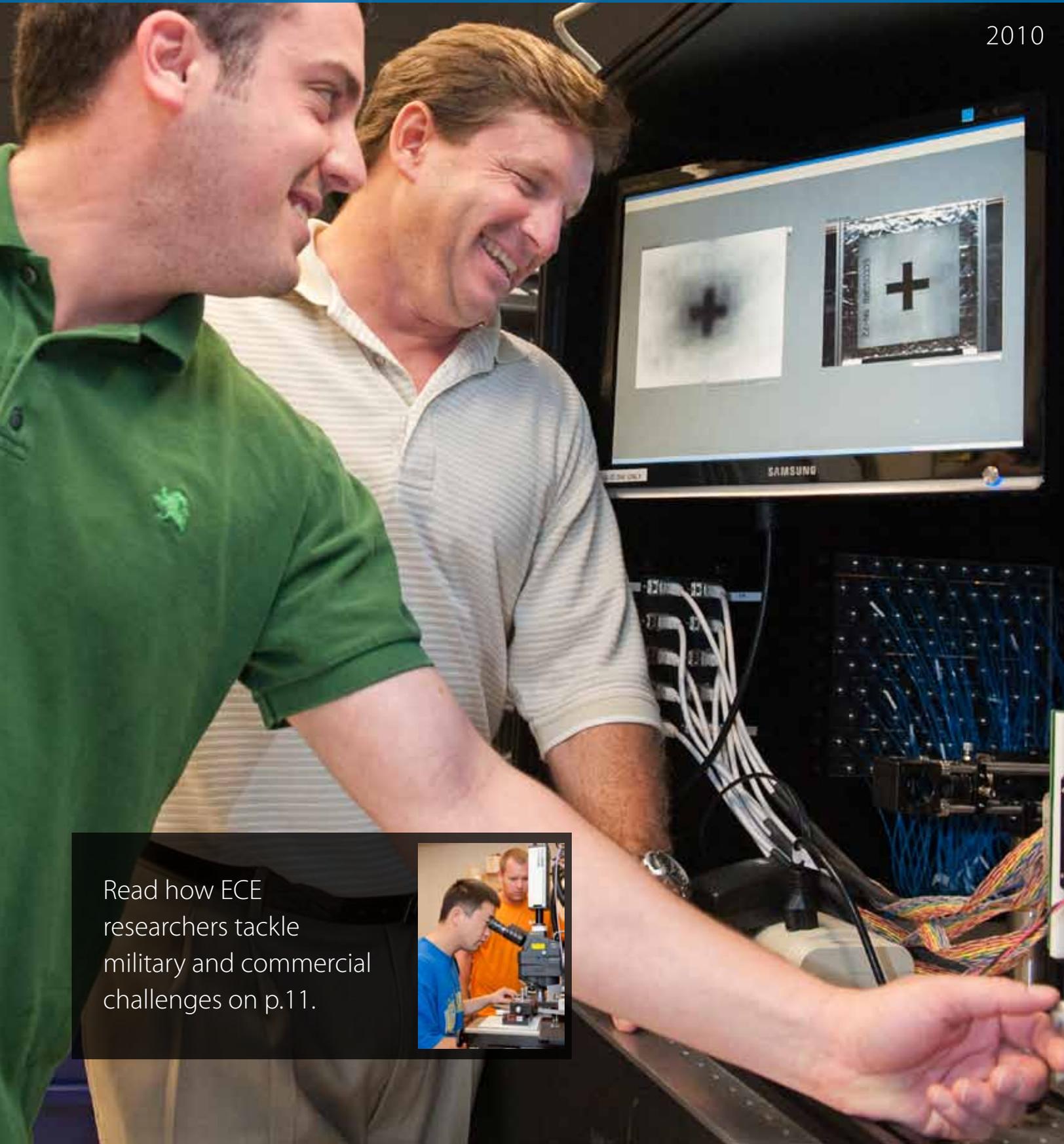


Dare to be first.



# Electrical & Computer Engineering *Highlights*

2010



Read how ECE researchers tackle military and commercial challenges on p.11.





## MESSAGE FROM THE CHAIR

KENNETH E.  
BARNER

I am glad to have the opportunity to share with you the latest news and highlights from UD's Department of Electrical and Computer Engineering. Despite the tough economic times challenging many universities, UD's ECE department continues to move confidently forward. The department is on track to grow our current population of 27 faculty and approximately 250 undergraduate and 150 graduate students by nearly 50 percent over the next five to seven years. Research activities and expenditures, currently \$10M annually, are on a similar growth path.

Professor Mark Mirotznik is symbolic of that growth. Mark came to UD from Catholic University, bringing with him a well-established laboratory and research record in computational electromagnetics and optics, nano- and micro-scale photonic devices, bioelectromagnetics, and biomedical instrumentation. Mark is also a leader in our rapidly expanding research and educational collaborations with the Army at Aberdeen Proving Ground. Also joining the Department recently are Professors Steiner, Yang, and Winbadh—see their profiles on the following pages.

ECE will benefit from UD's recent purchase of the former Chrysler site, which will add 273 acres to the UD campus, and from the current construction of the Interdisciplinary Science and Engineering Laboratory (ISE-Lab), which will house core clean room facilities, multidisciplinary laboratories, and energy-related research efforts.

The following pages highlight additional recent achievements by our students, faculty, and programs. I am extremely proud of these accomplishments, and I am confident that ever greater achievements will be realized as UD ECE continues to grow and be a field leader.

I thank our alumni, faculty, staff, and friends for your generosity which enables us to recruit outstanding faculty, enhance student activity, support research, fund graduate students and provide much needed scholarships to our students. Your gifts help us meet objectives vital to instruction and the mission of our department. Your continued commitment to the department allows us to create and sustain a stimulating environment of intellectual curiosity and discovery. As always, we are happy to hear from you with your ideas to further UD ECE accomplishments. Please don't hesitate to email, call or drop me a note at [barner@udel.edu](mailto:barner@udel.edu). To stay connected with the department, visit our website at [www.ece.udel.edu](http://www.ece.udel.edu) or join our online community at [www.udconnection.com](http://www.udconnection.com).

A handwritten signature in yellow ink that reads "Kenneth E. Barner". The signature is fluid and cursive, written in a professional style.

Kenneth E. Barner, PhD  
Professor and Chair  
Electrical and Computer Engineering

## In this issue...

Be sure to *like* the  
*University of Delaware Electrical  
and Computer Engineering  
Department* Facebook page!

WE'RE ON  
**facebook**

4	News
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19	Students
23	Alumni

- Content Direction: Kenneth Barner
- Graphic Design: Sarah Rosenthal, Carrie Qualls
- Photography: Ambre Alexander, Kathy Atkinson, Doug Baker, Jon Cox, Tyler Jacobson, Evan Krape, Kevin Quinlan
- Printing: University Printing



Construction has begun on the new interdisciplinary science and engineering building, known as the "ISE Lab." The 194,000 ft.<sup>2</sup> building will provide classroom space for our growing number of students as well as house core clean room facilities, multidisciplinary laboratories, and energy related research efforts.

Looking for an old friend? Want to share your latest news? Searching for information on upcoming alumni events such as Homecoming? Now you can do it all in one place, [www.UDconnection.com](http://www.UDconnection.com). UD and the UD Alumni Association (UDAA) have collaborated to bring alumni a vibrant online community—so register and get active! The online community allows you to search the alumni directory, post class notes, update your contact information, and see if there are any upcoming alumni events in your area. You can also take advantage of networking opportunities and volunteer opportunities to get involved with your alma mater! Visit [www.UDconnection.com](http://www.UDconnection.com) today!

SAVE THE  
DATE!

**Monday, October 18, 2010**

Engineering Alumni Association  
Annual Golf Outing

**Saturday, November 6, 2010**

Homecoming

**Saturday, June 3–6, 2011**

Alumni Weekend (*pictured*)

## UD Hosts International Computing Language Conference

The 22nd International Workshop on Languages and Compilers for Parallel Computing was held at UD from October 8-10, 2009.

Attended by some 75 researchers and practitioners, the event was hosted by the departments of Electrical & Computer Engineering (ECE) and Computer & Information Sciences (CIS).

The conference was co-chaired by professors **GUANG GAO** (ECE) and Lori Pollack (CIS), together with assistant professors John Cavazos (CIS) and **XIAOMING LI** (ECE) as the organizers. Representatives of seven countries—Canada, France, Japan, Spain, Taiwan, the U.K., and the U.S.—served on the program committee.

Held since 1988, the annual workshop covers all aspects of languages, compiler techniques, run-time environments, and compiler-related performance evaluation for parallel and high-performance computing. This year's program offered a variety of presentations, including keynote addresses, short and full-length papers, and tutorials.



## 2009–2010 Distinguished Lecture Series

The 2009–2010 ECE Distinguished Lecture series included talks by four nationally recognized speakers on a variety of topics.



**"The Technical and Political Evolution of the Internet—A Personal Perspective"**

David Farber, Distinguished Career Professor of Computer Science and Public Policy at Carnegie Mellon University



**"Information Theory Today "**

Sergio Verdu, Eugene Higgins Professor of Electrical Engineering at Princeton University



**"Prospects for Superconducting Quantum Computers"**

David DiVincenzo, Research Staff Member in the Physical Sciences Department at the IBM T. J. Watson Research Center



**"US Utility Sector—Turmoil and Transition"**

James Miller, chairman, president and chief executive officer of PPL Corporation

UNIVERSITY OF DELAWARE

# Electrical & Computer Engineering

## 2010–2011 Distinguished Lecture Series

Co-Sponsored by the Delaware Bay IEEE



Wednesday October 27, 2010

**JOSEPH BORDOGNA**

University of Pennsylvania

“Life at the Edge—Embracing Cacophony,  
Enabling Symphony”



Wednesday December 1, 2010

**STEPHEN CHOU**

Princeton University

“Nanostructure Engineering—  
A Path to Discovery, Innovation  
and Commercialization”



Wednesday February 16, 2011

**FEDERICO CAPASSO**

Harvard University

“Sub-wavelength Photonics: From Light  
Manipulation to Quantum Levitation at  
the Nanoscale”



Wednesday May 4, 2011

**RICHARD BARANIUK**

Rice University

"Compressive Sensing"



Wednesday March 23, 2011

**DAVID CARLSON**

BP Solar

"Photovoltaics and Its Potential Impact on  
Climate Change"

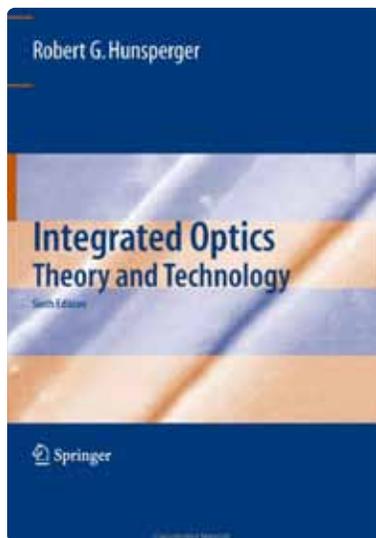
***All talks begin at 3pm with reception to follow.  
Please check website for room location.***

Electrical & Computer Engineering  
140 Evans Hall  
Newark, DE 19716-3130

**[www.ece.udel.edu](http://www.ece.udel.edu)**  
P: 302-831-2405  
E: [info@ece.udel.edu](mailto:info@ece.udel.edu)

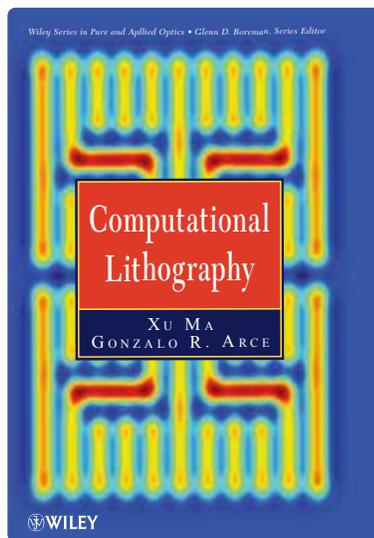
# Published

UD ECE faculty members regularly publish books in their areas of research and instruction. Books include long-established references in the field, such as *Integrated Optics, Theory and Technology*, now in its sixth edition, as well as books in emerging fields, such as *Computational Lithography* and *Photonic Crystals*.



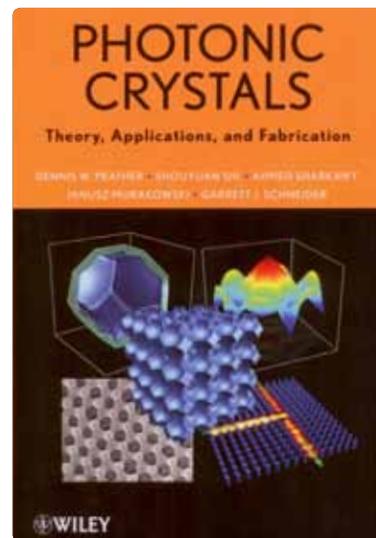
## Integrated Optics Theory and Technology

**ROBERT HUNSPERGER** has recently produced the sixth edition of his book, *Integrated Optics: Theory and Technology*. This book, published by Springer-Verlag, first appeared in April 1982. Over the years it has been regularly updated in new English editions and has been translated into Chinese, Russian and Ukrainian editions as well.



## Computational Lithography

**GONZALO ARCE** and his former PhD student Xu Ma, have published the first book in the area of *Computational Lithography* (Wiley & Sons, 2010). *Computational lithography* exploits the rich mathematical theory and practice of inverse problems, mathematical optimization, and computational imaging to develop optimization-based resolution enhancement techniques for optical lithography. As such, this book provides mask design tools for the semiconductor industry that can aid in keeping pace with Moore's law.



## Photonic Crystals Theory, Applications, and Fabrication

**DENNIS PRATHER**, Ahmed Sharkawy, Shouyuan Shi, Janusz Murakowski, Garrett Schneider have published this book that presents in detail the fundamental theoretical background necessary to understand the unique optical phenomena arising from the crystalline nature of photonic-crystal structures and their application across a range of disciplines. The book is organized to take readers from basic concepts to more advanced topics.

# New Faculty



## MARK MIROTZNIK

*Associate Professor*  
Electrical & Computer Engineering

*Ph.D. '92*  
University of Pennsylvania

Mirotznik's research is in the general area of applied electromagnetics and optics with a special emphasis towards electromagnetic design and characterization of materials. His current interest is focused on the development of new multifunctional materials that combine attractive electromagnetic, mechanical and thermal properties. His group applies modern theoretical, computational and experimental methods to design, fabricate and characterize artificial electromagnetic materials from 2 to 110 GHz. Practical applications of this work include the development of new multifunctional structural composites for use in future military and commercial platforms. Mark's interests also include radiofrequency, microwave and optical instrumentation design for a variety of biomedical applications.



## KARL STEINER

*Senior Associate Provost for  
Research Development*

*Professor*  
Electrical & Computer Engineering

*Ph.D. '95*  
University of Kaiserslautern

Image enhancement and visualization methodologies are the predominant focus of Steiner's research. His current research interests centers on interactive immersive visualization methodologies for the life sciences, primarily in complex multi-variant data analysis and in biomedical imaging with a focus on virtual surgery simulations. His early research focused on nondestructive evaluation and image analysis of engineered structures, such as aircraft wings, automotive panels, bridge structures, and hip implants.



## KRISTINA WINBLADH

*Assistant Professor*  
Electrical & Computer Engineering

*Ph.D. '10*  
University of California, Irvine

Winbladh's primary research centers on software engineering, with a focus on requirements engineering. The overall goal of her research is to increase stakeholder participation in early software engineering activities and thereby improve the quality of the final product. Kristina's interests also include exploring ways to leverage software requirements in other software engineering activities such as design and testing.



## CHENGMO YANG

*Assistant Professor*  
Electrical & Computer Engineering

*Ph.D. '10*  
UC San Diego

In the face of the increasing levels of execution uncertainty in future computer systems, Yang's work focuses on defining a reliable multicore architecture with fine-grained, yet predictable, adaptivity support to advance semiconductor technology. Among her interests are execution adaptivity and reliability enhancement in multicore systems, power- and thermal-aware system design, efficient on-chip communication and synchronization schemes, as well as compiler-directed optimizations of embedded processors.

## Li receives NSF Career Award

**XIAOMING LI**, assistant ECE professor, is the recipient of a prestigious Faculty Early Career Development Award from the National Science Foundation (NSF).

The award, which is highly competitive, is bestowed on those scientists deemed most likely to become the academic leaders of the 21st century. Fewer than 20 percent of the proposals submitted to the annual competition are funded, according to NSF.

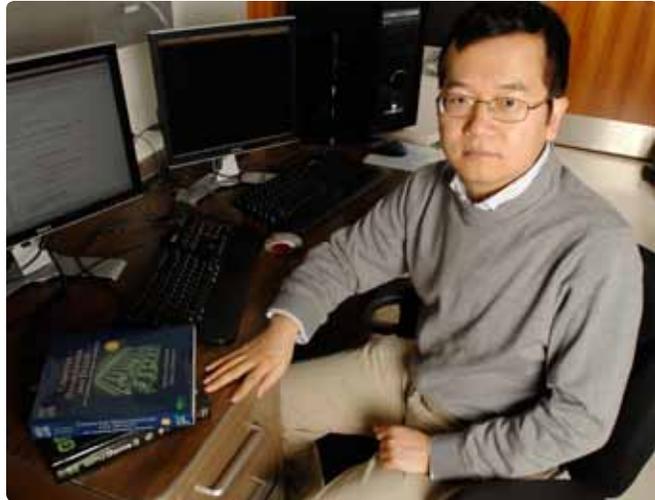
The five-year, \$399,999 grant will support Li's research and education program in the optimization of code for high-performance computing platforms.

"I am quite excited about this research and very happy to receive this award so I can pursue my vision," Li said.

The NSF project is designed to provide a new generation of compiler optimization technology to meet the needs of users of high-performance computing platforms, Li said, as the field has evolved from single core processors to multi-core processors and graphics processing units (GPUs).

Li said that new general high-performance computing platforms simultaneously run multiple programs and a large number of threads, which presents unprecedented challenges for code optimization. The programs face extensive competition for available resources and are being executed in an ever-changing environment.

The project will employ a systematic approach to optimization and adaptation through a system of context-aware and context-adaptive optimization, or CACAO. Li is developing tools to analyze programs, determine what computing resources are available, predict how the program will run in changing environments and extend existing technologies.



The bottom line, Li said, is to devise a framework to make it possible for programs to run faster.

The project is expected to provide new code optimization techniques that accelerate programs in high-performance computers, Li said, and those techniques and resources will be disseminated as open-source software tools and packages.

Li said the project would lead to more effective compilation and code generation in all domains, thus bringing broad benefits to computer users in general and to those who require high computation power in particular.

He said the need for computational power is vital to a variety of disciplines in the sciences and engineering.

Li joined the UD faculty in 2006 after receiving his doctorate from the University of Illinois at Urbana-Champaign. He said the NSF project is a "very ambitious next step" after his doctoral work. Li received bachelor's and master's degrees in computer science and technology from Nanjing University, China.

## ECE Collaborates with Army on Research and Education

ECE's relationship with the U.S. Army at nearby Aberdeen Proving Ground (APG) encompasses a broad range of activities from graduate education and research to senior projects and lab tours.

"We're working to match the Army's core interests and technologies with our strengths as we develop professional and graduate education programs for their employees," says associate professor **MARK MIROTZNIK**. "Our plan is to supplement our on-campus and distance learning offerings with a number of courses taught each semester at their site to make it convenient for APG employees to continue their education."

"Our hope is that we'll engage APG employees with ECE faculty through these graduate programs," he adds. "We even plan to offer a part-time Ph.D. option, which should strengthen the collaboration in terms of not only education but also research."

A Cooperative Research and Development Agreement (CRADA) signed with CERDEC (Communications-Electronics Research, Development, and Engineering Center) in 2008 opened the door for a variety of collaborative research programs.

"We have statements of work ongoing in two areas, simulation and information assurance," says professor **DAVE SINCOSKIE**, Director of UD's Center for Information and Communication Sciences (CICS), "and we're in the process of drawing up SOWs in mobile networking and electronic warfare."

Additional interactions include student internships and funding for senior projects.

"CERDEC provided us with not only money to provide parts but also a list of real problems for our students to solve," Sincoskie says. "The projects have turned out to be a real eye-opener for our students. The thing we've learned is that one semester isn't enough to create a design, order parts, and complete the projects, so we plan to extend the project to an entire year in a capstone type of course."

ECE students have also had the opportunity to visit Army labs for educational tours. For example C4ISR (Command, Control,

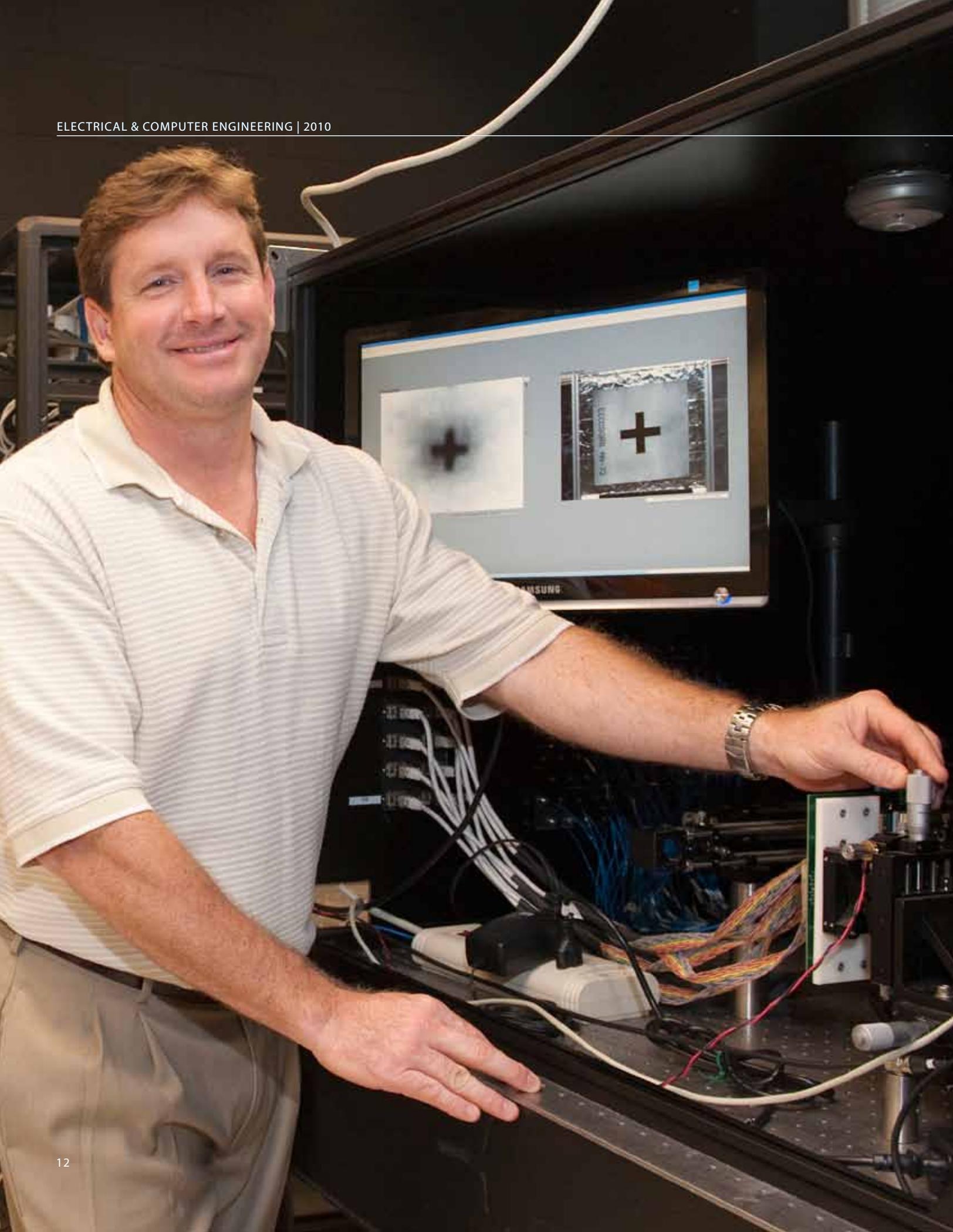
Communications, Computers, Intelligence, Surveillance, Reconnaissance) at Ft. Dix recently held a networking and control demonstration for a group of UD students.

The relationships are expected to grow rapidly in the coming months with Base Realignment and Closure (BRAC) bringing thousands of additional Army employees to APG.

"CERDEC is a huge electrical engineering and computer science organization," says Sincoskie. "It's like having a major industry move into the area. With 2,000 scientists and engineers and another 5,000 contractors, we expect it to dramatically change the character of the University and the surrounding area."



UD and the U.S. Army Research, Development and Engineering Command (RDECOM) signed a Cooperative Research and Development Agreement (CRADA) on Jan. 26, creating a powerful research partnership between UD's Category 1 research capabilities and Aberdeen Proving Ground (APG) in Maryland. The CRADA was signed by UD President Patrick Harker and Maj. Gen. Nickolas Justice, commanding general of RDECOM and installation commander of APG, during a ceremony at UD's Newark campus.



# ECE researchers tackle military and commercial challenges

Students and postdoctoral researchers in the Department of Electrical and Computer Engineering, through a grant from the U.S. Air Force Office of Scientific Research, are using state-of-the-art tools, as well as the department's \$20-million, 8500-square-foot Nanofabrication Facility, to design, simulate and analyze nanophotonic devices for application in both military and commercial sectors.

The research group, led by **DENNIS PRATHER**, College of Engineering Alumni Distinguished Professor, is well-known for their involvement in theoretical and experimental aspects of nanoelectronics, electromagnetics and photonics. Prather, also a Commander in the U.S. Navy Reserve, is appointed as the United States representative to the NATO Technical Group for High-Performance Millimeter Wave Imaging.

"Everyone wants smaller, lighter systems that consume less power," says Prather, whose academic and military background contributes to a focused research program on pressing military challenges. "Given the impact of system size, weight, and power, known as SWaP, on military platforms, it is imperative to develop new technologies that ultimately allow us to do much more, with much less," he says.

The group's research impacts three main areas:

## 1: CREATING ADAPTIVE, INTELLIGENT DEVICES

Silicon nanomembranes are thin layers of electronic material that can be integrated with other devices and materials in multiple dimensions. Because silicon nanomembrane-based electronics are thinner and more flexible, they benefit various applications, including high-performance computing, communication and sensing systems.

"We will soon expand our research into materials other than silicon-based systems, which will facilitate hybrid integration," explains research associate Ahmed Sharkawy, who has worked on the project for the past year and a half.

A new project from the Air Force to integrate electro-optic polymers with silicon nanomembranes will enable the group to develop adaptive intelligent photonics and electronics devices and systems that are flexible, deformable, and conformable – key attributes for next-generation telecommunications, avionics, and medical systems, Sharkawy says.

## 2: HELPING PILOTS SEE CLEARLY

Prather's research group is also developing ultra-high-frequency optical modulators used to encode electromagnetic waves up to 130GHz in frequency on laser beams. These modulators are an intrinsic component of a millimeter-wave imaging system that is being designed to help pilots "see through" obscurants, primarily thick clouds of dust, or brownout conditions. Other applications include wireless communications, all weather remote sensing, atmospheric radiometry, and monitoring of forest fires and active volcanoes.

## 3: GOING ORGANIC

Integrating organic materials with silicon photonics is the newest venture for this accomplished research group. Silicon, historically an electronic material, is difficult to integrate with photonic materials, but silicon nanomembranes coupled with organic materials can help overcome those hurdles.

According to Prather, by integrating crystalline semiconductor nanomembranes that are transferred and stacked with organic materials, one can incorporate the best of both worlds. In particular, they offer unique opportunities for making the next generation of electronics for high-performance computer systems.

"These are pressing applications that need solutions now," says Prather. "We are fortunate to have the infrastructure at UD to allow us to demonstrate viable solutions that truly make a difference.

## UD Teams with Jefferson to Win Defense Grant for Imaging System

A collaboration of Thomas Jefferson University (TJU) and UD, funded by an \$849,000 grant from the U.S. Department of Defense, will take surgery simulation to the next level, enabling surgeons to interact with an organ in 3-D, aiding the planning and preparation for difficult surgeries.

Two faculty members in UD ECE are part of the team that won the award from the U.S. Army's Telemedicine & Advanced Technology Research Center (TATRC).

The UD team includes **KENNETH BARNER**, ECE professor and chairperson; **KARL STEINER**, ECE professor and senior associate provost for research development; and **RUI HU**, a doctoral candidate in electrical engineering.

Biochemist Eric Wickstrom at TJU is serving as the principal investigator on the project, which also includes TJU team members radiologist Matthew Thakur, surgeon John Kairys, medical educator Martha Ankeny, computer specialist Devakumar Devadhas, synthetic chemist Chang-Po Chen, and biochemistry doctoral candidate Yuan-Yuan Jin.

Under the UD component, Barner and Steiner will build upon their earlier research in 3-D virtual surgery simulation and work with their medical colleagues at TJU to UD teams with Jefferson to win Defense 26 create the next generation of a "touch" or haptics-based virtual surgery simulator.

While radiologic images give surgeons a visual representation of what they may encounter at the time of exploration, current imaging systems do not provide genetic information or tactile information about the tissues that will be encountered during surgery, nor do they allow physical interaction with the image.

"Haptics provides tactile, or touch, feedback to the user via a small robot that is integrated with the visual simulation on the screen," Steiner explains. "As the user moves the robot, a simulated object, such as a scalpel or other surgical instrument, moves within the 3-D environment, which includes simulations of various organs in the human body."



The organ simulations have been generated through a process called segmentation, where data taken from anatomical CT scans and molecular or genetic PET scans are digitally processed slice-by-slice to extract the outlines of individual organs in a patient.

Once the internal structure of the body has been segmented, that data is processed and the organs are integrated with a volumetric simulation that represents the physical properties — for example, healthy tissue or diseased tissue in a lung or pancreas. Next, the biochemical activity inside cancer cells is fused with the anatomical image. The haptics interface then allows manipulation of the surgical instrument, and, as the instrument touches one of the simulated organs, the deformation of the organ is



Members of the TJU-UD research team view a 3-D surgical simulation. From left, UD Profs. Karl Steiner and Kenneth Barner, TJU principal investigator Eric Wickstrom, UD doctoral candidate Rui Hu, and TJU surgeons Mathew Thakur and John Kairys.

calculated and visualized. Information is provided to the haptic robot that produces the force-feedback touch interaction. Tumor texture will be represented as firmer than normal, healthy pancreas.

“This environment is the basis for our new collaboration with TJU,” says Steiner, “where we will now focus on a set of data from CT and PET scans provided by TJU. We will merge these datasets to provide a scene with state-of-the-art information about the disease state of the organ.”

The project is yet another link among research groups at UD and TJU. The research benefits from and contributes to the growing collaboration under the Delaware Health Sciences Alliance.

“The unique aspect of this project,” Barner says, “is that it enables us to build on our prior results for deformable objects in surgery simulation by partnering with researchers at Jefferson. Our aim is not only to take surgery simulation to the next level, including the realistic interaction of multiple surgical tools and organs, but also to incorporate information from multiple imaging modalities to provide doctors with a comprehensive environment from which surgeries can be practiced and planned.

“The project is also a great opportunity for our graduate students,” Barner adds, “as engineers will find it increasingly important to work with professionals from other fields as technology becomes more complex and as its applications broaden.”

## Buma Wins NSF Career Award

**TAKASHI BUMA**, assistant ECE professor, is the recipient of a prestigious Faculty Early Career Development Award from the National Science Foundation (NSF) for his leading-edge work in bioengineering.

The award, which is highly competitive, is bestowed on those scientists deemed most likely to become the academic leaders of the 21st century. Five UD assistant professors have received the honor so far in 2008, and three are from ECE.

“The NSF Career Award was a very, very pleasant surprise,” Buma said. “I am quite humbled, in fact. This has been an amazing year for the University of Delaware, and for our department.”

The five-year, \$399,999 grant will support Buma’s research and education program on ultrasound biomicroscopy, a high-resolution imaging technique with potential biomedical applications in dermatology and ophthalmology.

Buma said that ultrasound biomicroscopy produces exquisite images of tissue microstructure but has failed to make the leap to widespread clinical use. A major technical obstacle has been the lack of suitable sensor arrays operating at high ultrasonic frequencies.

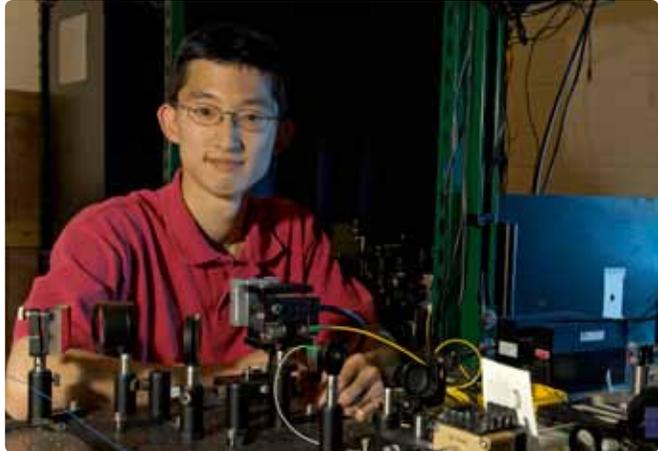
“To be able to image smaller features requires ultrasound wavelengths that are smaller,” Buma said. “That in turn requires smaller ultrasound transmitters and receiver arrays.”

Buma said conventional engineering methods have not been successful in developing miniaturized arrays. His research is in optoacoustic technology, which he said could potentially revolutionize the imaging performance of ultrasound biomicroscopy systems.

Optoacoustics involves the use of light to detect ultrasound. “The wavelength of light is so small, you can focus to a very small spot,” Buma said. “If you can detect ultrasound from that small spot, you can exploit the high resolution properties of light to create an array.”

Optical techniques for ultrasound detection can produce broadband, large aperture and highly populated sensor arrays unattainable with conventional ultrasound technology, he said.

Buma’s goals are to develop optoacoustic sensor arrays for high-speed data acquisition and to develop optoacoustic-based array scanners for real-time imaging. Ultimately, he said the future of ultrasound biomicroscopy would provide for three-dimensional visualization.



**TAKASHI BUMA**

A five-year, \$399,999 NSF Career Award will support Takashi Buma’s research and education program on ultrasound biomicroscopy, a high-resolution imaging technique with potential biomedical applications in dermatology and ophthalmology.

Buma said development of optoacoustic sensor arrays would fill a void in medical imaging. Optical microscopy can image the skin’s surface, while conventional ultrasound can image deeper into the body, the latter familiar to anyone who has been expecting a baby. The new arrays would provide high-resolution images within about 5 millimeters of the skin surface.

Clinical applications include dermatology, where it could be used to detect skin diseases and cancers, and ophthalmology, where it could be used to determine the health of the cornea and particularly the iris. Ultrasound biomicroscopy also can be used in imaging small animals, such as laboratory mice, for developmental biology research.

In addition to research, NSF Career Awards have strong education and outreach components and Buma said he plans to include graduate, undergraduate and even high school students in the work. He teaches a medical imaging course and hopes to develop distance learning and distance laboratory components to broaden instruction in the principles of bioimaging.

Buma received a bachelor’s degree in electrical engineering and a certificate in engineering physics from Princeton University and a master’s degree in electrical engineering and doctorate in applied physics from the University of Michigan, where he was a postdoctoral research fellow at the Center for Ultrafast Optical Science. He joined the UD faculty in 2005.

## UD Start-Up Company Leverages Decades of Research on Parallel Computing

ET International (ETI), a computer technology and software company founded by **GUANG GAO**, Distinguished ECE Professor, was recently awarded a \$15 million contract from the Department of Defense to deploy the company's software for a variety of core technologies.

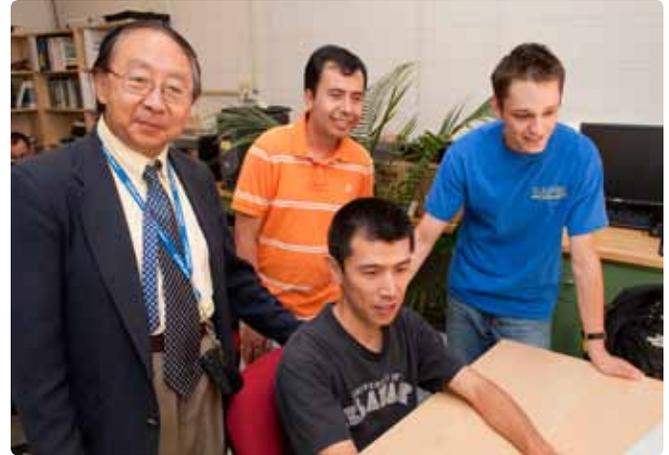
Based in Newark, Del., ETI specializes in developing and deploying system software solutions and tools for advanced computing architectures and platforms based on new multi-core chip technology. The company's technology can be optimized and adapted to a variety of domains, including finance, space exploration, and embedded systems such as hand-held devices.

The contract is just the latest chapter in ETI's success story. While the company has been in business for only 10 years, its intellectual property leverages decades of research on parallel computer architectures and software technology.

Last year, ETI was part of a team that was awarded \$16 million from the Defense Advanced Research Projects Agency (DARPA) to develop a set of tools that can improve the performance of virtually any application running on a microprocessor.

"ETI is an excellent example of the impact that engineering research conducted at the University of Delaware can have in the commercial and government sectors," says Michael Chajes, dean of the UD College of Engineering. "These two grants, one for research and one for technology deployment, demonstrate ETI's success in taking an idea from the laboratory to practical applications."

According to David Weir, director of UD's Office of Economic Innovation and Partnerships, ETI is the second start-up company in which the University has taken a small equity position. The other is PAIR Technologies LLC, which is preparing to commercialize a high-precision detector that can rapidly identify low levels of biological and chemical agents in solids, liquids, and gases.



### ET INTERNATIONAL

Guang Gao, left, leads a meeting at ET International.

"ETI's success supports the strategy of creating high-quality jobs in the state through the establishment of high-tech start-ups," says Weir. "Based on national economic development data, each high-tech professional job supports at least three additional jobs in the local economy."

ETI now employs more than 30 people, some from as far away as Europe, Asia, and the west coast of the United States. Since 2005, the company has been awarded more than \$26 million in funding.

In 2007, ETI was one of only five companies selected to demonstrate its disruptive technology at Supercomputing 2007, the International Conference for High-Performance Computing, Networking, Storage, and Analysis.

"As the world continues to move toward a knowledge-based economy," says Gao, who serves as president of ETI, "it is crucial that the state of Delaware not only embrace the new economic model but also actively incubate the high-tech initiatives that have the greatest local economic impact."

"To this end, ETI is interested in applying high-performance computing technology to improve energy efficiency, financial security, and other aspects of the economy that have a direct impact on the well-being of humanity."

More than a third of ETI's employees hold degrees from UD, and the company proactively recruits University graduates for employment and internships.



## Arce named first Fulbright-Nokia Distinguished Chair

**GONZALO ARCE**, Charles Black Evans ECE Professor, has been selected as the first recipient of the Fulbright-Nokia Distinguished Chair in Information and Communications Technologies.

Funded by the Nokia Foundation and the Finnish Fulbright Commission, the position offers one American scholar each year a unique opportunity to collaborate with a higher education institution in Finland. The award includes a monthly stipend, a travel allowance, housing, and administrative and academic support for the scholar.

“The Fulbright Distinguished Chair position is viewed as among the most prestigious appointments in the Fulbright Scholar Program,” says Kenneth Barner, ECE chairperson. “We are very honored to have one of our faculty members be the first recipient of the Fulbright-Nokia position.”

Arce will spend the six months from June to December 2010 in Helsinki and Stockholm developing collaborative research with Nokia Research Centers and the Helsinki University of Technology.

His research will focus on exploring new frontiers of compressive sensing in communications and imaging. Compressive sensing allows the accurate recovery of signals and images from far fewer data measurement

than required by traditional methods. The technology has potential impacts in a broad array of applications from microscopy and medical imaging to communications and consumer electronics.

“Underlying this methodology is a protocol for sensing and compressing data simultaneously,” Arce says. “Following this protocol would bypass the current wasteful acquisition process in which massive amounts of data are collected, only to be in large part discarded at the compression stage, which is necessary for storage and transmission purposes. In the compressed sensing paradigm, one could translate analog data into already compressed digital form, obtaining super-resolved signals from just a few sensors.”

According to Arce, Finland and Nokia are world-class leaders in these technologies, so the work is ideally suited for the program. He will be hosted by Prof. Visa Koivunen, the Academy of Finland Distinguished Professor and director of the Signal Processing Laboratory at the Helsinki University of Technology (HUT). “HUT, which is close to Nokia’s research center and other high-technology hubs, will provide an ideal collaborative environment for the project,” Arce says.

The collaboration will include researchers at several centers of excellence across Finland, including the Center of Excellence in Signal Processing at the Tampere University of Technology and the Finnish Center of Excellence in Inverse Problems, co-led by HUT and several other universities.

Arce’s project will include not only research but also a set of short courses on compressive sensing theory and applications to disseminate knowledge in this emerging field to the broad scientific and engineering community.

The Fulbright-Nokia research project will leverage funding from the National Science Foundation and several other U.S. government funding agencies to further develop the theory and applications of compressive sensing. The U.S. partner for the Fulbright-Nokia Distinguished Chairs Program is the Council for International Exchange of Scholars.

“Gonzalo has already led the establishment of strategic global partnerships by forming alliances with internationally renowned universities around the world, including a partnership with a consortium of universities in Colombia,” says Michael Chajes, dean of UD’s College of Engineering. “The Fulbright-Nokia Distinguished Chairs Program will provide him with unique opportunities to explore collaborative research and education relationships on information technologies with academic institutions in Finland.”

## Electrical engineering students take Colburn Prize two years in a row

**XU MA** and **CHARAN MASARAPU** have set the bar high for electrical engineering students by winning the coveted Allen P. Colburn Prize two years in a row. The prize, given annually at UD, recognizes the best dissertation in engineering and mathematical sciences.

Xu Ma, who completed his doctorate in electrical engineering and computer engineering, won in 2010 for his dissertation, "Optimization of Resolution Enhancement Techniques in Optical Lithography." Ma was advised by **GONZALO ARCE**, the Charles Black Evans Professor of Electrical Engineering. The dissertation results have been extended and published as a book, Computational Lithography, which is coauthored by Ma and Arce and published by Wiley & Sons. Ma is currently a postdoctoral researcher in the Video and Image Processing Laboratory at the University of California, Berkeley.

Ma is the fourth student advised by Arce to win the Colburn Prize in the past 18 years. Yinbo Li was selected in 2006, Juan Gonzalez in 2002, and Kenneth Barner in 1992.

Charan Masarapu received the 2009 Colburn Prize for his dissertation entitled, "Carbon Nanotubes: Synthesis, Properties and Applications in Modern Electronic Devices." Masarapu worked under College of Engineering Alumni Distinguished Professor, **DENNIS PRATHER** in Electrical and Computer Engineering and under Bingqing Wei, associate professor in Mechanical Engineering. He completed his doctorate in January 2009 and is currently a post doc working under the direction of Bingqing Wei.



## ECE Senior Ranked No.39 in Men's Doubles Tennis

The UD men's tennis doubles team of ECE senior **CAMILO PEREZ** and freshman **RYAN KENT** was recently selected as one of 10 teams to tie for the No. 39 national ranking by the Intercollegiate Tennis Association, the governing body of collegiate tennis.

The duo compiled a 5-0 record during fall competition headed by a perfect 4-0 performance at the Old Dominion Collegiate Open with wins over doubles teams from NJIT, Morgan State, William & Mary and Campbell. The team's fifth win came over a Monmouth doubles squad at the Lehigh Invitational in October.

The Stanford team of Bradley Klahn and Ryan Thacher ranked first in the Jan. 5 poll, while Perez and Kent were joined in the No. 39 spot by teams from Central Florida, California, Wright State, Drake, Alabama, Oklahoma State, Georgetown, East Tennessee State and North Florida.

## ECE alumni recognized in national competition



Two ECE students were recognized for their scholastic achievements this past year in the Eta Kappa Nu Outstanding Electrical or Computer Engineering Student Awards. The national competition recognizes "outstanding scholastic excellence and high moral character, coupled with demonstrated exemplary service to classmates, university, community, and country."



**MATTHEW CHURGIN** was one of five finalists in the country for 2010, earning him distinction as one of the top graduating ECE students in the nation. Churgin received an honors degree with distinction in electrical engineering at UD in 2010. For his Honors

Program senior thesis, he conducted undergraduate research on optical coherence microscopy with ECE assistant professor Takashi Buma. Today, Churgin is a doctoral student at the University of Pennsylvania, where he is studying biomedical imaging under a Howard Hughes Medical Institute Interfaces Scholarship.

**JILL DESMOND** won honorable mention in 2009, which is equivalent to being tied for second place in the competition. Desmond earned a bachelor's degree in electrical engineering at UD in 2009, where she conducted undergraduate research on signal processing with Gonzalo Arce, Charles Black Evans ECE Professor. She is now a doctoral student at Duke University, where she is concentrating on the application of signal processing to cochlear implants for individuals with hearing impairments.

"We're extremely proud of our Eta Kappa Nu Chapter and our students," says department chair Kenneth Barner. "These awards demonstrate that they are not only excelling academically but also using their engineering skills to make the world a better place for others."

Eta Kappa Nu (HKN) is a 106-year-old honor society for electrical and computer engineering students and professionals. The society has more than 200,000 members and 200 university chapters.



## ECE Grad Student Wins Laird Fellowship

**NICOLE KOTULAK**, a doctoral student in the Solar Power Program at the University of Delaware, has been chosen to receive the 2010 Laird Fellowship. The award is aimed at encouraging the recipient to become engaged in a broadening intellectual pursuit that may or may not have direct applications to his or her chosen field of study.

First awarded in 1977 to honor the memory of George W. Laird, a mechanical engineering graduate of UD who died in an accident at the age of 35, the prestigious fellowship is bestowed upon candidates who exhibit character, creativity, imagination, and perseverance, all of which are focal points of the selection process.

Like all previous winners of the Laird, Kotulak plans to be an engineer, and, like most of the others, she has wide-ranging interests that have little to do with the ability to solve equations. She is a classically trained singer and a black-and-white photographer who does things the old-fashioned way—shooting with 35 mm film and spending hours in a darkroom to produce prints.

Now, with the money from the fellowship, Kotulak will be able to follow both of these passions while also giving a priceless gift to her grandmother. “My Nonna was a singer as well,” she says. “It was her passion, her gift. But it was a gift she gave up for her family.”

The oldest daughter of Sicilian parents, Kotulak’s grandmother grew up in Baltimore, singing in various area establishments and training at the Peabody Conservatory. But she was denied the chance to tour the U.S. because she didn’t have a chaperone, and she turned down a singing scholarship at La Scala because it would have required her to leave her home and family for five years.

“I want to give her the opportunity to finally walk the halls of LaScala,” Kotulak says, “to feel the music flow through her veins, to relive

those perfect moments the way I do when I attend a performance. My plan is for us to vicariously experience her dream together.”

To enable others to share in the experience, Kotulak also plans to record the trip with her camera. “Old-school film and a darkroom have a mystique about them that digital photography cannot touch,” she says. “It’s nothing short of magic to take a blank piece of paper, expose it to light, slip it delicately into a tub of solution, and watch figures materialize from the void.”

Kotulak earned a bachelor’s degree in physics with a minor in mathematics from the College of Notre Dame of Maryland in May 2009. She credits the small liberal arts school with instilling in her an understanding of how interconnected—and sometimes mutually misunderstood—the various disciplines of academia can be. “Interdisciplinary approaches are not only useful in the classroom,” she says, “but they have the potential to revolutionize the workplace as well.”

That philosophy, combined with her growing concern for the depletion of natural resources, brought Kotulak to the University of Delaware as an IGERT Fellow, where she is advised by Prof. **ALLEN BARNETT**. Her research focuses on high-efficiency photovoltaics.

“I have always been fascinated by the notion of alternative energy,” Kotulak says. “As a developing researcher, I believe it is my duty to educate people about the functionality, importance, and potential of photovoltaics. This requires the ability to speak the language of fellow researchers, policy makers,

environmentalists, and the general populace. Through IGERT’s interdisciplinary approach to learning and interaction and its public outreach component, I feel that the acquisition of this ability is a very achievable goal.”

“Nicole is determined to use all of her skills to ‘apply science to the optimum conversion of natural resources to the benefit of man,’ consistent with the classic definition of engineering,” Barnett wrote in nominating her for the fellowship.

Kotulak said she is grateful for the Laird Fellowship and praises its goals and selection criteria. “So many fellowships focus only on academics,” she says. “But there’s so much more to engineering than that, and it’s those things that color how you approach a problem.”

She is also really pleased with her decision to come to UD as part of the Solar Power Program and an IGERT Fellow. “The other students in this group were a major factor in my decision to come here,” she says, “and they have been wonderfully supportive, especially in bringing me up to speed on the engineering aspects of our work.”

“I honestly don’t think my time here at UD would be as enjoyable a learning experience as it has been without the camaraderie of my fellow students in the solar program. They are a large part of why I’m here, and I have to give them some of the credit for my success.”

## UD students answer America's call for cyber security experts

Nine University of Delaware students and alumni recently graduated from a first-of-its-kind cyber training camp held as part of an effort to shore up the nation's capability to protect its information systems. Currently, there is a critical shortfall of individuals trained in this area.

The 2010 U.S. Cyber Challenge Delaware camp, held Aug. 9-13 at Wilmington University, brought together 20 college students from across Delaware and the region with the potential to become world-class cyber security professionals.

Four members of the UD group took home top honors for their ingenuity, winning the fierce "capture-the-flag" style competition that culminated the event.

The UD group included a mix of graduate and undergraduate students and alumni: **ROBERT DEATON, STEPHEN JANANSKY, JAMES KERRIGAN, CHRIS MERRICK, MARK PELLEGRINI, GLEN SAUNDERS, JARED SMITH, RYAN VAN ANTWERP** and **NICHOLAS WAITE**.

Collectively, these individuals represented the College of Engineering, the College of Arts and Sciences, the Alfred Lerner College of Business and Economics and the Honors Program.

"Cyber security is one of the few scientific fields that encourages and rewards creativity, persistence, and the ability to view difficult problems with a different perspective," said Van Antwerp, who won with teammates Janansky, Deaton, and Saunders.

During the week-long camp, students received advanced security training from cyber industry experts, toured the State Police High Tech Crimes Lab and faced a myriad of challenges on hacking, digital forensics, incident handling, and penetration testing.

"With everyone putting more and more of their private information online, it becomes an increasingly larger issue that this information is not secure," said Janansky.

**CHASE COTTON**, senior scientist in the Department of Electrical and Computer Engineering and associate director for cybersecurity at UD's Center for Information and Communications Sciences, agrees adding, "These security skills are critical to the fight against cyber crime and to securing

the systems we all use daily, like email, social networking, and banking. And these same skills are also being sought to help the government and military prepare to defend the country in this electronic battlefield."

Cyber threats are increasing in complexity, volume and seriousness, as criminals and terrorists become more adept at accessing critical information with little more than a computer. State agencies and private sector companies face equal challenges in securing critical infrastructure and services, including the electric grid, our telecommunications network and our financial system.

Delaware was one of only three states chosen to host a cyber-security training camp in 2010. New York and California also held camps. Candidates who rise to the top at the camps will be invited to participate in other national challenges and have the potential to be introduced to key federal agencies and corporations involved in advanced cyber security work.

U.S. Sen. Tom Carper, Gov. Jack Markell and Jim Sills, Delaware's chief information officer, congratulated and met with the students the last day of camp. Photos of the event can be viewed at Markell's Facebook site.

This year's camp was organized by Wilmington University, the University of Delaware, Delaware Technical and Community College, the SANS Institute, and the Delaware Department of Technology and Information.



## David F. Welch inducted to Alumni Wall of Fame



**DAVID F. WELCH** was one of 10 University of Delaware graduates inducted into the University Alumni Association's Wall of Fame as part of Forum & Reunion Weekend, June 4-6, 2010.

During a ceremony held at the Roselle Center for the Arts June 5th, Cindy Campanella commended the inductees for their achievements and thanked them for helping to further the value of a UD diploma for all alumni.

"The world-wide recognition of these individuals brings pride to the University of Delaware and inspires fellow alumni and current students alike," said Campanella, director of alumni relations.

The awards were presented by UD President Patrick Harker along with Alan Brayman, president of the UD Alumni Association. Harker noted that these individuals are in the top 0.1 percent of alumni, and this group's "leadership is shaping the world."

Welch ('81) earned a bachelor's degree in electrical engineering from UD before obtaining his doctoral degree in electrical engineering from Cornell University. He started his career as a scientist with SDL Inc. and eventually rose to chief technical officer and vice president of corporate development to negotiate six mergers and acquisitions valued at \$43 billion.

In 2001, Welch founded Infinera Corp. and serves as the executive vice president and chief strategy officer. He also holds 125 patents.

Established in 1983, the Alumni Wall of Fame recognizes outstanding professional and public service achievements by UD graduates. Including this year's class of honorees, there are now 229 inductees.

**ADAPTED FROM A UDAILY ARTICLE BY MEREDITH CHAPMAN.**

## Wayne Westerman Awarded Presidential Citation for Outstanding Achievement



**WAYNE WESTERMAN**, who received his doctoral degree in electrical engineering from UD in 1999, developed the revolutionary computer interface technology, based on human touch, that is used in Apple's iPhone.

"I still remember the excitement of the day when **JOHN ELIAS** [UD ECE professor] and I began brainstorming our future," said Westerman, remembering his first few weeks as a student at UD, after being introduced by Gonzalo R. Arce, ECE chairperson.

"We were working together from the start," said Westerman, who teamed with Elias to develop the computer "touchstream" keyboard technology, which is operated by gesturing or moving fingers across a touch- and motion-sensitive surface. "It has been a great and shaping relationship."

Westerman talked about the role serendipity played in the invention, from his stubborn bout with tendonitis, which hobbled his progress until he devised the touch-sensitive technology, to his experience as a pianist, in which his interaction with the keyboard was graceful and natural.

"I had an ergonomic problem and I paired it with a motivation," Westerman said of the early inspiration. "I'd always felt that playing the piano was so much more graceful and expressive than using a computer keyboard, and I thought how great it would be if I pulled some of that expression from the piano to the computer experience."

Currently a senior engineer at Apple Inc., Westerman began his research at UD, where he started the touch screen project as his doctoral thesis. The technology was at the heart of the foundation of Fingerworks, a company Westerman started in 1998, along with Elias.

In 2005, Apple Inc. purchased Fingerworks, and in July 2007, an 80-page patent filing, partially credited to Westerman, hinted at the next-generation touch screen technology. Three years ago, in 2005, Westerman established a scholarship fund at UD, in honor of his father, to be used to support ECE students who demonstrate invention, innovation and entrepreneurial vision.



Courtesy of Apple

## Time Article Traces Apple's Roots to Fingerworks

Company founded by UD's **JOHN ELIAS** and **WAYNE WESTERMAN** pioneers gesture-recognition technology

## Engineering Alumni Association Honors Sean X. Wang

On Honors Day, the UD Engineering Alumni Association recognized **SEAN X. WANG** with an Outstanding Alumni Award. Sean earned his ECE Ph.D. in 1992.

Sean is an accomplished entrepreneur who has founded, incubated, and financed more than a dozen high-tech companies over the past 10 years. Currently, he is the chief executive officer of B&W TEK, a local photonic instrument company. He is also founder and chairman of Litecure, a rapidly growing medical device company, and BWT Lighting, a start-up solid-state navigational lighting company. In addition, he serves on the boards of several other privately held companies.

Sean has authored more than 50 scientific publications and one book chapter, and he holds 14 U.S. patents, with more than 30 patent applications pending in the areas of optical instruments, lasers, spectroscopic sensors, and medical devices.

Sean serves on the boards of the Independence School of Delaware and the Chinese Entrepreneur Association, which is a national organization of Chinese American CEOs, executives and professionals. He is also a member of the external advisory council for UD ECE.



### ALUMNI ASSOCIATION HONORS SEAN X. WANG

Wang, left, with Steven H. McKnight (Materials Science Awardee), Thomas Buchanan (deputy dean of the College of Engineering) and E. Alan Uebler (Chemical Awardee).

*The following paragraph was excerpted from an article in the Nov. 1, 2007, issue of Time on Apple's iPhone being named The Invention of the Year.*

“Apple didn’t invent the touchscreen. Apple didn’t even reinvent it (Apple probably acquired its much hyped multitouch technology when it snapped up a company called Fingerworks in 2005). But Apple knew what to do with it. Apple’s engineers used the touchscreen to innovate past the graphical user interface (which Apple helped pioneer with the Macintosh in the 1980s) to create a whole new kind of interface, a tactile one that gives users the illusion of actually

physically manipulating data with their hands—flipping through album covers, clicking links, stretching and shrinking photographs with their fingers. This is, as engineers say, nontrivial. It’s part of a new way of relating to computers. Look at the success of the Nintendo Wii. Look at Microsoft’s new Surface Computing division. Look at how Apple has propagated its touchscreen interface to the iPod line with the iPod Touch. Can it be long before we get an iMac Touch? A TouchBook? Touching is the new seeing.”

## UD Electrical Engineering Alumnus Named to National Bioethics Commission



**JAMES W. WAGNER**, a 1975 graduate of UD, has been named vice chair of President Barack Obama's Commission for the Study of Bioethical Issues. The appointment was announced with the establishment of the commission by an executive order Nov. 24.

Wagner, who earned his bachelor's degree at UD in electrical engineering, has been president of Emory University since 2003. An elder in the Presbyterian Church, he holds a master's degree in clinical engineering and a doctorate in materials science and engineering, both from Johns Hopkins University.

Wagner is credited with championing the role of ethics in Emory's mission by significantly enhancing the prominence of the university's interdisciplinary Center for Ethics and by incorporating ethical engagement as a key element in Emory's strategic vision.

Amy Guttmann, a political scientist who has served as president of the University of Pennsylvania since 2004, has been appointed chair of the commission.

"As our nation invests in science and innovation and pursues advances in biomedical research and health care, it's imperative that we do so in a responsible manner," Obama said in a statement issued by the White House with the executive order. "I am confident that Amy and Jim will use their decades of experience in both ethics and science to guide the new commission in this work, and I look forward to listening to their recommendations in the coming months and years."

"Jim Wagner's appointment to President Obama's bioethics commission demonstrates that a degree in engineering can lead in many directions," says Michael Chajes, dean of the UD College of Engineering. "It is a testament to his experience and perspective that, as an engineer, he served as president of Emory, which does not have an engineering program. He is also known for developing a very forward-looking vision for the Case School of Engineering, where he served as dean for two years—a vision that focused on fundamentals, creativity, societal awareness, leadership skills, and professionalism. He obviously brings tremendous credentials to his new position."

The bioethics commission has been charged with examining a number of issues, including the creation of stem cells by novel means; intellectual property issues involving genetic sequencing, biomarkers and other screening tests used for risk assessment; and the application of neuro- and robotic sciences.

The group will also address broader issues such as the protection of human research participants, scientific integrity and conflicts of interest in research, and the intersection of science and human rights.

Prior to his appointment as president of Emory, Wagner had served as dean, provost, and interim president at Case Western Reserve University. He spent the first ten years of his career at the U.S. Food and Drug Administration, where he developed quality-assurance methods and performed failure analyses on medical devices. He then joined the faculty at Johns Hopkins, where his research focused on the nondestructive evaluation and characterization of materials and structures.

Wagner has authored more than 115 professional publications. He received the Distinguished Alumnus Award from the Johns Hopkins University Whiting School of Engineering and the Johns Hopkins Alumni Association in 2007 and was elected a fellow of the American Academy of Arts and Sciences in 2009. He also won several teaching awards at Hopkins, including the 1994 George E. Owen Award for excellence in teaching and dedication to undergraduates.

## Electric Power Exec Talks About Turmoil and Transition in U.S. Utility Sector



**JAMES H. MILLER**, chairman, president, and CEO of PPL Corporation, recently spent half a day on the University of Delaware campus, meeting with faculty and students and delivering a public lecture as part of the ECE Distinguished Lecture Series.

Miller earned his bachelor's degree in electrical engineering at the University of Delaware in 1977 after serving in the Navy for six years. He began his career in the electricity industry at Delmarva Power, where he held various engineering and management positions.

A member of the boards of directors of several energy-related and community organizations, Miller is on the leadership team for Education 2010, which is dedicated to improving education in Allentown, Pa., where he and his wife currently live. The couple recently endowed a scholarship at the University of Delaware that will go to a promising freshman electrical engineering student.

"Many people think of the electric power industry as a stodgy and dull business," Miller said in his lecture, "but right now the utility sector is going through greater changes than I ever could have imagined when I began my career in the 1970s. It's characterized by tremendous turmoil and transition."

Miller said that energy is central to the prosperity of a country and to its citizens' quality of life. "There's a close correlation between electricity and literacy rates," he said. "Energy technologies are responsible for educating children and saving lives.

"We have an insatiable appetite for electricity in this country, and it's growing. The Consumer Electronics Association estimates that the average home has 23 devices powered by electricity, including TVs, flat screens, video games, iPhones, iPods, computers, and DVD players."

With continued increases in usage predicted, Miller said that we have to consider how this demand will be met in the face of concerns about air and water quality and climate change.

At the same time, however, he emphasized prudent use of resources rather than conservation. "There's an awful lot of talk about conservation driving down the need for electricity, but to me that's counterintuitive to the continued progress of our country—we want to make things, and that takes power. Using it effectively and efficiently is the key."

One approach to this issue is a "smart grid" system to provide consumers with feedback on power use that can guide them in making choices about how and when to run various devices in their homes. Miller envisions this being available in the not-too-distant future.

In the face of regulatory uncertainty, environmental concerns, and an aging power infrastructure, Miller said that there is no silver bullet; rather, progress must be made on all fronts from coal and gas to nuclear power and renewables such as wind and solar power. "There are immense challenges with all of these sources," Miller said.

Nuclear power requires tremendous capital investment, the use of coal raises issues of how carbon capture and sequestration will be carried out and funded, and sustainable sources need to become more efficient if they are to be financially feasible.

One major problem, according to Miller, is that deregulation has been inconsistently implemented across the country. "Right now, we have a hybrid system," he said. "We need to either return to a completely regulated system or open up a nationwide wholesale market where everyone pays the real cost of electricity. Our mission should be to formulate a national energy policy, not to have 50 different energy policies."

Looking for an old friend? Want to share your latest news? Searching for information on upcoming alumni events such as Homecoming? Now you can do it all in one place, **UDconnection.com**. UD and the UD Alumni Association (UDAA) have collaborated to bring alumni a vibrant online community—so register and get active! The online community allows you to search the alumni directory, post class notes, update your contact information, and see if there are any upcoming alumni events in your area. You can also take advantage of networking opportunities and volunteer opportunities to get involved with your alma mater! Visit **www.UDconnection.com** today!

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