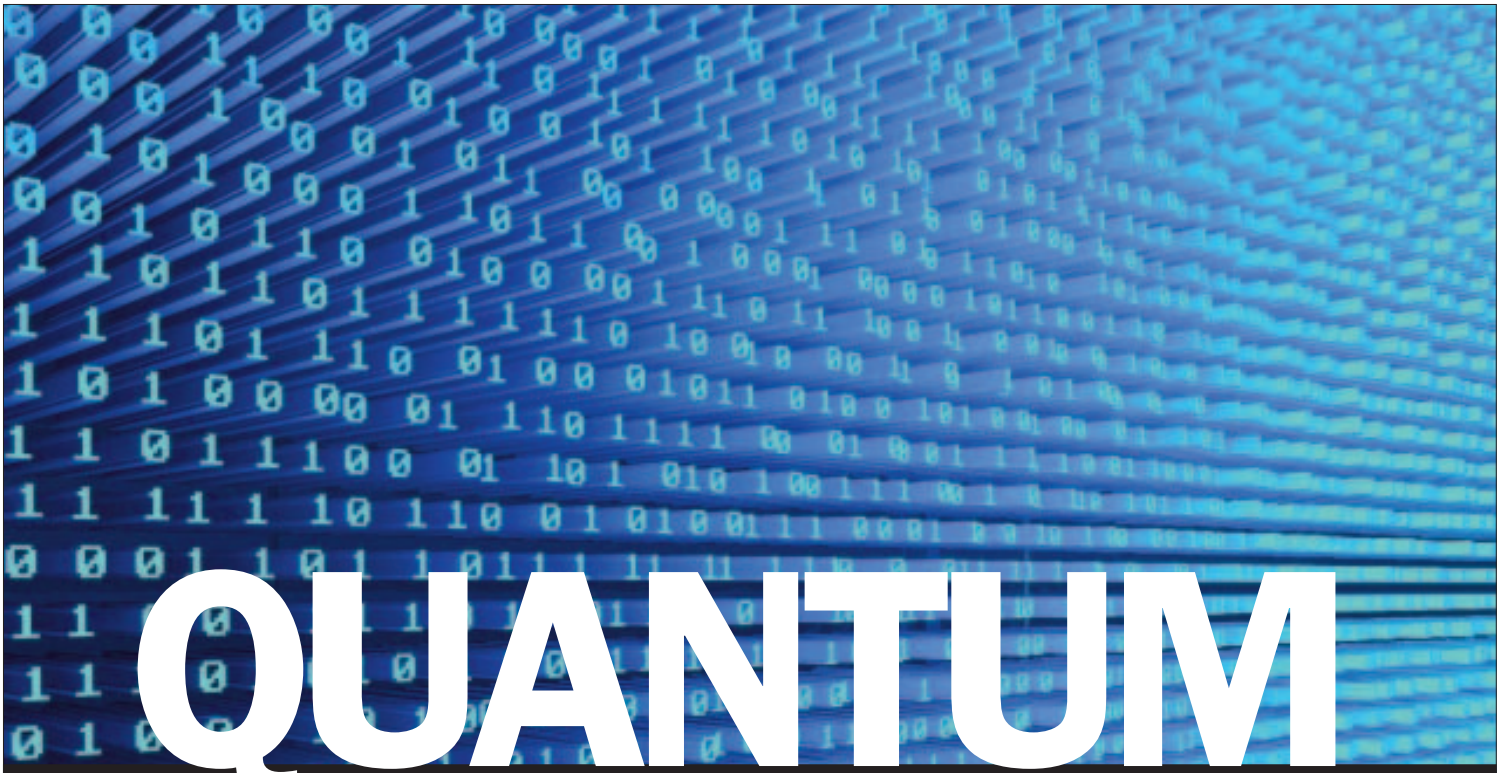
PRATT SCHOOL OF ENGINEERING

ECE NEWS
DUKE UNIVERSITY

Now you see it...
Now you don't.
see story on page 4

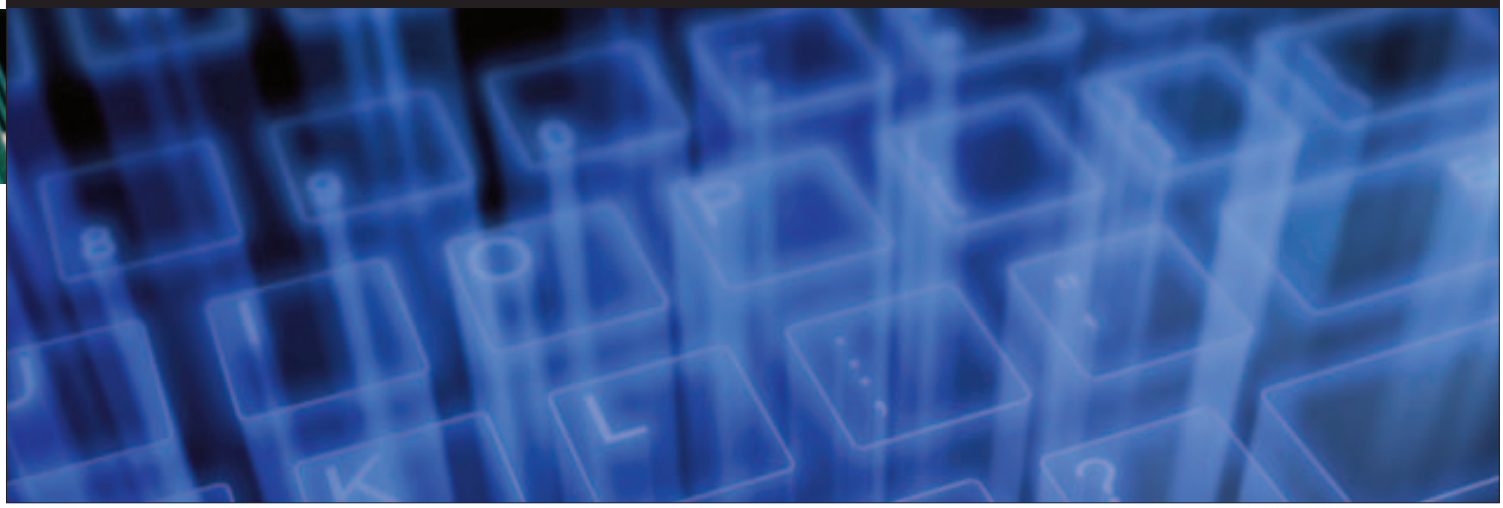
department of electrical & computer engineering / www.ece.duke.edu



QUANTUM

The Next Generation in Computing

While computers are getting progressively smaller and more powerful, the underlying principles encoding information in long strings of ones and zeroes have not changed markedly in 50 years. **But that could soon change.**



AY 2009

LESLIE COLLINS, PROFESSOR AND CHAIR

Welcome to the 2008-2009 ECE Newsletter. It has been a great year and we have many exciting things to showcase. As you are probably well aware, last year culminated in a successful search for Pratt's Dean, Professor Tom Katsouleas, and ECE is particularly proud to be his home department. Tom joined us from USC and has certainly been an invigorating leader in his first year as Dean.

Tom Katsouleas

We also have new leadership within ECE – Professor Steve Cummer is now directing our graduate program and in January 2010, Professor Lisa Huettel will begin directing our undergraduate program. These are both key leadership positions in our department as we continue to enhance our educational offerings. Our department owes a profound thank you to Professor Gary Ybarra who has directed the undergraduate program for the last 10 years, and in particular who shepherded the department through the ABET accreditation process this year.

Rhett George

The department marked a major milestone this spring, as we celebrated the retirement of Professor Rhett George after 52 years of dedicated service to ECE and to Duke. Since joining the faculty in 1957, Rhett's patient, hands-on teaching style has gently introduced thousands of students to the joys and challenges of our discipline. We expect his retirement will be an active one, and that we will continue to see him often, but Hudson Hall will not be the same.

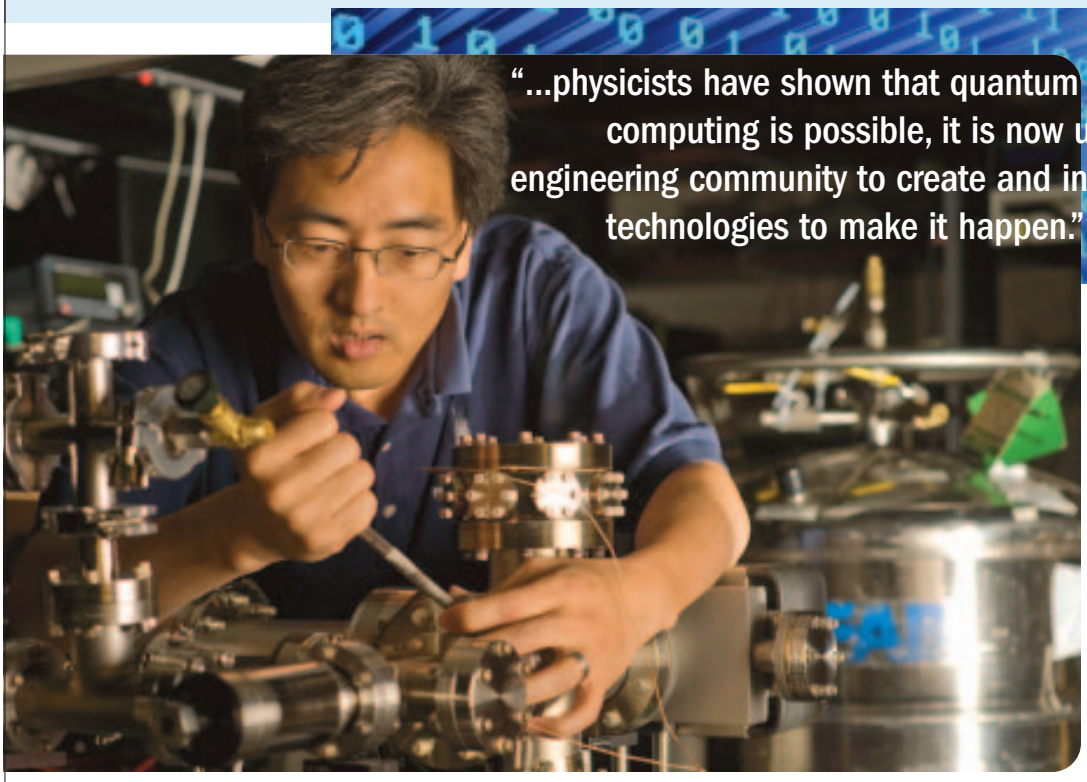
I am very happy to report that Daniel Sorin was promoted to Associate Professor and awarded tenure. His research in fault tolerant computing has garnered significant interest in both academia and industry. In other faculty news, Professor Chris Dwyer won a DARPA Computer Science Study Group award. Professor Krishnendu Chakrabarty was named Editor-in-Chief of *IEEE Design & Test of Computers*. He was also named a Chair Professor (Member of the Chair Professor Group in Software Theory) in the School of Software at Tsinghua University in Beijing, China—a visiting professor position that will involve several trips 2009-2011. Professor Adrienne Stiff-Roberts won the 2009 IEEE Early Career Award in Nanotechnology. The Nanotechnology Council cited Adrienne for her "contributions to the development of nanoscale quantum dots for infrared detection." She will travel to Genoa, Italy, in July 2009 to officially receive the award during the ninth annual meeting of the IEEE Conference on Nanotechnology. Additional faculty accomplishments and awards are listed throughout the newsletter.

Our students, both graduate and undergraduate, also continue to receive awards and accolades. Graduate student Mahmut Yilmaz won the 2009 Outstanding Doctoral Thesis Award in test technology from the IEEE Test Technology Technical Council. The "PhonePoint Pen," a student produced project by Duke engineering senior Sandip Agrawal and graduate student Ionut Constandache was selected as the winner of Hoffman and Krippner's first annual Award of Excellence in Student Engineering Scholarship. Sandip presented this work at a national press conference on June 9, 2009. While still in the conceptual stages, his PhonePoint Pen concept would allow a cell phone user to write short notes or draw diagrams in the air based on hand gestures and capture the information to the user's email address for future reference. Sandip studied under ECE Assistant Professor Romit Roy Choudhury. Graduating senior Daniel Roberts, whom you may remember from last year as a Marshall Scholar winner, won a Hertz Fellowship for postgraduate study in the physical sciences. Dan studied metamaterials as a Pratt Fellow under ECE Professor David Smith.

I hope you enjoy reading about the exciting things going on in Duke's Department of Electrical and Computer Engineering.

Leslie Collins
PROFESSOR AND CHAIR

Scientists at Duke University and elsewhere are making advances in a new type of computing that may have seemed purely theoretical, but could now be possible within our lifetimes. Literally, this new generation of computers will be a quantum leap forward in technology.



> "...physicists have shown that quantum computing is possible, it is now up to the engineering community to create and integrate technologies to make it happen." - Kim

The workings of conventional computers are driven by the laws of classical physics, where the millions of ones and zeroes are maintained on an actual physical entity, whether it be a chip or a hard drive, and respond to "yes" or "no" questions. However, chips can only get so small before they become the size of an atom, at which time another type of physics, known as quantum physics, comes into play.

In this sub-atomic quantum world, governed by its own often counter-intuitive laws, great potential lurks. But this potential can only be realized when scientists figure out how to create and capture the fleeting events at the atomic scale that are at the core of the computer's power. When brought under control, these properties offer the possibility of unimaginable computing power.

For example, explains Jungsang Kim, assistant professor of electrical and computer engineering at Duke's Pratt School of Engineering, future quantum computers could easily crack cryptosystems widely used for secure communication today whether to bank accounts or military installations in the blink of an eye. Current security measures rely on the impossibility of conventional computers to calculate all the computational possibilities in a reasonable amount of time.

"In many ways, we stand at the same place we did in the 1950s," said Kim. "The physicists knew how to make transistors, but integration was still lacking until the integrated circuits technology was invented. Just like then, the physicists have shown that quantum computing is possible, it is now up to the engineering community to create and integrate technologies to make it happen."

Not surprisingly, the federal government is keen to find out if quantum computing is a pipe dream or the real deal. Recently, a team of engineers from Duke, Georgia Tech and Massachusetts Institute of Technology received a multi-year grant from the Intelligence Advanced Research Projects Activity (ARPA) and the Army Research Office to work on specific challenges facing the development of quantum computers.

At the heart of a quantum computer are quantum bits of information trapped in a single atomic ion known as a qubit.

"We manipulate these qubits in physical systems using light in the form of lasers," Kim explained. "Lasers control the internal atomic states, as well as measure scattered light to read out the quantum registers (the quantum analogue of the processor register)."

The main focus of the team's effort (Georgia Tech, Duke and MIT) is to create technologies that integrate all of the components necessary to create a complex quantum information processor. This includes ion traps fabricated on a chip, controllers to move ions around on the chip, and optical components needed to control and measure the ion qubits.

Specifically, Duke will be developing optical components that can be integrated into the rest of the system to provide advanced optical capabilities.

"We are working on microfabricated optical components like small mirrors and micro-scale optical cavities to enhance the detection and communication of the qubits," Kim said. "We will be integrating these small optical components into microfabricated ion traps currently under development at Georgia Tech. We also have a separate program to utilize micromachined mirrors to control the laser beams that control the quantum registers."

Next Generation Cloaking Device

A device that can bestow invisibility on an object by "cloaking" it from visual light is closer to reality. After being the first to demonstrate the feasibility of such a device by constructing a prototype in 2006, a team of Duke University engineers has produced a new type of cloaking device that they said is significantly more sophisticated and has a broad frequency bandwidth.

The latest advance was made possible by the development of a new series of complex mathematical commands, known as algorithms, to guide the design and fabrication of exotic composite materials known as metamaterials. These man-made materials can be engineered to have properties not easily found in natural materials and can be used to form a variety of "cloaking" structures. These structures can guide electromagnetic waves around an object, only to have them emerge on the other side as if they had passed through an empty volume of space.

The results of the Duke experiments were published January, 16, 2009 in the journal *Science*. First authors of the paper were Duke's Ruopeng Liu, who developed the algorithm, and Chunlin Ji. David R. Smith, William Bevan Professor of electrical and computer engineering at Duke, is senior member of the research team.

Once the algorithm was developed, the latest cloaking device was completed from conception to fabrication in nine days, compared to the four months required to create the original, and more rudimentary, device. This powerful new algorithm will make it possible to custom design unique metamaterials with specific cloaking characteristics, the researchers said.

"The difference between the original device and the latest model is like night and day," Smith said. "The new device can cloak a much wider spectrum of waves — nearly limitless — and will scale far more easily to infrared and visible light. The approach we used should help us expand and improve our abilities to cloak different types of waves."

Cloaking devices bend electromagnetic waves, such as light, in such a way that it appears as if the cloaked object is not there. In the latest laboratory experiments, a beam of microwaves aimed through the cloaking device at a "bump" on a flat mirror surface bounced off the surface at the same angle as if the bump was not present. Additionally, the device prevented the formation of scattered beams that would normally be expected from such a perturbation.

The underlying cloaking phenomenon is similar to the mirages seen ahead at a distance on a road on a hot day.

"You see what looks like water hovering over the road, but it is in reality a reflection from the sky," Smith explained. "In that example, the mirage you see is cloaking the road below. In effect, we are creating an engineered mirage with this latest cloak design."

Smith believes that as the technology is perfected, cloaks should find numerous applications. By eliminating the effects of obstructions, cloaking devices could improve wireless communications, or acoustic cloaks could serve as protective shields, preventing the penetration of vibrations, sound or seismic waves.

"The ability of the cloak to hide the bump is compelling and offers a path towards the realization of forms of cloaking abilities approaching the optical," Liu said. "Though the designs of such metamaterials are extremely complex, especially when traditional approaches are used, we believe that we now have a way to rapidly and efficiently produce them."

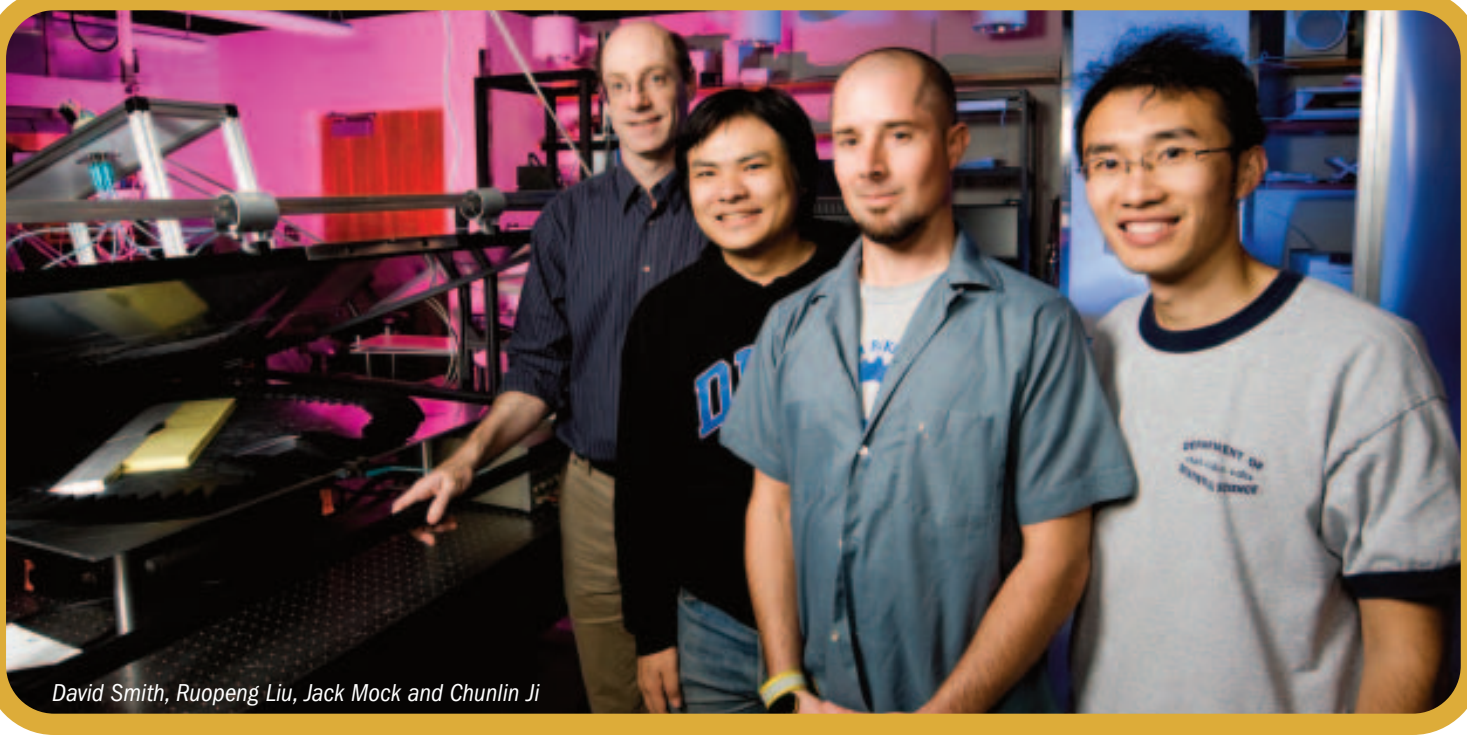
With appropriately fine-tuned metamaterials, electromagnetic radiation at frequencies ranging from visible light to electricity could be redirected at will for virtually any application, Smith said. This approach could also lead to the development of metamaterials that focus light to provide more powerful lenses.

The newest cloak, which measures 20 inches by 4 inches and less than an inch high, is actually made up of more than 10,000 individual pieces arranged in parallel rows. Of those pieces, more than 6,000 are unique. Each piece is made of the same fiberglass material used in circuit boards and etched with copper.

The algorithm determined the shape and placement of each piece. Without the algorithm, properly designing and aligning the pieces would have been extremely difficult, Smith said.

Others members of the research team were Duke's Jack Mock, as well as Jessie Y. Chin and Tie Jun Cui from Southeast University, Nanjing, China.

"The new device can cloak a much wider spectrum of waves — **nearly limitless** — and will scale far more easily to infrared and visible light. - **Smith**



David Smith, Ruopeng Liu, Jack Mock and Chunlin Ji

ECE Faculty Focus

JOHN BOARD

John Board, associate professor of ECE and computer science, also holds a 40 percent appointment as the Associate Chief Information Officer at Duke in the Office of Information Technology. Board's research interests focus on embedded sensor networks, power management and conservation. He is the faculty advisor for Duke's high profile Smart Home Program.

DAVID J. BRADY

David Brady, professor, specializes in optical imaging and spectroscopy. He launched two new DARPA projects this year, garnering $2 million in funding for a 3.5-year project called Dual Mode Detector Ensemble (DUDE) and a one-year Quantum Coherence Sensors project.

Brady completed his first textbook this year titled Optical Imaging and Spectroscopy, published by Wiley-OSA in March 2009, and is already working on a second edition. He was also awarded eight patents for technologies ranging from compressive sampling and signal inference to structured coded aperture fiber bundles to hyperspectral imaging coding and modulation. Brady currently serves as the chair of the Optical Society of America Image Sensing and Pattern Recognition Group and will co-chair the 2010 OSA Optical Imaging Conference. He was elected a Fellow of the IEEE in January 2009.

MARTIN BROOKE

Martin Brooke, associate professor, specializes in mixed signal integrated circuit design applied to sensors, signal processors and sensor networks. In the past year, Brooke was awarded two grants to explore archival and interactive dance through unobtrusively imbedded technology, and the creation of a digital multimedia archive for live dance performance.

APRIL BROWN

April Brown, the John Cocke Professor and senior associate dean for research, specializes in nanoscale materials and devices. In her capacity as Sr. Associate Dean, Brown led the program committee and logistic team to host the Summit on the NAE Grand Challenges national event in Durham, in March 2009. More than 1,000 people registered for the Summit event, encompassing 97 universities, 52 businesses, 12 government agencies and five professional scientific societies. In addition, Duke provided live web streaming of the event. On March 2, 2009, 924 unique visitors accessed the live event-streaming page, and 377 unique visitors accessed the feed on March 3, 2009. The average length of viewing time was an hour and a half. The entire Summit is now available online at: **http://grandchallengesummit.org**.

DID YOU KNOW? Brown also launched a new company, called Knoesis, Inc., that aims to develop bio-analytical hardware and reagents enabling cost-effective, point-of-care clinical diagnostics. The Knoesis, Inc. team won the Healthcare Track of the 2009 Duke Start-up Challenge.

LAWRENCE CARIN

Lawrence Carin, William H. Younger professor, specializes in signal processing, sensing and sensing systems, land mine detection, and homeland security applications. Carin's research is currently focused on overcoming data sparseness by developing innovative techniques to comb large datasets for useful information. From research on explosives detection he has branched into a range of projects, including identifying genes responsible for certain illnesses, improving methods for shrinking military and medical image files, and streamlining medical diagnoses. He is also exploring new compressive sensing, the complex process of creating computer image files that are initially stored in a compressed, or minimized state, instead of compressing larger files after the fact.

KRISHNENDU CHAKRABARTY

Krishnendu Chakrabarty, professor, specializes in the design, testing and optimization of embedded microsystems and networks. He is currently focused on the computer-aided design and testing of integrated circuits, design tools for digital microfluidics, circuits and systems for DNA self-assembly, and embedded real-time systems. Chakrabarty was awarded a three-year $235,256 grant from the National Science Foundation for a project titled "GOALI: Scalable Techniques for Detecting Small-Delay Defects in Nanometer Integrated Circuits." He is also a co-inventor on an international patent application titled "Droplet Actuators Systems and Methods" in October 2008.

Chakrabarty was named a Fellow of the Japan Society for the Promotion of Science in 2009, a Fellow of the IEEE in 2008, and both Distinguished Engineer and Distinguished Speaker of the Association for Computing Machinery (2008). He was also recognized by the IEEE Computer Society as a Golden Core Member, and recognized by Duke's Graduate School with a Dean's Award for Excellence in Mentoring in 2008.

DID YOU KNOW? Chakrabarty is an amateur poet and an enthusiastic student of history, culture, and foreign languages. He has traveled to over 40 countries in six continents.

LESLIE COLLINS

Leslie Collins, professor and department chair, specializes in the integration of physically-based phenomenological models with statistical signal processing techniques to address problems involving signal detection and identification. Collins' work spans the areas of cochlear-prostheses and EEG-based brain computer interfaces to landmine detection and unexploded ordnance detection and discrimination. She holds a secondary appointment in Biomedical Engineering and the Division of Otolaryngology-Head and Neck Surgery, Department of Surgery, within the Duke School of Medicine. A recent publication, "Mandarin Chinese Tone Identification in Cochlear Implant Subjects: Predictions from Acoustic Models," published in *Hearing Research* in July 2008, typifies Collins' research method of blending theoretical analysis, simulations and experimental validation.

CHRIS DWYER

Chris Dwyer, assistant professor, specializes in self-assembled nanostructures and optical devices for future computer architectures. In particular, Dwyer aims to create integrated nanoscale devices from self-assembling metallic, semiconductor, and organic nanoparticles to explore the application potential of light-reactive logic devices in computer architecture. He is also expanding his research portfolio to cross over into biological applications of self-assembled nanoparticles and DNA systems. In 2008, Dwyer was awarded $100,000 from the National Science Foundation for a one-year project titled "EMT: Resonance Energy Transfer Sensors." Dwyer is also a member of the 2009 DARPA Computer Science Study Group that introduces young faculty to urgent research needs within and throughout the Department of Defense.

DID YOU KNOW? Dwyer has a yen for gardening and building with stone as well as welding and building embedded hardware for fun.

STEVE CUMMER

Steve Cummer, the Jeffrey N. Vinik associate professor, specializes in electromagnetic wave remote sensing and the design of engineered electromagnetic materials. Much of his remote sensing research focuses on the production by lightning of powerful radio waves that travel great distances. He uses the measurements to more directly study several lightning-related phenomena, including unusual effects of lightning on the upper atmosphere and gamma ray production by thunderclouds. His materials research involves the study and design of advanced materials that artificially manipulate electromagnetic radiation. He wrote and co-authored 18 peer reviewed journal publications over the past year and contributed to 24 conference presentations. He was awarded the Capers and Marion McDonald Award for Excellence in Teaching and Research in 2009 at the annual Duke Engineering Alumni Awards Banquet.

RICHARD FAIR

Richard Fair, professor, specializes in microfluidic systems with an emphasis on bio-fluidic detection, transport and chemical synthesis, and lab-on-a-chip technology. Fair has been awarded an international patent for droplet-based pyrosequencing, and five U.S. patents for methods for sampling a liquid flow and droplet-based surface modification and washing. Fair continues to collaborate with spin off company Advanced Liquid Logic, Inc., and the Stanford Genome Center to develop a pyro-sequencing chip for massively parallel on-chip DNA sequencing. Additionally, he and Duke collaborators are working to develop real-time air sampling and chemical analysis on chip. Fair serves on the editorial board of the *Journal of Microfluidics and Nanofluidics* and served as guest editor for a special issue on Sensors for Microfluidic Analysis Systems for *IEEE Sensors Journal* in 2008.

DID YOU KNOW? Fair is an avid fly fisherman. He and his son Peter head to Idaho or Montana each summer to fish.

JEFFREY T. GLASS

Jeff Glass is the senior associate dean for education, professor and director of the Master of Engineering Management (MEM) program, and the Hogg Family Director of Engineering Management and Entrepreneurship. Glass specializes in micro mass spectrometry and was awarded a three-year $329,998 NSF-funded grant for a project titled "Development of a Microfabricated Coded Aperture Mass Spectrometer" with David Brady. He and Brady were also awarded a U.S. patent for technology titled "Coded Mass Spectroscopy Methods, Devices, Systems and Computer Program Products."

In his role as education dean and director of the MEM program, Glass led development of the initial professional masters degree curricular framework with each of Pratt's four engineering departments and initiative leaders. He established three new pilot MEM courses on topics such as quantitative finance, services engineering management, and design and marketing essentials for early stage technology. He also successfully piloted distance-learning courses for the MEM program.

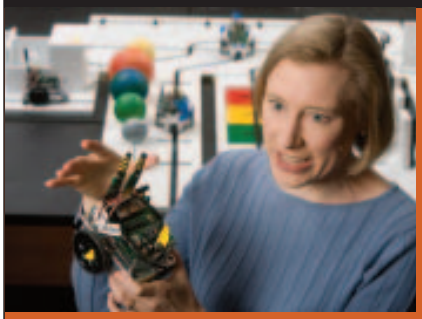
DID YOU KNOW? Glass is frequently told he looks a lot like John Malkovich.

MICHAEL GUSTAFSON

Michael Gustafson, assistant professor of the practice, specializes in engineering education and conducts research in the areas of control systems and interface between electrical and mechanical systems. Gustafson developed a new class and laboratory titled EGR 119L: Electrical Fundamentals of Mechatronics, now a required course for mechanical engineering undergraduates. He is also collaborating with mechanical engineering Associate Professor Pei Zhong on image processing of kidney scans to analyze lithotripsy damage.

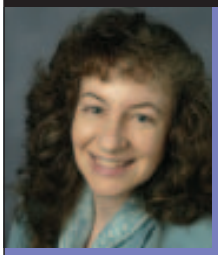
DID YOU KNOW? Gus has a lifetime lease on one square foot of the Scottish island of Islay. The Laphroaig Distillery, accordingly, owes him one dram of Scotch per year, though it can only be collected in person.

LISA HUETTEL



Lisa Huettel, associate professor of the practice, specializes in engineering education and statistical signal processing. Her research focus includes the improved educational practices in engineering courses, the integration and effective use of technology to benefit engineering pedagogy, and the creation of signal processing algorithms that can be applied to solve real-world problems such as hearing, remediation, and humanitarian mine detection. Huettel gave an invited talk titled "Integrating Sensing and Information Processing in an ECE Undergraduate Curriculum" at the 2008 NSF Department Level Reform Awardees Workshop.

NAN MARIE JOKERST



Nan Jokerst, J.A. Jones professor, specializes in integrated micro and nanosystems, integrated optoelectronics, integrated sensing, photonics, THz and optical metamaterials. Her main research focus is on miniaturizing optics and lasers and integrating them with related technologies to create a range of innovative chip-scale sensing systems. Jokerst's work is about bringing photonics down to a level comparable to integrated circuits, and coupling photonics with miniaturized technologies already more widely used. Over the past 20 years, she and her colleagues have developed the methods needed to thin and integrate lasers – ten could fit on the typed period at the end of this sentence. More recently, the team became the first in the world to successfully glue these devices with waveguides and optical detectors directly onto silicon, an achievement that opens a huge range of application options. She is also working on lab-on-a-chip technologies and early detection devices for health issues such as sepsis or malaria. Jokerst gave a keynote presentation on "Chip Scale Integrated Photonic Systems" at the 14th IEEE International Mixed-Signals, Sensors and Systems Test Workshop in Vancouver, Canada in 2008.

DID YOU KNOW? Jokerst owns and operates an organic farm in North Carolina.

JEFFREY KROLIK

Jeffrey Krolik, professor, specializes in signal processing, with a particular focus on sonar and radar applications, and understanding and conquering multipath environments where signals bounce around. A primary goal for Krolik's sonar research is to accomplish the deceptively simple sounding task of discriminating between objects such as enemy submarines and everything else, including seafloor features or scattered shipwrecks. Closely related to this work is a project to develop a new microphone system that would work from a distance and eliminate the need for handheld and wireless standard microphones. He is also working on over-the-horizon radar applications in which the signal waves route through a region of the atmosphere called the ionosphere that is around 200 km above the surface of the earth. Over the past year, Krolik was awarded more than $1.5 million in funding from the Office of Naval Research for projects ranging from undersea surveillance to adaptive radar signal processing.

DID YOU KNOW? Krolik once played violin professionally in the Canadian Opera Company Orchestra in Toronto, and each summer he performs during the annual Chamber Music Conference and Composers' Forum of the East.

WILLIAM JOINES

William T. Joines, professor, specializes in electromagnetic field and wave interactions with materials and structures, particularly the microwave and optical frequency range where wavelengths are commensurate with structures such as antennas, circuit elements, body parts, fibers and biological cells. Joines was awarded a $103,200 grant from the Army Research Office for a project titled "Microwave Laboratory Capability Enhancement." In December 2008, Joines co-authored an invited article for *Microwave Journal*, Vol. 51, No.12 pp. 28-42, titled "Towards a Validation of a Commercial Hypertheria Treatment Planning Systems."

DID YOU KNOW? Joines has been on the faculty at Duke for 42 years.

JUNGSANG KIM

Jungsang Kim, assistant professor, specializes in quantum information science, integrated microsystems, micro-electromechanical systems, and advanced photonic devices. His research applies cutting-edge micro-integration technologies to realize highly multi-functional integrated systems. Kim is part of a team of engineers from Duke, Georgia Tech and the Massachusetts Institute of Technology that received a multi-year grant from the Intelligence Advanced Research Projects Activity (IARPA) and the Army Research Office to tackle the challenges of realizing scalable quantum computers based on trapped atomic ions. The team is focusing on developing a scalable technological platform to create a complex quantum information processor, equivalent to the integrated circuits technology for silicon-based information processors. This includes ion traps fabricated on a chip, controllers to transport ions on the chip, and optical components needed to efficiently control and measure the ion qubits. Kim will be developing the micro-optical components that can be integrated into the rest of the system to provide advanced optical functionalities.

In addition, Kim is co-PI on a Multidisciplinary University Research Initiative (MURI) team working on integrated quantum circuits. The team plans to explore the exchange of quantum information between dissimilar quantum memories like trapped ions and quantum dots using photons as the mediators. This effort will study the challenges associated with interconvertion of qubits over complex hybrid quantum systems. The team is led by Professor Christopher Monroe at the University of Maryland/Joint Quantum Institute and includes collaborators from the University of Maryland, the University of Michigan,the University of California at San Diego, the University of Illinois at Urbana-Champaign, and the Naval Research Laboratory.

DID YOU KNOW? Kim is an entrepreneur, and co-founded Applied Quantum Technologies, Inc. (**http://www.appliedquantumtechnologies.com/**) in 2006. He currently serves as the President and CEO of the company.

QING LIU

Qing Liu, professor, specializes in computational electromagnetics, biomedical imaging, and nanodevices. Much of his work focuses on imaging breast tissue to detect cancer. He has developed a 3-D microwave imaging technology and a 3-D nonuniform fast Fourier transform (NUFFT) for MRI reconstruction. In addition to work on fast computational electromagnetics and acoustic solvers, Liu's research group aims to apply electromagnetic theory to study the physics of carbon nanotube antennas and interconnects. In 2008, the National Science Foundation of China recognized Liu as a Distinguished Overseas Young Scholar. He is also the lead PI on a Small Business Technology Transfer (STTR) grant from the Army Research Office to exploit a multiscale software tool for field/circuit simulation.

DID YOU KNOW? Liu is an enthusiastic badminton player and often participates in southern U.S. badminton tournaments (and has won some titles). He is the Faculty Advisor to the Duke Intramural Badminton Club and Duke InternationalHouse Badminton Club.

HISHAM MASSOUD

Hisham Massoud, professor, specializes in silicon microelectronics with a particular focus on Metal/Oxide/Semiconductor Field-Effect Transistors (MOSFETs) and integrated circuits. His research explores MOSFET device physics, characterization, technology and design, and the physics and technology of ultrathin dielectrics. He recently co-authored a publication with colleague Qing Liu titled "3-D Self-Consistent Schroedinger-Poisson Solver: The Spectral Element Method," published in the *Journal of Computational Electronics*, Vol 7, No. 3, pp 337-341 (2008). Massoud was the founding Director of the Semiconductor Research Laboratory.

LOREN NOLTE

Loren Nolte, professor, specializes in signal detection and estimation theory and its application using physics-based models. He is particularly interested in the development of Bayesian optimal decision and sensor fusion with application to problems in detection, identification and tracking in biomedical engineering, medical imaging, systems biology and ocean acoustics. Nolte recently co-authored a book chapter with Zoi-Heleni Michalopoulou titled "Matched-field Processing in the Presence of Environmental Uncertainties: a Baysian Approach," published in *Signal Processing and Reverberation in Underwater Acoustics*, 2008.

DID YOU KNOW? Nolte plays racquetball and is an avid Duke basketball fan.

DOUG NOWACEK

Doug Nowacek, associate professor, holds a joint appointment with the Nicholas School of the Environment in the Department of Marine Science and Conservation and at the Pratt School of Engineering in the Department of Electrical and Computer Engineering. His research focuses on the link between acoustic and motor behavior in marine mammals such as cetaceans and manatees and how they use sound in ecological processes. He is also exploring the effects of anthropogenic noise on marine mammals.

NEW FACULTY HIGHLIGHT

Three weeks spent traveling the crystal clear waters of the Caribbean may sound like a vacation, but for Douglas Nowacek, it's part of the job. Nowacek, a new marine biologist at Duke, spends about two months out of the year on such research cruises. Still, he claims that his work isn't necessarily as romantic as it seems.

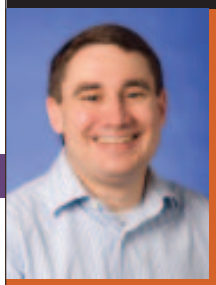
"The rest of my time is spent staring at a computer screen just like everybody else," he said. Nowacek earned a bachelor degree from Ohio Wesleyen University, and earned his doctorate through the joint program of the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution. Prior to coming to Duke, he was an assistant professor at Florida State University for five years.

Tracking the behavior of right whales, or any wild animals, is a difficult task. The tags Nowacek uses in his research record acoustics, movement patterns, direction, water pressure, temperature, and – coming soon – GPS location. Part of his Pratt research is developing new technology for marine applications. He is also teaching a course in acoustics and hearing with Leslie Collins, chair of ECE.

Through his teaching, Nowacek hopes to encourage students to think of animals differently than they have in the past – not just as complex organisms but also as acoustic signal processors. Currently, Nowacek is starting two major projects. The first takes him to the depths of the ocean to develop a map of the prey that exist 600 to 1,500 meters below the surface. The second takes him to the Antarctic to more accurately determine the amount of krill consumed by humpback whales.

FacultyFocus cont....

MATT REYNOLDS

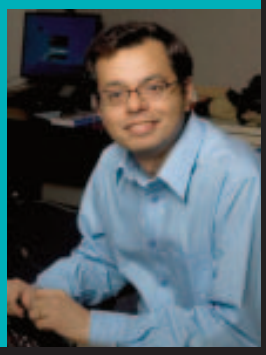


Matthew Reynolds, assistant professor, specializes in distributed sensing and communications systems. His research focuses on creating innovative connections between the digital and the physical worlds, with a special focus on giving digital "vision" to robots and other devices, primarily through the use of radio frequency identification (RFID) tags. Ongoing work in the Reynolds lab ranges from the development of RFID-based indoor navigation systems to guide robots that might help the handicapped or elderly live independently, to an RFID localization system for The Home Depot Smart Home at Duke. He was awarded a patent in 2008 for an RFID reader system incorporating antenna orientation sensing and filed patent applications for four additional technologies. He was appointed a Visiting Scientist at the Janelia Farm Research Center, Howard Hughes Medical Institute for the 2008-2009 year, and won the best paper award at the Association for Computing Machinery Conference on Ubiquitous Computing held in Sydney, Australia in 2008.

DID YOU KNOW? Reynolds created an interactive art for the 2004 Summer Olympics held in Athens, Greece.

ROMIT ROY CHOUDHURY

Romit Roy Choudhury was named the **Nortel Networks assistant professor** in 2009. Roy Choudhury specializes in wireless networking and mobile computing. In wireless networking, he is closing the gap between the demand for wireless bandwidth and the limits of current technology. He is designing network protocols that exploit physical layer capabilities, such as smart antennas and software-defined radios. In mobile computing, Roy Choudhury's vision is to translate mobile phones into a platform for people-centric sensing and computing. As of today, mobile phones are primarily viewed as a device for personal communication. Roy Choudhury is conceiving mobile phones as densely deployed sensors, enabling new ways of perceiving the world around us. His students' research has won several awards, including the ACM Mobicom 2008 Student Research Contest, 2009 Hoffmann Krippner Award, and the 2009 Cisco Champion's Award. More information about his group's activities is available at **http://synrg.ee.duke.edu**.



DID YOU KNOW? Roy Choudhury watches movies from across the world in his spare time.

DAVID R. SMITH

David R. Smith, professor, specializes in metamaterials, transformation optics, plasmonics and general electromagnetics. Smith led a successful proposal team to secure $6.25M for a five-year Multidisciplinary University Research Initiative titled Transformational Optical Metamaterials that aims to design optical media that can achieve functionality not obtainable by conventional optics. Smith plans to explore applications such as electromagnetic cloaking, sub-diffraction limited imaging and improved solar cell efficiency through omni-directional light concentrators. The key for each of these applications is the use of metamaterials, a class of artificially structured materials that extend the electromagnetic properties of conventional materials. Collaborators include Duke's Steve Cummer and Nan Jokerst, as well as Sir John Pendry from Imperial College, London, one of the founders of the Transformation Optical approach. Other team members include faculty at Purdue University and North Carolina State University.

DANIEL SORIN

Dan Sorin, associate professor, specializes in fault-tolerant computer architecture. Through his research he has developed efficient error detection schemes for processor cores and memory systems, fault diagnosis for cores, and self-repair for both cores and memory systems. He is currently working to prototype a low-cost, self-checking and self-repairing multicore processor. Sorin's research titled "Argus: Low-Cost, Comprehensive Error Detection in Simple Cores," was selected for a special issue of *IEEE Micro: Micro's Top Picks from Computer Architecture Conferences*, Jan/Feb 2008. He secured a three-year grant from the National Science Foundation for a project titled "Verification-Award Microarchitecture," in which he plans to design microprocessors that are easier to verify with formal verification methods such as model checking. He was also awarded a U.S. patent on technology described as "self-repairing of microprocessor array structures."

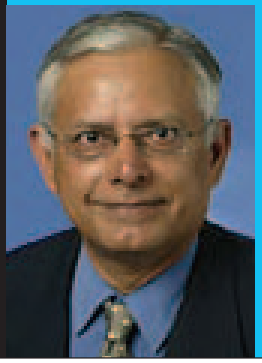
DID YOU KNOW? Dan sneaks into Cameron Indoor Stadium for a few Duke basketball games a year by playing in the Alumni Pep Band. He plays clarinet.

ADRIENNE STIFF-ROBERTS

Adrienne Stiff-Roberts, assistant professor, specializes in the design, fabrication and characterization of optoelectronic/photonic devices and multifunctional sensors featuring hybrid nanomaterials. Stiff-Roberts has been named the winner of the 2009 Institute of Electrical and Electronics Engineers (IEEE) Early Career Award in Nanotechnology and received the award at the ninth annual meeting of the IEEE Conference on Nanotechnology in Genoa, Italy. She was honored by the Nanotechnology Council for her "contributions to the development of nanoscale quantum dots for infrared detection."

KISHOR TRIVEDI

Kishor Trivedi, professor, specializes in the reliability/availability of computer and communication systems, software reliability and software rejuvenation. In 2008, Trivedi was selected for the IEEE Computer Society's Technical Achievement Award. He was noted as being the first to monitor and statistically analyze data for the validation of aging and to predict the time to exhaustion of various resources. He is further credited with publishing the first paper that presented concrete quantitative evidence of software aging in large-scale, general-purpose computer systems. Trivedi secured a two-year grant from the National Science Foundation for a project titled MiMANSaS: Metrics, Models and Analysis of Network Security and Survivability.



DID YOU KNOW? Trivedi is a member of Duke Faith Council representing Hinduism. He is also a priest who has officiated at several weddings.

REBECCA WILLETT

Rebecca Willett, assistant professor, specializes in statistical signal processing and communications with applications to medical imaging, astrophysics, bioinformatics, and networks.

Through her research, she aims to improve our ability to process very large collections of data and extract meaningful information from datasets that may be distorted, error riddled, corrupted, or partially irrelevant. Her work is used in many diverse settings, including compressive digital imaging, environmental monitoring, multiphoton microscopy and social network analysis.

GARY YBARRA

Gary Ybarra, professor of the practice, specializes in engineering education for students in grades K-12 as well as in active microwave imaging of the human breast for early detection of breast cancer. Ybarra currently leads a range of educational programs aimed at encouraging students to pursue science, technology, engineering, and mathematics careers. Programs include National Science Foundation supported MUSIC: Math Understanding through Science Integrated with Curriculum; TeachXcite: Discover Engineering; TeachEngineering; TASC: Teachers and Scientists Collaborating; and a Burroughs Wellcome Fund program titled Techtronics: Hands-on Exploration of Technology for middle-school children. He also serves as the faculty adviser for FEMMES (Females Excelling More in Math, Engineering and Science), a student organization that hosts 200 female children for a day of science and engineering activities.

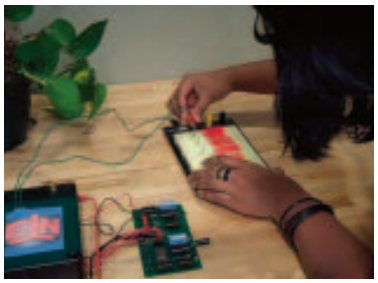
DID YOU KNOW? Gary loves his pet dogs and recreational off-road motorcycling.

TOMOYUKI YOSHIE

Tomoyuki Yoshie, assistant professor, specializes in nanophotonics. His research encompasses the theory, modeling, fabrication and characterization of nanophotonics devices, including nanolasers, single photon switches, and nonreciprocal nanophotonic devices. He recently published "Monopole woodpile photonic crystal mode for light-matter interaction and optical trapping" in the journal *Optics Express*, vol. 17, pp 1346-1451, 2009. Yoshie was awarded a $330,000 grant from the National Science Foundation for a project titled "Microlasers and Microcavities Based on Three Dimensional Photonic Crystal."

UNDERGRADUATE StudentHighlights

ECE 135, Opto-Electronic Design Project senior capstone design course, students were challenged to design, build, and operate optical sensor and sensor interface and communication circuitry to optically test the water quality of area water sources. Seniors **Vedrana Novosel '09**, **Jason Greenhut '09**, **Andrew Cook '09**, **Yuanlong Du '09**, and **Benjamin Isaacson '09** used colorimetry to measure the absorbance of colors of a solution and thus perform various water quality tests. Their design was able to measure chlorine, sulfates, and nitrates in water samples and communicate wirelessly to a computer using a Zigbee module.



ECE 51, Microelectronic Devices and Circuits, is a vertically integrated microelectronic devices, sensors, and circuits course with a real-world emphasis on project management and design. Sophomores **Nasia Haque '11** and **Nick Bottenus '11** identified the need for moisture level checking in common household and garden plants. They developed together a wireless soil moisture sensing system which probed plant moisture levels and allowed a user to remotely check that level. Their design allowed for quick access to reliable numerical water levels for several different plants at a time.

Students in **ECE 27** this year were challenged with **designing autonomous robots** that participated in the board game Clue. Working in teams of 2 – 3 students each, their robots had to maneuver on the gameboard and go through the mansion rooms to identify each suspect, weapon, and room present. Robots could not leave the gameboard at any time or be reprogrammed during play. The team of 3 robots had to collectively solve the mystery by making one, and only one, deadly accusation. Students on Team Lead Pipe show-off their robots players: Mrs. Peacock, Colonel Mustard, and Professor Plum. From left-to-right, **Stepahnie Chang '11, Kaiting Chen '11**, **Indu Manickman '11**, **Nabila Haque '11**, **Oriana Wen '11**, and **Ga-Young Joung '11**.

UNDERGRADUATE
StudentHighlights

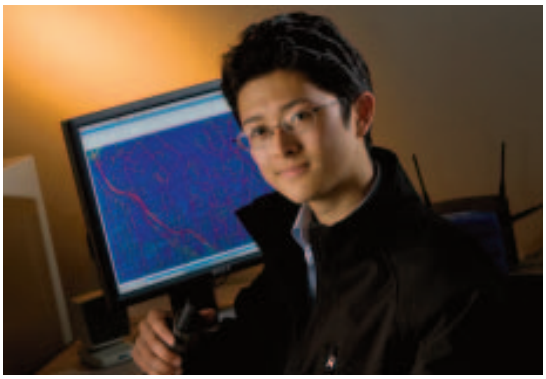
RESEARCH FELLOWS

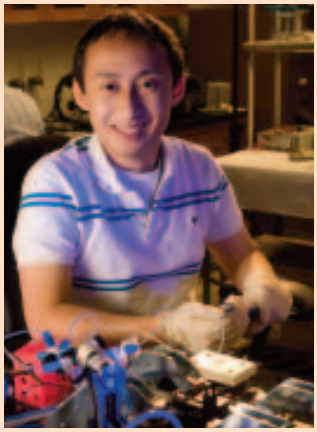
Joe Meyerowitz

Double major: electrical and computer engineering, and physics
Adviser: Romit Roy Choudhury
Project title: Creating Confusion at Crossroads: Real-time Location Privacy via Mobility Prediction

Abstract: New mobile devices are increasingly connected to GPS and other localization technologies. The tie between users and their locations provides a broad opportunity for new location-based services (LBSs). An example of an LBS is Geolife, a location-based reminder system. If a user puts "Buy Milk" on their to-do list, Geolife will remind them to buy milk if the user passes by a grocery store. The benefit of these services must be balanced with the risk to the user's privacy. By revealing accurate and frequently updated personal locations to the LBS, the user may expose undesired information to an untrusted third party service. Our work has concentrated on ways to protect the user's privacy without impeding the usefulness of various LBSs. This is achieved by predicting mobility patterns for protected users and preemptively querying LBSs at intentionally varied locations. The criss-crossing pattern of requests can be used to hide the user's actual location while simultaneously retrieving the desired location-varying data for the user.

Future plans: Joe graduated with distinction in ECE in May 2009. He has accepted Caltech's offer of admission to the Biochemistry and Molecular Biophysics graduate program, a joint program with the Division of Biology and the Division of Chemistry and Chemical Engineering. He plans to pursue research in synthetic biology. He will be funded by a National Defense Science and Engineering Graduate (NDSEG) Fellowship. Prior to starting graduate school, Joe will be a student volunteer for the Office of Science and Technology Policy (OSTP) for the Obama administration, and will be working in Washington, DC.





David Chen

Double major: electrical and computer engineering, and biomedical engineering
Project title: Light Sensitive Logic Gated DNA Nanostructures as a Drug Delivery Platform
Adviser: Chris Dwyer

Abstract: Current drug delivery methods are highly nonselective, thus causing many deleterious side effects. This can be exacerbated by drug interactions in drug cocktails. An intelligent drug delivery vector that could selectively deliver separate drugs to different areas of the body would greatly reduce side effects as well as drug interactions. Such a vector may be possible using DNA nanostructures because of the addressability, scalability, and biocompatibility properties of DNA nanostructures. While DNA is normally in a helical structure, it is possible to design a sequence such that the DNA folds into almost any shape. In this case, the DNA forms nano-scaled grids. However, the mechanism for drug selection and release is not based on DNA but rather on a system of chromophores. When the correct wavelengths of light are inputted, the drug will be released from the DNA grid. Within this context, selection of a drug can be modeled as addressing data in a computer with an output of the release of a drug. Preliminary results show that the drug is released in a manner corresponding to an OR-gate in response to the optical input.

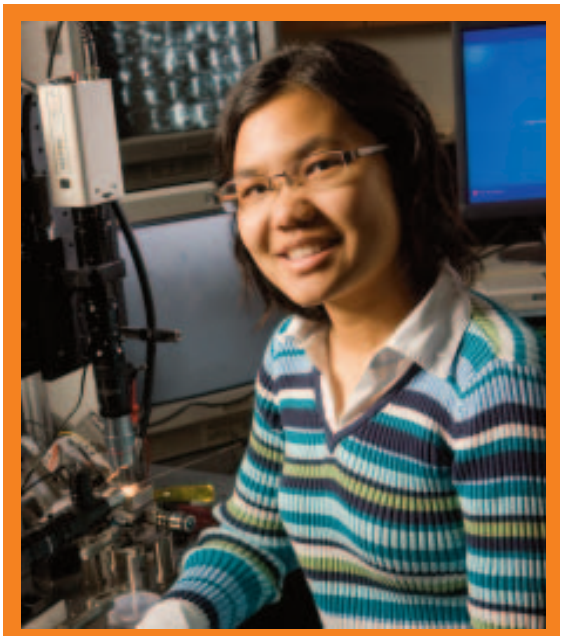
Future plans: David will be attending graduate school at Northwestern University. He graduated with a double major in biomedical engineering and electrical and computer engineering in May 2009.

Jonathan Odom

Double major: electrical and computer engineering, and computer science
Adviser: Jeffrey Krolik
Project title: Microphone Array Beamforming with Near-field Correlated Sources.

Abstract: Due to the traditionally high cost of large microphone arrays, the use of arrays for large-room audio capture has not become widespread. Generally, single microphones are placed on or near sources to amplify voices and sounds. However, arrays of many small omnidirectional microphones can now be efficiently developed and deployed. A single array could replace several wired and wireless microphones. The large wavelength of speech places most applications in the near field. Large-room applications have loudspeakers, which create correlated sources and severely limit the use of optimum beamformers. Widrow and Kailath's work on correlation assumed far-field sources (often seen in sonar and radar); therefore, most of their work cannot be directly applied to large room acoustics. A new beamforming method has been developed that incorporates near field and correlation. The ability to control the loudspeaker signal is exploited. An estimate of the transfer function for the loudspeaker is used to form a new covariance matrix. A null can be placed in the array pattern even when signals are perfectly correlated.

Future plans: Jonathan graduated with distinction in ECE in May 2009. He will attend Duke next year to pursue a M.S./Ph.D. under professor Jeff Krolik. He has been given a James B. Duke Fellowship. In May 2009, he presented a lecture on his work at the Acoustical Society of America conference in Portland, OR.



Pantana (Poy) Tor-Ngern

Double major: electrical and computer engineering and physics
Adviser: Tomoyuki Yoshie
Project title: Current-injection Two-dimensional Photonic Crystal Laser

Abstract: An electrically driven photonic crystal laser has been recently demonstrated. This breakthrough indicates the feasibility of incorporating ultrasmall lasers with semiconductor integrated optical circuits. However, this design requires complicated fabrication procedures and lacks good heat sink. In order to resolve these challenges, we propose a two-dimensional photonic crystal slab sandwiched by metal in place of the conventional free-standing (air-cladding) structure. We used Indium Tin Oxide (ITO) as the metal in the design since it has relatively low optical absorption. Our simulation results suggest that it is possible to achieve thelasing operation despite the absorptive property of ITO. Photonic band gap of (PBG) ITO-clad photonic crystal was analyzed to determine the resonant mode inside PBG and its quality factor using finite-difference time-domain technique. Fabrication process is under investigation.

Future plans: Poy graduated with distinction in ECE in May 2009. She has decided to stay at Duke for a Ph.D., studying under assistant professor Tomoyuki Yoshie, her Pratt Fellows adviser. She has a Royal Thai government scholarship. She will also be awarded the John T. Chambers Fellowship (2009-2010) in the Fitzpatrick Institute for Photonics at the Pratt School of Engineering once she has enrolled in the program.

Duke University Senior Wins **Marshall Scholarship**

Dan Roberts, a Pratt School of Engineering student involved in research that created such unconventional electromagnetic devices as an "invisibility cloak," will receive one of 40 Marshall Scholarships offered for the 2009-2010 academic year.

Roberts, a senior from Melville, NY, is the 19th Marshall Scholar from Duke.

Established in 1953 to commemorate the Marshall Plan, the scholarships are awarded each year to 40 or more "talented, independent and wide-ranging" young Americans to finance two years of graduate level studies at a college or university in the United Kingdom.

"I couldn't imagine a better research opportunity than to work in an emerging field with one of its leading investigators."

Roberts is majoring in both physics and electrical & computer engineering and minoring in mathematics. He currently conducts research in the laboratory of David R. Smith, William Bevan Professor of Electrical & Computer Engineering. Smith's lab is known for its work in transformation optics and metamaterials -- and specifically for developing the so-called invisibility cloak. (For more about the invisibility cloak, see **http://www.pratt.duke.edu/news/?id=792**.)

For the first year of the scholarship program, Roberts plans to complete a Certificate of Advanced Study in Mathematics at the University of Cambridge. During the second year, he will conduct research at Imperial College, London, with Sir John Pendry, a leader in the field of transformational optics. Pendry is also a research collaborator with David R. Smith.

"We are proud that the work of one of our students has been recognized by such a distinguished and competitive scholarship," said Tom Katsouleas, dean of Duke's Pratt School of Engineering. "It is exciting to see that Dan will be able to continue his research with one of the giants in the field."

Roberts' research is focused on the use of novel coordinate transformations to create unconventional electromagnetic devices.

"I am excited and honored to have the chance to work with Professor Pendry, who is the foremost authority of the field I study — transformational optics," Roberts said. "I couldn't imagine a better research opportunity than to work in an emerging field with one of its leading investigators."

Previously, Roberts received a Goldwater Scholarship for the current school year. This scholarship provides up to $7,500 toward annual tuition and expenses to college sophomores and juniors in the field of mathematics, science or engineering.

Departmental Awards
FOR GRADUATING SENIORS

The Charles Rowe Vail Memorial Outstanding Undergraduate Teaching Award – Kevin James Brown from Dallas, TX (Recognizes the most outstanding teaching assistant in the Department of Electrical and Computer Engineering.)

The David Randall Fuller Prize – Aneesh Ramesh Butani from Deira, Dubai, and Matthew Vincent Harte from Wyckoff, NJ (Presented to the graduating electrical engineering seniors who have shown the most improvement in academic performance over the first three years.)

The Charles Seager Memorial Award – Daniel Adam Roberts from Melville , NY(Recognizes outstanding achievement in the annual Student Prize Paper Contest of the Duke branch of the Institute of Electrical and Electronics Engineers or significant contributions to electrical engineering.)

The George Sherrerd III Memorial Award in Electrical Engineering – Daniel Adam Roberts from Melville, NY (Awarded to seniors in electrical engineering who, in the opinion of the faculty, have attained the highest level of scholastic achievement in all subjects and who have rendered significant service to the School of Engineering and the university.)

Graduation with Distinction:

Douglas William Bycoff, Tawanda Caesars Chaunzwa, Shi Gu, Joseph Toshiro Meyerowitz, Jonathan Lawrence Odom, Daniel Adam Roberts, Pantana Tor-ngern

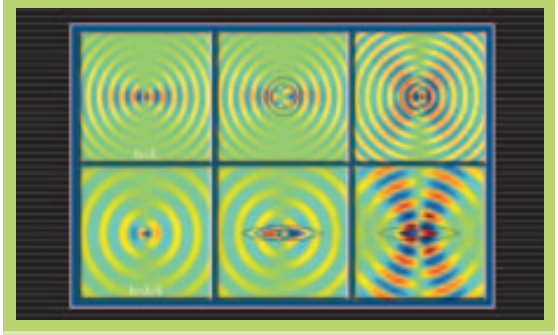
ECE Graduates

GRADUATE STUDENTS

Ashwin Wagadarikar, a doctoral student in Professor David Brady's lab, was awarded a $3,000 Scholarship in Optical Science and Engineering from SPIE, the International Society for Optics and Photonics.

ECE graduate student **Mahmut Yilmaz** won the IEEE Test Technology Technical Council's 2009 Outstanding Doctoral Thesis Award in test technology for his thesis titled "Automated Test Grading and Pattern Selection for Small-Delay Defects." In addition to receiving an honorarium, he will have an invited paper in *IEEE Design & Test of Computers*. Mahmut, who studied under Krishnendu Chakrabarty, graduated in May 2009.

Jeffery Allen, second year doctoral student, got the cover of *Applied Physics Letters* in April 2009 with a paper titled "Electromagnetic Source Transformations Using Superellipse Equations." Jeffery works with Professor David Smith and is currently conducting an internship at the Hanscom Airforce Base in Massachusetts. The paper reference is Appl. Phys. Lett. 94, 194101 (2009).



Jeff Rogers won first place and a $500 prize in the student paper competition at the IEEE OCEANS 2008 Conference in Quebec City last week for his paper, "Passive Broadband Source Localization in Shallow-water Multipath Acoustic Channels." Jeff's work beat out 60 other papers. His advisor is ECE Professor Jeff Krolik.

Tom Hand presented his paper titled "Controllable Magnetic Metamaterial Using Digitally Addressable Split-ring Resonators" at the International Union of Radio Science General Assembly that was held August 2008 in Chicago. He received first prize and an award of $1,500 in the student paper competition and an additional $1,000 for his research as one of the top five papers submitted to the URSI Commission B section.

ECE GRADUATES FOR **SEPTEMBER 2008**

Li Zhen, Ph.D.
Adviser: William Joines
Dissertation: Controlled Microwave Heating of Inhomogeneous Materials in Medical and Space Applications

Erkan Acar, Ph.D.
Adviser: Sule Ozev
Dissertation: Controlled Microwave Heating of Inhomogeneous Materials in Medical and Space Applications

Liu Yun, Ph.D.
Adviser: Kishor Trivedi
Dissertation: Survivability of Networked Systems

Nathan Kundtz, M.S.
Adviser: David R. Smith

Ruopeng Liu, M.S.
Adviser: David R. Smith

Matthew Royal, M.S.
Adviser: Nan Jokerst

Astha Vijay, M.S.
Adviser: Krishnendu Chakrabarty

Raymond Kozikowski, M.S.
Adviser: Martin Brooke

ECE GRADUATES FOR **DECEMBER 2008**

Tao Xu, Ph.D.
Adviser: Krishnendu Chakrabarty
Dissertation: Optimization Tools for the Design of Reconfigurable Digital Microfluidic Biochips

Qi An, Ph.D.
Adviser: Larry Carin
Dissertation: Bayesian Multi-Task Learning on Clustering and Classification with Non-Parametric Priors

Robert Michael Angelo, Ph.D.
Adviser: April Brown
Dissertation: Nitric Oxide in Health and Disease: Physiology, Pathophysiology, and Clinical Measurement

John Stang, Ph.D.
Adviser: William Joines
Dissertation: A 3-D Active Microwave Imaging System for Breast Cancer Screening

Iulian Pruteanu-Malinici, Ph.D.
Adviser: Larry Carin
Dissertation: Dirichlet Process Mixture Models for Text and Video Analysis

Vito Mecca, Ph.D.
Adviser: Jeff Krolik
Dissertation: MIMO Space-Time Adaptive Processing for Doppler Spread Multipath Clutter Mitigation

Kyle Bradbury, M.S.
Adviser: Leslie Collins

Cihat Eldeniz, M.S.
Adviser: Loren Nolte

Yayuan Zhang, M.S.
Adviser: Adrienne Stiff-Roberts

Sabarni Palit, M.S.
Adviser: Nan Jokerst

Yuchuan Jian, M.S.
Adviser: Tomoyuki Yoshie

ECE GRADUATES FOR **MAY 2009**

Mahmut Yilmaz, Ph.D.
Adviser: Krishnendu Chakrabarty
Dissertation: Automated Test Grading and Pattern Selection for Small-Delay Defects

Joshua Stohl, Ph.D.
Adviser: Leslie Collins
Dissertation: Investigating the Perceptual Effects of Multi-Rate Stimulation in Cochlear Implants and the Development of a Tuned Multi-Rate Sound Processing Strategy

Andrew Portnoy, Ph.D.
Adviser: David Brady
Dissertation: Coded Measurement for Imaging and Spectroscopy

Pae Wu, Ph.D.
Adviser: April Brown
Dissertation: Plasmonic Gallium Nanoparticles - Attributes and Applications

Thomas Hand, Ph.D.
Adviser: Steve Cummer
Dissertation: Design and Applications of Frequency Tunable and Reconfigurable Metamaterials

Mustafa Lokhandwala, M.S.
Adviser: Martin Brooke

Haojun Chen, M.S.
Adviser: Larry Carin

Nan Jian, M.S.
Adviser: Larry Carin

Xuhan Peng, M.S.
Adviser: Leslie Collins

Yanni Zhang, M.S.
Adviser: Leslie Collins

Feng Han, M.S.
Adviser: Steve Cummer

Zhe Chen, M.S.
Adviser: Chris Dwyer

Wei Zhong, M.S.
Adviser: Chris Dwyer

Viresh Thusu, M.S.
Adviser: Chris Dwyer

Sulochana Dhar, M.S.
Adviser: Nan Jokerst

Archana Ramamoorthy, M.S.
Adviser: Loren Nolte

Abhinav Mohan, M.S.
Adviser: Romit Roy Choudhury

Rahul Ghosh, M.S.
Adviser: Romit Roy Choudhury

Patrick Eibl, M.S.
Adviser: Gary Ybarra

Chi Zhang, M.S.
Adviser: Tomoyuki Yoshie

Samuel Drezdzon, M.S.
Adviser: Tomoyuki Yoshie

Yulin Zhang, M.S.
Adviser: Martin Brooke

Mengyuan Huang, M.S.
Adviser: Nan Jokerst

Yu-Ju Tsai, M.S.
Adviser: David R. Smith

Andrew Wang, M.S.
Adviser: Martin Brooke

Chensheng Wang, M.S.
Adviser: Adrienne Stiff-Roberts

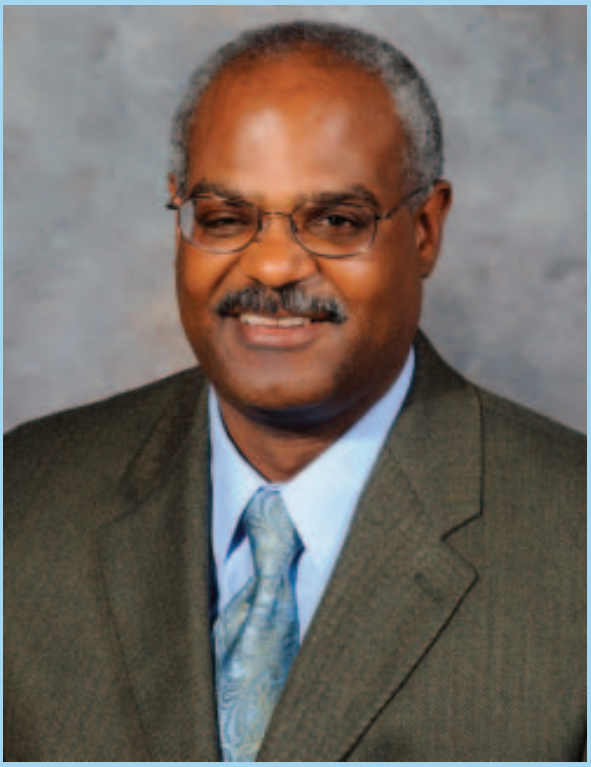
Bi Wu, M.S.
Adviser: Chris Dwyer

Kalyani Krishnamurthy, M.S.
Adviser: Rebecca Willett
Thesis: Multiscale Photon-Limited Hyperspectral Image Reconstruction

Christopher Ratto, M.S.
Adviser: Leslie Collins
Thesis: A Context-Dependent Approach to Land Mine Detection with Ground-Penetrating Radar

Jason Yu, M.S.
Adviser: Jeff Krolik
Thesis: Multiband Chirp Synthesis

AlumniNews



Alumnus wins **R&D 100 Award** for "Earthworm-like" Circuits

NASA Langley researcher Stanley Woodard (Duke engineering Ph.D. '95) and colleague Bryant Bryant Taylor of ATK Space Systems won a 2008 R&D 100 Award for a technology innovation dubbed SansEC (without electrical current).

SansEC is a single electronic component sensor with the functions of an inductor, a capacitor and a resistor. It is also also an open circuit.

The SansEC design harnesses parasitic capacitance—a common nuisance that plagues all electrical device designs, namely unwanted "parasitic" attributes of an electrical element. Instead of trying to eliminate it, Woodard and Taylor decided to explore whether they could use it to advantage by increasing it as much as possible.

In essence, they devised a sensor that acts more like an earthworm than a snake when damaged. When cut in two, and earthworm survives and becomes two worms. Woodard and Taylor's sensor does much the same. They punched holes in the sensor and it continued to work. Because it was an open circuit, there was no place on it that if punctured, it would not work. In many cases, the puncture resulted in two working circuits.

"In a certain way, the ability of the sensor to survive damage emulates the natural ability of some animals to regenerate lost limbs or appendages," Woodard said. "If you sever a sensor you end up with two separate sensors that could still be used for detecting damage. That means that in inhospitable environments – like space – you would have a device that would give you a much better chance of surviving and completing the mission at hand."

What's more, the team discovered the SansEC design can make and report more than one type of measurement simultaneously. For example, a single sensor placed on a container could at the same time monitor what is happening inside and outside the container. In addition, since this new sensor approach does not need an electrical connection to a power source or solder to connect any circuit elements, Woodard said it would theoretically be possible to employ some version of the sensor in biomedical settings, including inside the human body.

> "In a certain way, the ability of the sensor to survive damage emulates the natural ability of some animals to regenerate lost limbs or appendages."
>
> **-Woodard**

NASA began applying for patents in 2007 and expects to see the technology in use more widely within two to three years.

This new approach to electrical sensing also has welcome environmental impacts. Since there are no electrical connections to be made, manufacturing costs and wastes are minimized, Woodard said. Also, for the same reasons, the environmental "footprint" left in landfills is much smaller.

Alumnus Reibman Stalks 3D in the Living Room

Some day, people will routinely watch 3-D movies in their living rooms just as they now watch movies on their computer monitors.

Electrical engineer Amy Reibman (B.S. '83, M.S. '84, Ph.D. '87) has been involved in both of these technologies. During her 18 years at AT&T Labs – Research, she has worked to improve the quality of video transmitted over networks, just as she is now in the early stages of making 3-D television readily available.

"I've always been interested in what happens to video between the time it leaves the source to the time when it is seen by the viewer," said Reibman, a Lead Member of Technical Staff at AT&T. "As a network service provider, AT&T is quite interested in finding out how the network can improve video quality.

"When I joined AT&T, there was a lot of buzz about video over networks – video was going to be the 'killer app'," she continued. "However, it wasn't until past two or three years, with the success of YouTube, that so many people began watching video over the network. It has been interesting to watch its development, and finally see that the predictions from 18 years ago, that video over networks would be ubiquitous, has finally happened."

Amy Reibman

Her next challenge involves improving 3-D technology generally, and then figuring out a way to transmit the content to homes while maintaining the 3-D effect.

"Right now we're working on ways to make the 3-D viewing experience more comfortable," she said. "Watching 3-D movies can make some people feel dizzy or nauseous.

"However, the quality of the movies is beginning to improve. Instead of just trying to wow the audience by making things fly out of the screen, 3-D moviemakers are starting figure out that to be successful, they need to use the 3-D to draw you in and tell a better story," she said. "Today, the 3-D movies themselves are looking better. But there still are a lot of technical hurdles to overcome before we can bring the 3-D experience into the living room."

She estimates it may be 15 years before we see this technology go mainstream.

AlumniNews...continued

Duke Alumnus Fuchs Now Provost at Cornell

Kent Fuchs

Kent Fuchs' (B.S.E. '77) finds that his earlier studies in engineering and theology are serving him well in his new post as the top academic officer at an Ivy League school.

Named as Provost of Cornell University at the beginning of this year, Fuchs believes that the data-driven nature of engineering and the interpersonal skills gained while at divinity school have given him insights into the challenges faced by leaders in academia.

"In engineering, and science in general, the curriculum is very outcomes based," said Fuchs, who had served as Cornell's engineering dean for more than six years before taking on his new post. "This data-driven approach to things is moving more and more into higher education. The state of the economy has caused all of us to make informed decisions based on many different kinds of information. The ability to plan is essential."

After earning his undergraduate degree in electrical engineering at Duke, he enrolled in Trinity Evangelical Divinity School, Deerfield, Ill., with plans to become a church minister.

"While at divinity school I learned a great deal about theology and the history of religion, which enhanced what I learned in the humanities classes I took at Duke," he said. "I also learned a new set of skills in public speaking, personal relationships and counseling, all of which has proved helpful in administration."

With divinity degree in hand, he went back to pursue graduate degrees in electrical engineering at the University of Illinois. He then joined the faculty of Illinois, followed by a stint as head of the School of Electrical and Computer Engineering at Purdue University before heading to Cornell.

Fuchs has fond memories of his four years of engineering study at Duke.

"I took many courses that took advantage of the breadth of knowledge at Duke," Fuchs said. "I enjoyed the engineering, but also the many humanities classes I attended. I also gained a lot from my fellow students, and I appreciated the physical environment and beauty of the campus."

At many institutions, the position of provost is often a stepping-stone to presidency.

"Many provosts go on to be presidents, but that's not my aspiration," he said. "I made the decision that when I accepted the provost position, after the five-year term I would go back to being a faculty member."

Alumnus Huffman Part of New Breed of Non-Profit

When one thinks about working for the federal government, one often thinks of large conglomerates feeding off our tax dollars at the public trough.

However, there is actually a not-for-profit company that not only manages large programs for such federal agencies as the Department of Defense, the Federal Aviation Administration, the Internal Revenue Service, and the Departments of Veterans Affairs and Homeland Security, but does so in the public interest. And the chief technology officer and vice president of that company is a Duke graduate, Stephen D. Huffman (BSE '74, MS '76, Ph.D '78).

Founded in 1958, The MITRE Corporation has more than 7,000 employees and generates more than $1 billion in annual revenue.

Stephen D. Huffman

"MITRE is an exciting place to be the chief technology officer," said Huffman, who studied electrical and computer engineering during his eight years at Duke. "As a not-for-profit, public-interest company operating federally funded research and development centers, we have the freedom to pursue ideas that others might see as too risky. Because we don't compete, other organizations are willing to share their technology openly with us."

Huffman's expertise covers a broad spectrum of technology, including communications theory, communications networking, satellite communications, anti-jam and low-probability-of-intercept communications, large-scale software development processes, and the design and analysis of hardware and software systems.

"A large part of my role is strategic technology planning — providing the technical vision to complement MITRE's business vision," Huffman explained. "I also manage our research portfolio, which includes aligning the investment portfolio with MITRE's strategy, selecting research investments, and overseeing project execution. Through these and other activities, I try to connect MITRE to sources of technology and establish partnerships that lead to research of mutual interest."

With more than 65 percent of its workforce having advanced degrees, Huffman sees his job as creating the conditions so they can succeed.

"I help foster MITRE's innovative culture," he said. "My goal is to inspire, challenge, and enable the innovative spirit of our staff. I want to provide them with an environment for the exploration and realization of their ideas.

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