recipient of the Distinguished University Innovator Award for his development of a breakthrough technology, his experience with tech-transfer, and his commitment to educating students about entrepreneurship and intellectual property protection. He presented the lecture, "An Engineer's View of Start-Ups," to the University community in March. This new award recognizes faculty who have excelled in bringing research innovations to the marketplace. Islam's current research interests include mid-infrared laser sources and their applications in fiber-to-the-home, advanced semiconductor process control, combustion monitoring, infrared counter-measures, chemical sensing and bio-medical selective laser ablation.

Martha Pollack earns 2007 Sarah Goddard Power Award

Prof. Martha Pollack, associate chair of the CSE division, received the Sarah Goddard Power Award for her significant contributions to the betterment of women through distinguished leadership, scholarship, and other related activities. Prof. Pollack conducts research in automated planning and natural language processing.

Ken Wise Gives Henry Russel Lecture

Prof. Ken Wise, the William Gould Dow Distinguished University Professor of EECS, Reid and Polly Anderson Professor of Manufacturing Technology, and director of the Center for Wireless Integrated Microsystems (WIMS), presented the talk, "WIMS: Sparking Breakthroughs in Health Care and the Global Environment," March 13, 2007, to the University community. Wise discussed the research advances made possible through the WIMS Center, which combines sensors, electronics, and wireless technology to improve healthcare (through cochlear implants and cortical microsystems), the environment (by measuring air quality), and homeland security (by using sensors to detect threats). The Henry Russel Lectureship is one of the highest honors bestowed on a faculty member by the U-M.

Demos Teneketzis receives 2007 Rackham Distinguished Graduate Student Mentoring Award

Demos Teneketzis received this award for his sustained efforts and accomplishments as a mentor of doctoral students. Prof. Teneketzis conducts research in the areas of stochastic control, decentralized systems, queuing and communication networks, stochastic scheduling and resource allocation problems, mathematical economics, and discrete-event systems.
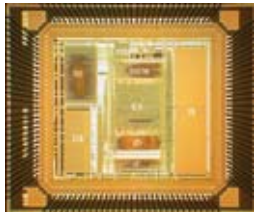
National and Professional Honors and Awards

ACAL Receives Microprocessor Report Analysts' Choice Award

The Advanced Computer Architecture Laboratory (ACAL) received a 2006 MPR Analysts' Choice Award in the newly created category, Innovation. ACAL was named with industrial partner ARM, Ltd. for introducing and implementing the technology called Razor, which MPR cited "is relevant to power consumption and the concept of future computing in general."

Pallab Bhattacharya receives Pioneer Award in Nanotechnology

Prof. Pallab Bhattacharya, Charles M. Vest Distinguished University Professor and James R. Mellor Professor of Engineering, is the co-winner (with Prof. Mark Reed of Yale University) of the first IEEE Nanotechnology Council (NTC) Pioneer Award in Nanotechnology. This award was created to recognize individuals who have had a significant impact on the field of nanotechnology. He will receive the award at IEEE-NANO 2007.

John Laird named 2006 ACM Fellow

John Laird, professor in the Artificial Intelligence Lab, was named a Fellow of the Association for Computing Machinery (ACM), "For contributions to the development and application of cognitive architectures."

Fawwaz Ulaby elected to AAAS

Professor Fawwaz Ulaby, Arthur F. Thurnau Professor and R. Jamison and Betty Williams Professor of Engineering, was recently elected to the American Association for the Advancement of Science (AAAS) for his outstanding contributions to microwave remote sensing, electromagnetic scattering and for his leadership in engineering education.

Steve Forrest receives IEEE Daniel E. Noble Award

Stephen R. Forrest, U-M Vice President for Research and the William Gould Dow Collegiate Professor of Electrical Engineering, was named a co-recipient of the 2007 IEEE Daniel E. Noble Award, for pioneering contributions to the development of organic light emitting diodes. The award recognizes outstanding contributions to emerging technologies.

Jessy Grizzle included in Scientific American 50

Prof. Jessy Grizzle has been selected for inclusion in the 2006 Scientific American 50 for his work in robotics. This prestigious list honors the top 50 outstanding leaders in science and technology during the past year. His work with the robot RABBIT enables it to walk and balance like a human, which is relevant to future medical applications such as prosthetics that adapt to the wearer and physical rehabilitation aids.

Young Faculty Awards

DARPA Young Faculty Award

Jamie Phillips, a member of the Solid-State Electronics Laboratory, was awarded a prestigious Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA), Microsystems Technology Office (MTO) for his proposed research titled, "Oxide Electronics for Integrated Microsystems and Displays." The Young Faculty Award is given to faculty who propose revolutionary research ideas that are critical to future technology developments.

NSF Career Awards

Three EECS faculty members have recently been awarded NSF Faculty Early Career Development (CAREER) awards. The CAREER award is NSF's most prestigious award in support of faculty in the early years of their career, and is intended to especially promote those teacher-scholars who most effectively integrate research and education.

Domitilla Del Vecchio, a member of the Systems Laboratory, received funding for her project, "A Partial Order Approach to Dynamic Feedback in Multi-agent Decision and Control Systems." Her research will extend our current ability to build safe and reliable large scale multi-agent systems, with potential impact on railway and air traffic control systems, intelligent transportation systems, and large robot teams in adversarial environments.

Z. Morley Mao, a member of the Software Systems Laboratory, received funding for her project, "Intent-based Network Management." Her research will advance the state of the art in managing IP networks by addressing key challenges in achieving automated, evolvable, and robust network management.

Petar Momcilovic, a member of the Systems Laboratory, received funding for his project, "Scalability Limits of Wireless Networks." Large-scale wireless networks are projected to dominate the information technology sector in the future, giving rise to a new set of research problems on scalability. The main goal of this project is to develop an essential understanding of the impact of large scales on the performance of wireless networks.

Student News

Electrical Engineering students participate in Space Elevator Games

The University of Michigan MClimber team made history at the International Space Elevator Games, when they were the first team to climb the tether all the way to the top, and make it back down. They did this on a blustery day that kept all other competitors at bay until the wind died down the next day. Several EECS students participated on the team, including Kwan Chong Tan (Power and Electrical subsystem leader), Mustafa Rangwala, and

EE graduate student Chris Deline, who worked on the solar panels which powered the crawler.

MRacing Formula SAE Team Races to the Finish

Jeff Lovell, BSE CE '06 and current graduate student, joined the MRacing Formula SAE (Society of Automotive Engineers) team as a freshman in 2002. Looking for something to tinker with as a counterpoint to his computer studies, he said he quickly found himself in the machine shop "shaping metal into shiny parts. I was hooked." He became

Chassis Leader in 2004 and Program Manager in 2005. This seemed like a good time to retire, but when the 2006 team found itself without an Electronics Leader, he assumed the responsibility.

The team had a great showing in 2006, earning third place overall at the FSAE East Competition, third at FSAE Japan, and third at the first annual FISITA (International Federation of Automotive Engineering Societies) FSAE World Cup. They are already gearing up for the 2007 competition.
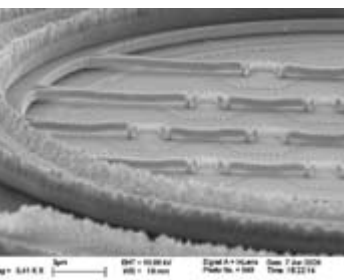
Raith Micrograph Award

Swapnajit Chakravarty received the 2006 Raith Micrograph Award. His winning micrograph was of a metallic nano-air-bridge contact to an array of H2 photonic crystal (PC) microcavities. Swapnajit recently defended his PhD thesis, "Two dimensional Photonic Crystal Slab Light Emitters, Light Emitting Arrays and Chemical Sensors," under Prof. Pallab Bhattacharya, and is currently an Applications Development Engineer at KLA-Tencor in San Jose, CA.

HKN Receives the Outstanding Chapter Award for 2005-06

Current Leadership (from left): Erin Thomas (Events), Cristina Mota (Operations), Matt Fojtik (Corresponding Sec.), Paul Cooper (VP), Cindy Tseng (Projects), Nan Li (President)

The Beta Epsilon chapter of Eta Kappa Nu, which is U-M's student chapter of the national Electrical and Computer Engineering Honor Society, is a recipient of the Outstanding Chapter Award for 2005–06, the second year in a row it earned this prestigious honor.

3rd Annual CSE Honors Competition

L: Xuan Zheng, Sandeep Tata, Zaher Andraus, Yevgeniy Vorobeychik

Celebrating some of the best research and presentations among CSE graduate students—faculty and students were present for the final presentations and announcement of the winners at the 3rd annual CSE Honors Competition, October 19, 2006. Representatives from Google, which sponsors the competition, were present to help judge the four finalists from each major area in CSE. First place went to Sandeep Tata (software), 2nd place to Zaher Andraus (hardware), and honorable mentions to Xuan Zheng (theory) and Yevgeniy Vorobeychik (artificial intelligence).

Students Display Class Projects at Design Exposition

David Liu and Adam Schrems show off their work at the Fall 2006 College of Engineering Design Exposition. Liu and Schrems, both undergraduate students in Computer Engineering, are displaying their senior-level project, *SensorNet,* a system to wirelessly monitor and control a home. Not shown are team members Eric Moore and Neil Pankey.

Liu appreciated the opportunity to present the team's work at the Design Exposition, and he hopes others will take advantage the course, Advanced Embedded Systems. Also presenting projects at the Design Exposition were team members Andrew Cramer, David Masselink, Jacob McCrary, and Jeffrey Rogers, who displayed their *Solar Car Micro-Controller System,* and Pritpaul Mahal, Douglas Li, and David Miller, who displayed their *iBrick MP3 Player.*

Undergraduate Student Awards

EECS Outstanding Achievement Award

> Paul Cooper, CE
> Brett Higgins, CS
> Kwan Chong Tan, EE

EECS Outstanding Research Award

> Joseph Steinmeyer, EE
> Adam Barnett, EE, Honorable Mention

EECS Outstanding Service Award

> Eric Moore, CE/EE

EECS Entrepreneurship Award

> Daniel Feldman, CS
> Zane Salim, CE

William L. Everitt Student Award of Excellence

Shaun Cox, CS
Christopher Hsiong, CE
Edwin Kek, EE

Richard K. Brown Scholarship

Paul Piong, EE
Jeff Vautin, EE

CoE Mildred & Steele Bailey Prize

Kwan Chong Tan, EE

CoE Marian Sarah Parker Prize

Alex Rutkowski, CS

CoE Henry Ford II Distinguished Class Prize

Joseph Steinmeyer, EE

CoE Distinguished Leadership Award

Ayush Agarwal, CS
Eric Moore, CE/EE

CoE William Harvey Seeley Prize

Brent Climans, EE
Alfred Eng, EE
John Treumuth, EE

CoE Distinguished Achievement Award

Adam Goodman, CE
Eric Wucherer, CS
Rajiv Prabhakar, EE

Graduate Student Awards

CoE Distinguished Achievement Award

Jonathan Brown, CSE
DaHan Liao, EE
Raghu Rangarajan, EE:Systems

Rackham Predoctoral Fellowships

Francesco Andriulli, EE
Aditya Mahajan, EE: Systems
Yuanyuan Tian: CSE

Barbour Scholarship

Dan Ruan, EE:Systems

2006 Rackham Distinguished Dissertation Award

Guoqing (Noah) Chang, Electrical Engineering, Optics, for his dissertation, "Nonlinear Propagations and High Power THz Generations Using Ultrashort Pulses."

Snapshots of our award-winning students

EECS students reach the pinnacle of their undergraduate experience in diverse ways—including involvement in student projects, student societies, and research. Here are the unique experiences and accomplishments of three of our award-winning undergraduate students.

Kwan Chong Tan—Taking Advantage of Opportunities

CoE Mildred & Steele Bailey Prize
EECS Outstanding Achievement Award

A senior electrical engineering student, Kwan Chong Tan has broadened his academic experience through long-term team projects, competitions, study-abroad, Alternative Spring Break, and research projects with faculty. With all this activity, he has somehow maintained a perfect academic record.

Kwan came to U-M wanting to experience research—so he explored the U-M Undergraduate Research Opportunity Program. Here he was introduced to the Student Space Systems Fabrication Lab, or S3FL. He was sold on the space elevator MClimber project, for which he became the lead of the Power and Electrical subsystem team. He describes days and countless nights spent in the lab with his teammates to ensure the robot met the required specifications, and was rewarded with a trip to the competition in Las Cruces, NM. "It was an amazing and extremely enriching experience which I will cherish forever," said Kwan. "It was a real learning experience in teamwork, leadership, determination, and perseverance."

Wanting to experience cutting-edge research, he applied for an undergraduate research opportunity with WIMS, and has been working on a project with Prof. Yogesh Gianchandani in the field of MEMS. Last summer, he returned home to Singapore, and researched sensor fusion technologies and algorithms for an indoor semi-autonomous four-wheeled robot.

Kwan has traveled to Missouri and Louisiana to help underprivileged children, and to rebuild homes still showing the ravages of Hurricane Rita. He spent a summer in China with the College of Engineering's Study Abroad program taking courses at Shanghai Jiao Tong University, and then working for Delphi Automotive Systems.

Asked how he manages his many activities with coursework, he said he is sure to attend all of his classes and discussion groups, and he does all his homework! Kwan will continue with graduate study at either MIT or Stanford, with a focus on technology management.

Joseph Steinmeyer—Understanding Technology, and Life

EECS Outstanding Research Award
Henry Ford II Distinguished Class Prize

Joseph Steinmeyer is a natural engineer. Son of an engineer and a nurse, he moved from working on simple robotics and trains, to building the 100 circuits in the back of the book, *Getting Started in Electronics.*

As a teenager, he earned pocket money repairing electronic audio equipment, and discovered his idol, Jack Kilby, at the age of 14—the same year Kilby won the Noble Prize in Physics for his part in the invention of the integrated circuit. What Steinmeyer found inspiring about Kilby was his humility. "He was selfless," Joe said of Kilby. "He felt that the world would have progressed without him, that he was just a vessel through which engineering happened."

When he got to Michigan, all the pieces of his acquired knowledge began to fall in place. "Classes like EECS 215, 320/421, and 330 have been like semester-long epiphanies," said Joseph. "When I finally learned what happened to a band diagram when an n-type and a p-type material are brought together, it was almost like discovering the meaning of life."

Now, he uses real-life processes to inform his research. Joe works with Prof. Michel Maharbiz and graduate student Ruba Borno on a research project that models the behavior of ferns spreading spores to create a device that will generate electricity simply through the process of evaporation. Joe has been working in the Maharbiz group for a year, and says, "I found it to be as valuable an experience, if not more so, than any single class I have taken at this university." Joe is still a junior, yet already is co-author of a journal and a conference paper.

It seems that Joe has found his niche. He is drawn to the methodology of this research, specifically using nature to solve engineering problems, and already anticipates pursuing an interdisciplinary approach to research in electrical engineering that will reach into the fields of biology and medicine.

Alex Rutkowski—Leading the Way

Marian Sarah Parker Undergraduate Prize

Alex Marie Rutkowski is used to leading the way. Salutatorian of her high school in Trenton, MI, and co-captain of the varsity volleyball team, she came to Michigan looking for a challenge.

The semester she was inducted into the EECS Honor Society, Eta Kappa Nu (HKN), Alex was voted most active electee, and quickly became an officer.

Alex knows that the heart of an organization is its people. When she became president of Eta Kappa Nu, she brought the officers together often so they could work more dynamically and comfortably as a team. She arranged to travel with her fellow officers to the annual HKN Regional Conference, a first for Michigan's chapter of HKN.

Her efforts to get people to work together truly paid off when HKN and fellow student society IEEE planned to merge their long-standing donut and bagel stands in preparation for the renovations of the EECS atrium. Alex coordinated getting the two societies to draw up a contract detailing how they would operate their new joint venture, bringing a peaceful close to a decades-long friendly rivalry.

Alex stated, "my leadership experience in Eta Kappa Nu was one of my most valuable learning experiences at the University."

Alex participated in a wide variety of activities to serve others through her sorority, Delta Gamma, and participated in Alternative Spring Break (ASB) her freshman year. ASB is a yearlong experience that offers students the opportunity to develop leadership skills while serving individuals and communities in need.

She rose to a different type of challenge during a summer internship at Intel Corp., where she received a bonus for exceeding expectations. At another internship at Bloomberg L.P. in New York City, she developed a taste for working in the financial sector.

Alex's goal—to continue to be challenged, and to lead, in the world of high finance and technology. She will embark on this new journey at a financial consulting firm in Chicago.

Alumni Society President's Message

With this newsletter we enter the fifth year of the EECS Alumni Society. There are now many more EECS alumni than when we first started and we continue our work to make a Michigan degree in EECS an increasingly valuable commodity. How? Though the power of networking—that is, social networking!

If you are reading this issue and thinking back about the great times you had at Michigan then this column is for you. If you are a current student and have just picked up a copy of this newsletter, then this column is for you too. Here's how you can (or will be able to) plug in to the powerful EECS Alumni network.

Attending Michigan is about more than just getting a great education, it's a unique life experience that builds connections to last a lifetime. And it's these connections, these ties, that are even more meaningful if you take advantage of them. How can you do that? Two words: Find and be Findable.
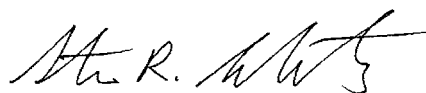
It likely won't surprise you that the University has a database of everyone who ever attended Michigan. It may surprise you, however, to know that you have access to it! It's called InCircle and you can search it and use it to reach out to anyone you choose.

Intrigued? Give it a try. Start out by using InCircle to look up an old friend. You can access it on the web by visiting http://alumni.umich.edu/ and clicking on the maize and blue 'InCircle' box at the bottom left of the page.

Feel free to look me up and add me as a friend (I'm Steve Schwartz BSECO '89, not 'the other' Steve Schwartz). Better yet, join the club! Find the group 'EECS Alumni' and join us.

This brings us to "findability." O'Reilly press has published a great book called *Ambient Findability —What We Find Changes Who We Become* by Peter Morville. The bottom line is that search is about both finding and being found. If you create a rich profile, and a rich network, you'll be more findable and will continue to increase the value and potential of your EECS affiliation.

Stay true and go blue!

Steve Schwartz, President
EECS Dept. Alumni Society
stevschw@umich.edu

Stay Connected • Reach Out to Others • Find a Mentor

All on the EECS Alumni membership pages at
https://www.eecs.umich.edu/eecs/alumni/membership.html

Students
Many EECS alumni have volunteered to be on-line mentors. Contact them to find out about different careers, or to ask questions about their company, where they live—anything you need to know.

Alumni
Contact friends you haven't spoken to in a while. Sign up as a potential mentor for our students, or recent alumni. Many of you have already signed up—Thank you!

2006 College of Engineering Alumni Society Merit Awards

Electrical and Computer Engineering

David C. Munson, Jr. (Dean, Engineering), George I. Haddad, Brian E. Gilchrist (EECS Interim Chair)

George I. Haddad (BSE EE '56, MSE '58, PhD '63), Robert J. Hiller Professor Emeritus of Electrical Engineering and Computer Science, retired from the Department in 2005.

His long and distinguished career at the University of Michigan spans almost five decades of remarkable achievement and leadership in research, teaching, service and administration.

When Prof. Haddad was still a graduate student, the renowned professor William Gould Dow (1895-1999) recognized his unique ability to communicate complex concepts in a comprehensible way —so he regularly brought visitors by George's desk to hear about his latest research activities. Later, he also made certain Prof. Haddad was hired as a faculty member.

Prof. Haddad quickly assumed a position of leadership as Director of the Electron Physics Laboratory (1969 to 1975), and later as Director of the Solid-State Electronics Laboratory (1986-1991), and Director of the Center for High Frequency Microelectronics (1986-2000). He served for nearly 20 years as Department Chair between the years 1975-1997.

During his tenure as department chair, the department grew significantly in both reputation and size and established itself among the top five departments in the country. He was instrumental in forming the current department from three existing departments and programs. "It is very gratifying to be honored by my colleagues," he stated, "particularly after serving them for so many years."

Prof. Haddad is internationally recognized for his research and expertise in microwave and millimeter-wave devices and integrated circuits, microwave-optical interactions and optoelectronic devices, and integrated circuits. He is also a highly respected educator, having graduated nearly 60 Ph.D. students, many of whom have become distinguished educators and industry leaders. In recognition of this accomplishment, he received the Distinguished Educator Award of the IEEE Microwave Theory and Techniques Society (1996). Professor Haddad is a Fellow of the IEEE and a Member of the National Academy of Engineering.

Computer Science and Engineering

David C. Munson, Jr. (Dean, Engineering), Daniel P. Siewiorek, Martha Pollack (Associate Chair, CSE Division)

Daniel P. Siewiorek (BSE EE '68) is director of the Human-Computer Interaction Institute, and Buhl University Professor of Electrical and Computer Engineering and Computer Science at Carnegie Mellon University.

Prof. Siewiorek truly enjoyed being back on campus. "Seeing faculty who where here in my undergraduate days and who are still active was an amazing testimonial to the loyalty and dedication of Michigan faculty. Keki Irani taught me my first course in computing and set me on my path to a career in computer engineering education and research. Also, it was great meeting the more recent faculty whom I have watched mature and who are carrying on the Michigan tradition."

Though he went on to earn his master's and PhD degrees from Stanford, he still keenly remembers his intense undergraduate years at Michigan. "The broad based education I received ranging from circuits to computers, thermodynamics to machine design, and Engineering English to philosophy not only taught me how to learn but also gave me
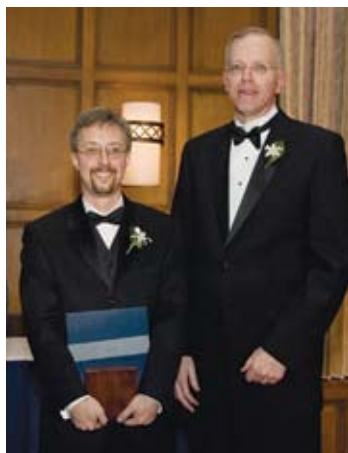
perspective to lead interdisciplinary teams encompassing all of those disciplines and more."

Dr. Siewiorek currently leads an interdisciplinary team that has designed and constructed over 20 generations of mobile computing systems. In addition, he helped to initiate and guide the Cm* project that culminated in an operational 50-processor multiprocessor system. He has designed or been involved with the design of nine multiprocessor systems and has been a key contributor to the dependability design of over two dozen commercial computing systems. He recently received the 2006 Outstanding Contribution Award from ACM SIG-MOBILE for pioneering and fundamental contributions to wearable and context-aware computing.

Dr. Siewiorek has written eight textbooks in the areas of parallel processing, computer architecture, reliable computing, and design automation. He is a Fellow of IEEE, ACM, and is a member of the National Academy of Engineering.

Recent Engineering Graduate Award

G. Robert Malan (MSE CSE '96, PhD '00) is chief

technology officer and vice president of Arbor Networks. Dr. Malan has successfully transferred cutting-edge research from his days as a graduate student into a fast-growing network security company that provides products and solutions for protecting network service providers and large enterprises against cyber-threats. Arbor Networks was recently recognized by *Inc.* magazine as the 9th fastest-growing private company in America. Dr. Malan founded the company Arbor Networks in 2000 with his thesis advisor, Prof. Farnam Jahanian.

G. Robert Malan, David C. Munson, Jr. (Dean, Engineering)

When Rob was on campus, he visited his friends and colleagues in CSE and said, "I thought the new building was fantastic! I really liked the amount of natural light that pervades both the public and personal areas."

Of his time at Michigan, Dr. Malan said, "There is no doubt that one of the main reasons Arbor has been so successful stems directly from the experience that I gained as a graduate student at Michi-

gan. The University of Michigan and its partnership with Merit Networks provided a unique network research and operations environment. This environment led to the development of technology that was applicable to real-world problems on a real-world scale. This type of technology is the foundation for any successful commercial enterprise, Arbor included."

Alumni Society Distinguished Service Award

Robert D. Scott (BSE CE '75) is vice president,

Innovation & Architecture, Global Business Services, Procter & Gamble Company. Mr. Scott has distinguished himself throughout his 30-year career with Procter & Gamble, beginning as a systems analyst, and ultimately working in virtually every business area within the company implementing information systems and integrating new business units. He has also overseen the global consolidation of the company's computing and communications infrastructure.

Robert D. Scott, David C. Munson, Jr. (Dean, Engineering)

He recently spent four years in Belgium managing P&G's IT services for Europe, the Middle East and Africa. He stated, "It was a real coming out, learning how to be a citizen of the world, which is very different than being a U.S. citizen leading a global organization."

Scott said of his U-M education, "Michigan taught me how to learn. It's not about the specifics—frankly I rarely use those—but how to continually learn." After his surprising zero on a chemistry quiz, he learned how to study and made Dean's list every quarter.

Mr. Scott is an active member of the CoE's Minority Engineering Program Office (MEPO) Advisory Council. He has been chair of the MEPO board of directors since the organization's inception in 1998. Mr. Scott is also involved in several youth initiatives in the Cincinnati area. He has been named a Cincinnati Black Achiever, and received a Cincinnati Imagemaker award in 1998 for business achievement.

Credits: Article by Kimberlee Roth in F/W2002 Michigan Engineer, and CoE

1940's

William H. Gordon Jr., MD (BSE '47) has retired after 44 years of practice of Nuclear Medicine. He hopes to attend the 60th Class Reunion in Ann Arbor this year.

1960's

Barrett Hazeltine (PhD EE '63) is currently teaching at Africa University in Mutare, Zimbabwe while on leave from Brown University. He tells us, "The sun is warm; colleagues and students equally warm-hearted; the inflation rate is an astonishing 1500%; we are enjoying it."

Prof. Hazeltine (right) and his friend, who is building his own house using appropriate technology.

Though Dr. Hazeltine only mentioned his current work in Africa, the editor discovered that he is Professor Emeritus at Brown University, and he still teaches. From 1972 to 1992, he was also associate dean of the College. His research interests include engineering management, technology planning especially in developing countries, teaching of technology for liberal arts students, and digital computers. He has spent several years teaching in Africa during the 70's and 80's, and has taught in several other foreign countries, including Indonesia, The Philippines, and Thailand. Hazeltine has written textbooks on electronic circuit design and small-scale technologies. He received thirteen teaching

View of the campus of African University. The building with the cone is the chapel.

awards from senior classes at Brown. In fact, the award now bears his name: the Hazeltine Senior Citation award for excellence in teaching, guidance, and support. He is a Trustee of Stevens Institute of Technology and sits on several advisory boards.

Dr. Galal Elsayed Ahmed Khadr (MS EE '68) fondly remembers those "nice days in Michigan." He is Chairman of the Computer Department at Arab Open University - Jeddah - Saudi Arabia.

1970's

Sue Kelly with the Red Storm Computer

Suzanne M. (De Smet) Kelly (BS CCS '75; also MAS CS 1980 Boston University) has been working at Sandia National Laboratories since 1980. She is a distinguished member of technical staff and specializes in system software for massively parallel high performance computing systems. She currently leads the software team for the second fastest computer in the world, Red Storm (see http://www.top500.org/lists/2006/11 and http://www.sandia.gov/ASC/redstorm.html). This computer integrates 13,728 commodity AMD processors, over 41 terabytes of memory, and a custom, high performance 3-D mesh network interconnect. Using messaging passing algorithms (MPI), a single application, running on the 12,920 compute processors, can cooperate to solve or simulate a scientific problem. The ability to distribute and scale a problem across thousands of nodes requires some specialized system software. A hallmark of the system software on Red Storm is its light weight kernel operating system, Catamount. Catamount functionality is limited to the minimum set to support scientific applications. Suzanne let us know that she is grateful for how her U-M CS degree helped her with her career.

Andrew Linnell (BSE '72, MSE CICE '73) works for EMC in Hopkinton, MA as a Technical Consultant. Prior to this he was CTO of an Austin, TX start-up, OmegaBand. His empty nest, created when his third child graduated from college in 2006, has been refilled. Andrew remarried in 2006 and now has two exchange students and a mother-in-law living in his happy home in Hudson, MA.

Bruce W. Sanderson (BSE EE '74, MSE '76) is retiring from Ford Motor Company after 30+ years work in the Dearborn Engineering and Corporate data centers.

Larry Aaronson (BSE EE '87) attended law school at U. of Illinois in Champaign. He says, "I have been practicing patent law (with a focus on wireless telecom technology) since then and have been a senior partner at the firm of McDonnell Boehnen Hulbert & Berghoff LLP since 1999. I have also been an active cast member of, and writer for, the Chicago Bar Association's annual "Christmas Spirits Show." Two years ago, I operated a Kermit the Frog puppet and sang a duet to the tune of "Rainbow Connection"—in a Kermit voice (see photo). This past year, I played the title role of *King Tort.* I have two adorable kids, Lindsey (9) and Adam (5), and an amazing wife, Holly."

David Boundy (MSE CCS '83) is married to Dr. Jane Epstein in New York, NY. He and Jane have a daughter, Lillian. David is a patent attorney at Cantor Fitzgerald. His practice relates to electronic trading systems, financial instruments and structures, and other financial services innovations. David obtains patents, and advises on infringement and validity issues.

Michele (Craven) Nicholas (BSE, EE '86) is pleased to announce that her daughter Renee's youth robotics team, the Gothic Lawn Gnomes (www.gothiclawngnomes.org), has won first place in the Washington State 2006 FIRST LEGO League (FLL) competition, and will be competing in the international FLL World Festival in the spring. These ten middle school age kids worked together to design a robot, built from the LEGO NXT kit, that could autonomously complete a series of predetermined, nanotechnology-related missions. They also spent time reviewing current research in nanotechnology, and presented to the FLL judges their idea for a new gum that uses nanobots to clean plaque and tartar from your teeth. Renee, the only girl on her team, is currently working on an improvement to one of the robot's attachments in preparation for the international competition. She enjoys the challenge of tackling the "impossible" mission, the dynamics of working with a group, and the opportunity to put her theater skills to work on the presentation. She plans to participate again next year in this inspiring program developed by FIRST, a not-for-profit public charity that "designs accessible, innovative programs that motivate young people to pursue education and career opportunities in science, technology, engineering, and math, while building self-confidence, knowledge, and life skills." Renee's FLL teammates include Mercury Herlan, grandson of Glenn O. Dentel (BSEM '63), and Alaric Sawade, son of Rennie Sawade (UM-F BS CS '86) and Vickie Sawade (UM-F BS MTH '92), as well as seven other boys from the Seattle area.

Michele has spent most of her career serving up custom database software, with a side of technical writing, web site development and graphics design, for a variety of clients including Apple, Charles Schwab and Microsoft. She is currently schooling her two (mostly) delightful children out of her Seattle area home, where she lives with her husband Andrew, one cat and a Hungarian herding dog.

Lanka Van Dort (MS CCS '85) is the Director of Engineering for Orion Systems, Inc., a software company in Ann Arbor.

Gothic Lawn Gnomes FLL team members Renee Nicholas, Mercury Herlan and Alaric Sawade

1990's

Kurt A. Carlson (BSE EE '91; also MBA from Grand Valley State University) has recently been named the new Call Center Director for a Charter Communications facility in Grand Rapids, Michigan. Charter (charter.com) is a broadband communications company based in St. Louis, MO and Kurt is looking forward to strengthening every aspect of customer service at his new company. Carlson was formerly Director of Business Customer Service at Consumer's Energy, and Director of Customer Operations for Greatland Corporation. He is also Vice President of the Board of Trustees for Wildlife Rehab Center, a nonprofit wildlife rescue center operating in western Michigan.

Ronald ("Ron") Y. Kim (BS CS '90; also MBA from U-M Ross School of Business '05) is a Partner with Accenture specializing in highly complex technology change programs for Fortune 100 clients. Ron authored Accenture's point of view and official position on Methodology Approaches for Service Oriented Architectures. He is currently leading the implementation of a Service Oriented Architecture reservation and booking capability for one of the world's leading global cruise line companies. This software will give them unprecedented agility and flexibility in delivering new customer offerings. Nearly 20 years after graduating from the Computer Science program, Ron says he still draws on key core skills he learned during the program, including working successfully with diverse individuals and opinions and using methodical problem solving techniques.

John Paxton (MS CSE '87, PhD '90) is a faculty member of The Computer Science Department at Montana State University in Bozeman, Montana. Currently, he has a Fulbright Award to spend the academic year at The University of Leipzig in Leipzig, Germany. While there, he is developing and teaching two courses, including a sophomore-level course on data structures and algorithms. He hopes to put the excitement and challenge back into these subjects by incorporating problems from programming competitions. Prof. Paxton also looks forward to combining his teaching with his college minor in German.

Steven J. Pazol (BSE CE '86) is founder, president, and CEO of nPhase LLC, which was recently acquired by QUALCOMM, Inc. nPhase, founded in 2003, is a leading provider of machine-to-machine solutions to manage fixed machine assets. It has been named one of the "Top Ten M2M Pioneers" by M2M Magazine, and received the Chicago Innovation Award in 2004. QUALCOMM expects that nPhase's fixed-asset machine-to-machine technol-ogy, experience and established customer base will complement its own success in the mobile machine-to-machine market. nPhase will continue to offer products under its own brand.

Mark Stephan (BSE CE '96) is currently working towards a Masters in Liberal Arts in Environmental Management from Harvard, focusing on renewable energy and wind power. Mark and Yvonne ('96 CS) are expecting their first child at the end of March!

2000's

Wan-Thai Hsu (left) receiving the EE Times ACE award for Innovator of the Year from Ross Ayotte (EE Times)

Wan-Thai Hsu (PhD EE '01), Chief Technology Officer of the U-M spin-off start-up company Discera Inc., received the EE Times 3rd Annual Creativity in Electronics (ACE) award for Innovator of the Year. The award is given to an individual who brings leadership, creativity and out-of-the-box thinking to a technology, a product or a business. For years the concept of using MEMS as a replacement for quartz had been theorized by academics but there were few who thought it would be possible to overcome the challenges required for real world use. Beginning in 2001, Hsu and his team moved the technology far beyond academic research, focusing on solving real world problems. Under Hsu's technical vision and guidance, Discera successfully developed, qualified and began producing silicon MEMS devices for timing applications in high volume, targeting to displace a decades-old, $3.5B per year quartz crystal market.

Mark V. LaRosa (BSE CS '05) is finishing his Master's in Human-Computer Interaction at the U-M School of Information. He recently accepted a job offer from Google's Mountain View office as a User Experience Researcher and Systems Engineer, and will start his new job in late May. He is interning out of the Ann Arbor office until he finishes his degree.

Rahul A. Sumant (BS CS '07) is currently consulting with Capgemini (global French IT consulting firm) out of their Chicago office. "Lots of travel, lots of work, lots of frequent flyer miles! I'm having a blast though."

Michigan Engineering Alumni Weekend

October 11–13, 2007 • **Come See What's New!**

If you haven't been back to campus in a while, prepare to be amazed!

The new CSE Building is absolutely beautiful—filled with light and open spaces, and cheerful people!

The EECS Building is in the process of being renovated, and should be nearly completed by Alumni Weekend. The upgrades include: a commons area with tables and chairs; a café run by students; a showcase lab; upgraded classrooms; a new conference room; and many additional features throughout the building.

The $40M Michigan Nanofabrication Facility (MNF) expansion and upgrade will be about done! Formerly called the Solid-State Electronics Laboratory, this world-class cleanroom facility will feature 37,500 sq. ft. in additional space, state-of-the-art air handling and safety features, as well as a spectacular covered tour aisle.

Please come and see the changes! While you're here, we invite you to attend the following events on Friday, October 12, 2007:

> 9:30-11:30 AM – EECS Alumni Society Board Meeting
> 12:00-1:00 PM – Lunch with alumni and faculty

Please simply contact Catharine June (cmsj@umich.edu) to confirm your attendance.

For tickets to the football game on Saturday with Purdue, and to confirm your attendance at a variety of special events, sign up with the College at http://www.engin.umich.edu/alumni/events/weekend.

Contribute to the EECS Alumni Society Fund

Support your alumni society efforts in mentoring, networking, recruiting, scholarships, and alumni events.

Name(s)_____
    ❑ *Please don't publish my name*

❑ I have enclosed my employer's matching gift form
❑ My check is payable to the University of Michigan
❑ Charge to ❑ MC ❑ VISA ❑ AMEX ❑ Discover

Address _____
    _____
    _____
Phone _____

Account Number _____
Signature _____
Expiration Date _____
E-mail _____

Enclosed is my gift of:

❑ $500   ❑ $250   ❑ $100   ❑ $50   ❑ Other _____

Mail To: ATTN: Catharine June
              EECS Alumni Society
              1301 Beal Avenue
              Ann Arbor, MI 48109-2122

Thank You!

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Keck Foundation grant will help decode chemical reactions in the body

Professor Michel Maharbiz is principal investigator of an interdisciplinary and multi-institutional team that recently won a prestigious W.M. Keck Foundation grant to build microsystems that will help scientists decode the mechanisms that guide embryo and stem cell development. Maharbiz will work with Prof. Cunming Duan from the Department of Molecular, Cellular, and Developmental Biology, Prof. Marie Csete of Emory University, and Prof. Erik Boczko of Vanderbilt University.

The team will investigate how cells organize and specialize to form tissues and organs. Cells in embryos organize themselves and develop perfectly almost every time, but the devices required to study the complex signals exchanged by the cells are just now becoming possible. The $1.7 million, three-year grant will fund the development of two devices that scientists hope will mimic chemical environments in the body.

The systems will consist of microscale fluidic and electrochemical devices, intracellular sensors, and feedback controls capable of chemically communicating with developing embryo and stem cell cultures. There is a gap between lab experiments and outcomes in the body that presents a pressing need in biomedical research, Maharbiz said. This research will allow scientists to reproduce the body's oxygen and chemical signals in the lab.

If successful, these technologies will radically change the way cell and embryo culture is performed, and will lead to medical research technologies that better capture the complexity of the cellular environment.

Courtesy U-M Press Release (3/27/07) by Laura Bailey

The W.M. Keck Foundation supports pioneering discoveries in science, engineering and medical research that lay the groundwork for breakthrough discoveries and new technologies that provide far-reaching benefits for humanity by investing in people and programs that make a difference in the quality of life, now and in the future.

Electrical Engineering and Computer Science

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