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# eee currents

ELECTRICAL ENGINEERING AT THE UNIVERSITY OF NOTRE DAME

## NSF Grants Support Research in Cyber-Physical Systems

Cyber-physical systems represent the next generation of engineering systems, with applications spanning critical infrastructure control, automotive systems, process control, energy conservation, environmental monitoring, avionics, and distributed robotics. They are complex dynamic systems that offer significant processing power while interacting across communication networks. Notre Dame has recently received large awards from the National Science Foundation in support of three projects focusing on cyber-physical systems.

### Wireless Sensor-Actuator Network Technologies

The first \$1 million grant will support a team led by Department of Electrical Engineering faculty as they seek to develop resilient wireless sensor-actuator network technologies (WSANs). WSANs are complex systems consisting of numerous sensing and actuation devices that interact with the environment and coordinate their activities over a wireless communication network.

“Examples of potential WSANs include the national power grid, air traffic control networks and water/gas distribution networks,” says **Michael Lemmon**, professor of electrical engineering. “All of these systems are components of our national civil infrastructure, and their resilient operation — when they identify catastrophic faults and take actions to quickly return a system to a normal operating state — is in the public’s interest.”



Alireza Partovi, a graduate student in electrical engineering, works with Assistant Professor Hai Lin as part of the wireless sensor-actuator network technologies project.

The WSANs team consists of Lemmon; **J. Nicholas Laneman**, associate professor of electrical engineering and director of Notre Dame’s Wireless Institute; and **Hai Lin**, assistant professor of electrical engineering.

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## A LETTER FROM THE CHAIR



### What Should We Teach Our Undergraduates?

Our department is currently undergoing a yearlong review with the goal of revamping our undergraduate curriculum. While we constantly “tweak” the courses we teach — adding electives as new technologies emerge and “sunsetting” others — the curriculum as a whole is subject to large-scale changes infrequently, so this is a pretty big deal to us.

Assuming we want our bachelor’s degree to be accredited — and we do — we must satisfy the constraints imposed by ABET, the organization that accredits all engineering degrees. Fortunately, ABET’s curricular requirements for BSEE degrees are broad and non-controversial:

*“... knowledge of probability and statistics, including applications ... knowledge of mathematics through differential and integral calculus, basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components ... Programs containing the modifier ‘electrical’ in the title must also demonstrate that graduates have knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables, and discrete mathematics.”*

Where ABET gets a bit intrusive is in the arguably-too-restrictive way it requires programs to demonstrate continuous improvement. (But that’s a column for another day.)

The last time we made major revisions to the curriculum was about 12 years ago. The main change that was implemented then involved adding more flexibility. Prior to 2000 the junior year was largely filled with required pairs of classes — i.e., *Electromagnetics I and II*, *Semiconductors I and II*, and *Signals & Systems I and II*.

Beginning in 2000 students were required to take only one course in each of those areas, opening up room for electives and the reduction of the number of credits required for a BSEE from 133.5 to its current value of 129.5.

Today, the EE “core” is made up of two circuits courses, an electronics course, courses in digital logic, programming (C/C++), and probability, as well as one course in each of the aforementioned electromagnetics, semiconductors, and signals/systems. The EE core concludes with a two-semester senior design sequence. The rest of the curriculum is made up of math, chemistry, and physics requirements — about 10 courses in all — as well as University requirements (two philosophy and two theology courses and one each in composition, history, literature/fine arts, and social science), and technical and EE electives. (See <http://www.ee.nd.edu/undergraduate/curriculum> for a complete listing.)

How does the Notre Dame BSEE compare with that of other universities? While Notre Dame’s EE degree is now more flexible than it was in the 20th century, it is still fairly traditional and restrictive compared with our peers and aspirational peers. At MIT, for instance, the Electrical Engineering & Computer Science (EECS) Department offers three undergraduate degrees — one in EE, one in CS, and a “hybrid” degree in EECS. The EECS degree — the most popular of the three — offers students the opportunity to spread themselves [perhaps thinly?] across the EE/CS continuum, requiring just two “foundational” EE courses (such as circuits, signals/systems, and electromagnetics) and just two foundational CS courses (such as computer architecture, software, and algorithms). And even the more conventional EE degree offers a surprising degree of flexibility.

As electrical engineering has become more pervasive — as the reach of the discipline has expanded and the boundaries between disciplines have blurred — the issue of what remains in the central “core” of EE becomes more nuanced. And for those of us tasked with educating

the next generation of electrical engineers, the suggestion that what **we** believe to be fundamental may, in fact, be someone else's option is a little unsettling. As a communications engineer, I can't imagine someone receiving a BSEE without having taken a "signals and systems" class that brings a frequency domain perspective to the time domain perspective every undergraduate starts college with. However, I know that MIT's EECS Department offers three BS degrees, and none of them **requires** such a course. Similarly, my more physics-centered EE colleagues at Notre Dame are bemused by the fact that it is possible to get a BSEE from MIT without taking a course in electromagnetics. (I should mention that it is not possible to get a BSEE from MIT while avoiding **both** electromagnetics **and** signals/systems. Even at MIT, flexibility has its limits.)

But beyond the question of what constitutes the EE core, there is a myriad of issues that go into constructing a curriculum:

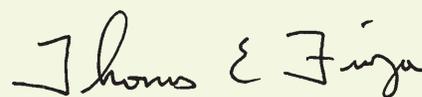
- How should we balance fundamentals — the math- and physics-based principles that underlie our technology — with exposure to the engineering applications that most of our students will confront upon graduation? Both students and employers appreciate the extent to which we prepare our graduates to be "job ready" the day after they get their Notre Dame degrees; however, we are mindful that we are educating each student for a **career** rather than for a first job, and while technologies ebb and flow, the fundamentals tend to persist.

- Once our students graduate, their paths will vary widely. Most will go to work in industry, some as engineers, and others in sales or as consultants. Of those who go to work immediately, many will eventually pursue an MS or an MBA, typically on a part-time basis. On the other hand, about 20% of our seniors immediately go to graduate school full time to pursue an MS or PhD. We want to prepare our students for success no matter which path they take, but the ideal preparation for one path may be less-than-ideal for another. A well-designed curriculum

offers choices without sacrificing coherence; a graduate of our program should never be precluded from pursuing any particular post-graduate option, even as we recognize that program choices make some options easier than others.

- Setting aside for the moment the question of **what** to teach, the question of **how** to teach is arguably just as important. A professor standing in front of a class, talking and writing notes on the board (or showing PowerPoint slides on the screen) is still the dominant content delivery method in most engineering classes. Technology — in the form of YouTube videos or podcasts or something else not yet invented yet — has the potential of changing that paradigm. For example, the flipped classroom is a model in which course content is made available via video outside of class, enabling class time to be spent not in lecture but in more interactive pursuits; it has been touted as a more efficient and effective means of instruction. (But every teacher who has assigned reading in advance of a class will ask, "How many students will actually **watch** the content before coming to class?") And the question of how to best use instructional labs — to integrate them with lecture-based courses or to set each up as its own coherent experience — is something many of us in engineering education still wrestle with.

As alumni and friends of Notre Dame's Department of Electrical Engineering, you are an important source of insight into the question, "What should we teach our undergraduates?" You have succeeded in life beyond Notre Dame, and you know what was valuable to you and what was not. Recognizing that not everyone's experience is the same, there is considerable wisdom out there that we would love to tap into to improve our BSEE curriculum. If you have any suggestions or ideas you'd like to share, I encourage you to contact me at [tfuja@nd.edu](mailto:tfuja@nd.edu) or at (574) 631-7244.



*Continued from page 1*

“Building resilient wireless network systems is challenging due to the time varying nature of these networks,” Lemmon says. “Temporal variations in a network’s quality of service introduce an unpredictability that is an obstacle to achieving resilient operation.”

The Notre Dame team believes it can overcome this obstacle through an approach that rests on two fundamental technologies. One technology uses machine-to-machine (M2M) communication networks that promise wireless networking with greater peak bit-rates (or data transfer rates) and reliability than previously possible. The other technology comes from recent ideas that reduce the bit rates needed by control applications through the use of quantized and event-triggered feedback.

“This project will evaluate and demonstrate this integrated control/communication approach to resilience on a multi-robotic testbed consisting of unmanned ground vehicles,” Lemmon says. “The testbed will integrate M2M communication hardware/software with a multi-robot control architecture addressing task coordination and platform stabilization.”

One practical outcome of the research would be that wireless industrial control systems could replace the current wired systems, thereby offering more flexibility and lower infrastructure costs and enhanced global competitiveness.

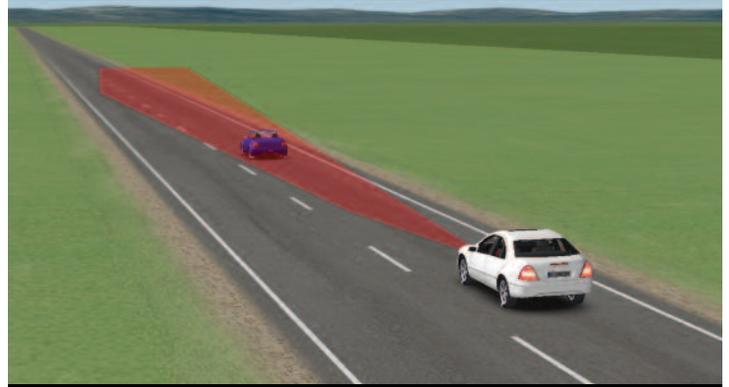
## Theoretical Concepts in Cyber-physical Systems

The second grant, a total of approximately \$5 million awarded through the same NSF program, is a five-year joint venture with Notre Dame, Vanderbilt University, the University of Maryland, and General Motors Research and Development Center.

Vanderbilt is leading the entire project, but Notre Dame is in charge of its theoretical aspects. The Notre Dame team has been using its expertise in theoretical concepts such as passivity and symmetry to address system uncertainties and the interdependence of design concerns. The scientific results will be validated on a GM electrical vehicle automotive testbed.

“Cyber-physical systems are physical, biological, and engineered systems whose operations are monitored, coordinated, controlled, and integrated by a computing and communication core,” says **Panos Antsaklis**, the H.C. and E.A. Brosey Professor of Electrical Engineering at the University of Notre Dame. “As computers become ever-smaller, faster, and more efficient, and communication networks become better and ever cheaper, computing and communication capabilities are being embedded in all types of objects and structures in the physical environment. This intimate coupling between the cyber and physical will be manifested from the nano-world to large-scale, wide-area systems of systems, and at multiple time scales.”

Antsaklis and team members **Vijay Gupta**, assistant professor of electrical engineering, and **J. William Goodwine**, associate professor of aerospace and mechanical engineering, highlight



Vehicles of the future will likely have a variety of control modules designed by several different vendors. In order to make sure these systems are designed correctly so that they avoid unintended interactions, the Notre Dame team is studying Advanced Cruise Control and lane changing control systems. As part of their research, they use CARSIM, a simulator that shows the range of vehicle sensors in detecting other cars in the area.

several technological and economic drivers indicating the necessity to pursue CPS systems, including the decreasing cost of computation, networking, and sensing; a variety of social and economic forces which will require America to use national infrastructures more efficiently; and environmental pressures which mandate the rapid introduction of technologies to improve energy efficiency and reduce pollution. Also, as the national population ages, more efficient use of the health care systems, ranging from facilities to medical data and information, will have to occur.

The NSF began funding CPS research in 2009. According to the agency, research advances in cyber-physical systems promise to transform our world with systems that respond more quickly (autonomous collision avoidance), are more precise (robotic surgery and nano-tolerance manufacturing), that work in dangerous or inaccessible environments (autonomous systems for search and rescue, firefighting and exploration), are large-scale, distributed coordination (automobile traffic control), are highly efficient (zero-net energy buildings), and augment human capabilities and societal well being (assistive technologies and ubiquitous healthcare monitoring and delivery).

Notre Dame is poised to play a leading role in CPS research, having had a significant presence in the area since its inception through the leadership efforts of its Systems and Control faculty. Antsaklis was a member of the 2007 committee of the President’s Council of Advisors in Science and Technology that recognized the importance of CPS to society and made it the number one national priority in networking and information technology federal research funding. “Cyber-physical systems will transform how we interact with the physical world, just as the Internet transformed how we interact with another,” he says.

## Plug-in Electric Vehicles

Funded by a \$1.3 million NSF grant, the third project focuses on plug-in electric vehicles, which are becoming a central part of the country's daily life and beginning to impact the nation's power grid. A University team is working to develop mathematical algorithms to help guide the integration of plug-in hybrid electric vehicles (PEVs) into the power grid.

The research team, which includes **Vijay Gupta**, assistant professor of electrical engineering; **Yih-Fang Huang**, professor of electrical engineering; **Peter Bauer**, professor of electrical engineering; and **Patrick Murphy**, program director for the University's Initiative for Global Development, view an electric transport system as an eventual win-win for consumers, electric and transportation companies, and the environment. Their goal in this project is to examine software and hardware issues related to charging at both commercial charging stations and at residences, as well as scenarios when PEVs function as consumers of power and situations in which PEVs could conceivably serve as a sort of battery, reinjecting energy from the vehicle to the home or from the vehicle to the grid.

"Electrification of the transportation market offers revenue growth for utility companies and automobile manufacturers, lower operational costs for consumers, and benefits to the environment," Gupta says. "By addressing problems that will arise as PEVs impose extra load on the grid, and by solving challenges that currently impede the use of PEVs as distributed storage resources, this research will directly impact society."

The Notre Dame team is working in collaboration with industrial partners to help ground the research in real problems and to facilitate quick dissemination of results to the marketplace.



Undergraduates in the *Hybrid & Electric Vehicles* and *Electrical Machinery & Power Systems* courses were able to view and analyze a 2012 Chevy Volt, courtesy of Gates Chevy World in Mishawaka, Ind.

They are also working with academic partners from the University of Washington and the University of Pennsylvania.

In addition to impacting the public, the project has a strong educational component that integrates the research into departmental classrooms to allow better training of both undergraduates and graduates students for future participation in an electrified transportation market.



(Photo courtesy of Lighthouse Imaging)

**Huili (Grace) Xing**, the John Cardinal O'Hara, C.S.C., Associate Professor of Electrical Engineering (right), was honored on the field at the Notre Dame-BYU football game on October 20. Xing, shown here with **Chris Maziar**, vice president, senior associate provost and professor of electrical engineering, was cited for her work in electronic materials and devices as part of a program that recognizes one Notre Dame faculty member at each home football game.



Huang

- Professor **Yih-Fang Huang** was recently named one of eight members of the Notre Dame faculty to be a Kaneb Faculty Fellow for the 2012-13 academic year. This designation came from the Kaneb Center for Teaching and Learning, an on-campus organization that stimulates scholarly reflection and conversation about teaching and supports the adoption of practices that enhance learning. Kaneb Fellows are named in recognition of

their records of teaching excellence; they share their insights and experiences through workshops, discussion groups, research, and individual consultation. Huang is a former EE department chair who has recently been teaching “Introduction to Electrical Engineering,” the first required EE course for EE majors.



Jena

- **Debdeep Jena**, associate professor of electrical engineering, has been selected as the 2012 Young Scientist by the International Symposium for Compound Semiconductors (ISCS). The award, established in 1986, acknowledges technical achievements in compound semiconductors by a scientist younger than 40 years on the first day of the symposium; this year’s symposium was held August 27-30, 2012, at the University of California at Santa Barbara.

A Notre Dame faculty member since 2003, Jena’s research focuses on the growth and properties of III-V semiconductors and their application in high-speed devices and photovoltaics (solar cells) and on the investigation and development of nanostructured semiconducting materials such as graphene, nanowires and nanocrystals, and their device applications, and in the theory of charge, heat, and spin transport in nanomaterials.



Antsaklis

- **Panos Antsaklis**, the H.C. and E.A. Brosey Professor of Electrical Engineering, was awarded an Honorary Doctorate (Doctor Honoris Causa) by the University of Lorraine, in Metz, France, in December 2012. This degree is one of just five conferred by the University of Lorraine in 2012, the others going to honorees from Canada, Germany, and Austria.

The University of Lorraine is one of the largest universities in France, created by the merger of four universities, the Henri

Poincare University (Nancy-I) which focuses on science and engineering, Nancy-II, Paul Verlaine University – Metz, and the National Polytechnic Institute of Lorraine (INPL). The *grands établissements* are counted among France’s most prestigious research and higher education institutions.

- **Wolfgang Porod**, the Frank M. Freimann Professor of Electrical Engineering and director of Notre Dame’s Center for Nano Science and Technology, has been invited to serve on the committee conducting a comprehensive strategic review of the U.S. government’s National Nanotechnology Initiative (NNI).

The NNI encompasses the nanotechnology-related activities of 25 federal agencies and coordinates a portfolio of basic and applied research activities focused on advancing the economic and national security interests of the United States. The 2012 Federal Budget provides \$2.1 billion for the NNI, and cumulative investment in the NNI since 2001 totals more than \$16.5 billion.

This second Triennial Review, mandated by the 21st Century Nanotechnology Research and Development Act, will be conducted through the National Academies and submitted to the White House’s National Science and Technology Council.



Porod



Costello

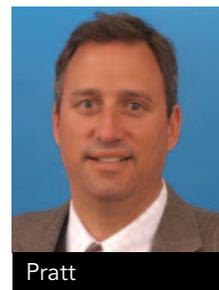
- A paper by **Daniel J. Costello Jr.**, the Bettex Professor Emeritus of Electrical Engineering, was recently selected as the recipient of the 2012 IEEE Communications Society and Information Theory Society Joint Paper Award. This award goes to outstanding papers published in any publication of the IEEE Communications Society or the Information Theory Society within the previous three calendar years.

It is based on quality, originality, utility, timeliness, and presentation. The paper should cover the interests and achieve the values of both the Communications Society and the Information Theory Society.

The winning paper was entitled “Iterative Decoding Threshold Analysis for LDPC Convolutional Codes,” and it was published in the October 2010 issue of *IEEE Transactions on Information Theory*. Prof. Costello’s co-authors were then-Notre Dame PhD student Arvind Sridharan, as well as Michael Lentmaier and Kamil Zigangirov, both of whom were research visitors at Notre Dame.

- A paper co-authored by **Thomas Pratt**, research associate professor of electrical engineering, was recently awarded the Neal Shepherd Memorial Best Propagation Paper Award for 2012. The annual award is sponsored by the IEEE Vehicular Technology Society and recognizes the best paper relating to propagation appearing in the *IEEE Transactions on Vehicular Technology*.

Prof. Pratt’s paper was entitled, “Wideband MIMO Mobile-to-Mobile Channels: Geometry-Based Statistical Modeling with Experimental Verification.” It was co-authored by **Alenka Zajic, Gordon Stuber**, and **Son Nguyen** and appeared in the February 2009 issue of *Transactions on VT*. The award was presented in early September at the 2012 IEEE 76th Vehicular Technology Conference in Quebec City, Canada.



Pratt

## New EE Faculty Members

Notre Dame's Department of Electrical Engineering recently welcomed two new faculty members to its ranks.

**Hai Lin** joined the department in January 2012 as an assistant professor. Lin is a "Double Domer," having received his MSEE and PhD degrees from Notre Dame in 2002 and 2005 respectively. From 2006 to 2011, he served as an assistant professor at the National University of Singapore. His teaching and research interests are in the multidisciplinary study of the problems at the intersections of control, networks, computation, and life sciences. His current research focuses on cyber-physical systems, multi-robot cooperative tasking, systems biology, and quantum control. Lin has been very active in the research community, having served as the program chair for the 2011 IEEE International Conference on Control and Automation as well as for the 2010 and 2011 IEEE Conference on Cybernetics and Intelligent Systems. He also served as the chair of the Singapore Chapter of IEEE Systems, Man and Cybernetics Society for 2009 and 2010.

Lin is married with a three-year-old daughter. His wife, Jing Yang, is also a "Domer," having received her PhD in biological sciences from Notre Dame in 2006.



Lin

**Anthony Hoffman** also joined the department in January 2012. Hoffman earned a BS in physics from the University of Maryland, Baltimore County, where he graduated valedictorian, and completed his PhD at Princeton University. He was awarded the Charlotte Elizabeth Proctor Fellowship from Princeton University, one of the highest awards given to graduate students, for his dissertation work on mid-infrared quantum cascade lasers and three-dimensional metamaterials. After completing his PhD in 2009, he accepted a position as a postdoctoral research associate at Princeton University working on the development of superconducting quantum circuits for applications in quantum computing and condensed matter simulations.

Hoffman's research interests blend his experience in low-dimensional semiconductors and cavity quantum electrodynamics. His research is currently focused on improving the performance of mid-infrared semiconductor lasers, creating room-temperature THz sources, and controlling the interaction of THz radiation with two-level systems. Hoffman is engaged to Jennifer Huynh, a sociologist from California. They will celebrate their marriage in summer 2013.



Hoffman

## Graduation 2012

On Sunday, May 20, 2012, almost 2,000 undergraduates took part in the University of Notre Dame's 167th commencement exercises held in Notre Dame Stadium. Included among the sea of blue caps and gowns were 27 graduates who received BS degrees in electrical engineering.

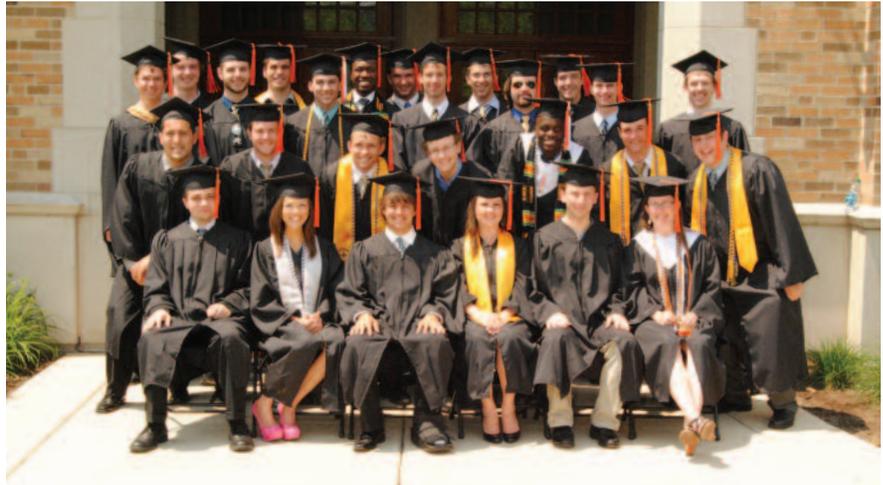
The main commencement speaker for Sunday morning's campus-wide event was former Notre Dame swimmer Haley Scott Demaria, who suffered grievous injuries in a tragic 1992 team bus accident. Her recovery from paralysis and her subsequent return to winning form continues to inspire the extended Notre Dame family, and her commencement address was warm, engaging, and at times humorously self-deprecating. (Recalling when Notre Dame President Fr. John Jenkins asked her to deliver the address, she said, "Over the next several days, I thought to myself many times, 'Wow! I can't believe Notre Dame asked me to be their graduation speaker.' Perhaps some of you thought the same thing.")

Haley Scott Demaria received an honorary degree from Notre Dame, as did ten other accomplished individuals, including Emory President James Wagner (whose honorary degree was an engineering doctorate) as well as former Mendoza Dean Carolyn Woo and longtime NBC television producer Dick Ebersol.

After the University-wide ceremony, there was a luncheon sponsored by the College of Engineering outside of Stinson Remick Hall of Engineering, giving engineering graduates and their parents the opportunity to relax, socialize, and meet with the faculty and staff in attendance.

The Department of Electrical Engineering Undergraduate Commencement Ceremony began at 1:30 p.m. in DeBartolo Hall. The gathered students, family members, and faculty heard remarks from classmates Caleb Atwood, Adebayo Omoyeni, and Alan Yanchak. The ceremony also included what has become a favorite of such events – a slide show of random moments from the last four years.

The EE Ceremony was also the occasion at which several undergraduates were presented with awards honoring their accomplishments. Those students included



John Zielinski (recipient of the Steiner Award), Katie Heinzen (James L. Massey Award), Sara Taylor (Basil R. Myers Award), Nathan Feldpausch (Arthur J. Quigley Award), Cameron Thorpe (Lawrence F. Stauder Award), and Alan Yanchak (William L. Everitt Award). Also honored were the recipients of two teaching awards – the 2012 Graduate Instructor's Award, which went to graduate student Zi Lin, and the 2012 Faculty Teaching Award, which went to Prof. Wolfgang Porod.

Here are the May 2012 graduates of Notre Dame's Department of Electrical Engineering, along with their immediate plans, where known:

- **Caleb Atwood** of Casper, Wy., has accepted a position with Microsoft Corp. in Seattle, Wash.
- **Thomas Blanford** of Andover, Mass., is working for Analog Devices in Wilmington, Mass.
- **Andrew Bolka** of Herndon, Va., is moving back to northern Virginia where he will take a position with Booz Allen Hamilton.
- **John Burns** of Clovis, N.M., will be undergoing pilot training at Laughlin Air Force Base, Texas.
- **Julian Corona** of Dolton, Ill., will pursue a PhD in mechanical engineering at Cornell University in Ithaca, N.Y.
- **Steven Cress** of Lima, Ohio, has accepted a position with Kiewit Power of Kansas City, Kan.
- **Nathan Feldpausch** of Fowler, Mich., is moving to Houston, Texas, where he will be employed by Spectra Energy.
- **Andrew Fons** will be returning to his hometown of Milwaukee, Wis.
- **Katie Heinzen** of Fairfax, Va., has accepted a commission in the U.S. Air Force and will be stationed at Hill Air Force Base, Utah.
- **Michael Higginson** of Mt. Prospect, Ill., has accepted a position with S&C Electric Company in Chicago.
- **John Kelly** of New York City was still contemplating his plans when he was last heard from.
- **Adrian Moreno** of El Paso, Texas, will be joining Texas Instruments in Dallas.
- **Eric Nolan** of Tinley Park, Ill., was still pondering his options as of graduation day.
- **Adebayo Omoyeni** of Lagos, Nigeria, is pursuing a PhD in electrical engineering at the University of Texas in Austin, Texas.
- **Odaro Omusi** of Lagos, Nigeria, is pursuing a PhD in electrical engineering at The Ohio State University in Columbus, Ohio.
- **John Plunkett** of Wykoff, N.J., was still undecided about his future plans as of graduation day.
- **Brian Rockwell** of Fort Mills, S.C., has accepted a position with Microsoft Corporation in Seattle, Wash.
- **Michael Sizemore** of Lenexa, Kan., is moving to Coopersburg, Pa., where he will be employed by Lutron Electronics.
- **Adam Swanson** of Braidwood, Ill., will be moving back home, where he will work at the Exelon-Braidwood Generating Station.

- **Sara Taylor** of Venetia, Pa., is moving to Chicago, where she has accepted a position with Accenture.
- **Cameron Thorpe** of Stratham, N.H., will be working for Raytheon Corporation in Marlborough, Mass.
- **Andrew Velzen** of Jenison, Mich., has entered the PhD program in electrical engineering at Purdue University.

- **John Walsh** of New Orleans, has started work at Electroimpact in Seattle, Wash.
- **Mark Wurzelbacher** of West Harrison, Ind., will be attending the University of Wisconsin in Madison, Wis., where he will pursue an M.A. in music theory.
- **Alan Yanchak** of Katy, Texas, is moving to Dallas to work for Texas Instruments.

- **Karen Yokum** of New Orleans, will be working for IBM Corporation in Austin, Texas.
- **John Zielinski** of Honeoye Falls, N.Y., has accepted a position with Deloitte in Boston, Mass.

## Notre Dame Department of Electrical Engineering Graduates 13 PhDs

The 2012 Graduate School Commencement was held on Saturday, May 19, in the Compton Family Ice Arena. The ceremony honored all students who received a master's or doctoral degree from Notre Dame in the previous 12 months – including 13 graduating with a PhD in electrical engineering. The principal speaker was Dr. Thomas Quinn (BS, '69, MS, '70), the founding director of the John Hopkins' Center for Global Health and the author of nearly 700 publications in the epidemiology, pathogenesis, and clinical features of HIV/AIDS.

The Doctor of Philosophy degree is awarded after a prolonged and deep course of graduate study and research. Notre Dame's PhD requirements in EE mandate 36 course credits beyond the BS degree, in addition to the completion of a PhD dissertation – a document that makes a substantive contribution to the theory and/or practice of electrical engineering. The PhD is the most advanced electrical engineering degree offered in the United States and most other countries; it is the de facto requirement for university faculty positions and many industrial research jobs.

The number of PhDs graduated in EE from Notre Dame over the last ten years has grown substantially – averaging 12.6 per year over the last five years compared with 5.4 per year between 1997 and 2002. This growth has reflected the department's increasing visibility and impact in research and its growing prominence among American research universities.

Here is a list of the 13 EE doctoral recipients honored during the ceremony, along with their advisers' names, the titles of their dissertations, and their post-graduation plans:

- **Ralf Bendlin**, advised by Prof. Yih-Fang Huang. The title of Bendlin's dissertation was "Intercell Interference Coordination without Base Station Cooperation for Wireless Cellular Networks," and he is employed by Texas Instruments in Dallas, Texas.
- **Michael Dickens**, advised by Prof. J. Nicholas Laneman. Dickens' dissertation was entitled, "SURFER: Any-Core Software Defined Radio."
- **Tian Fang**, co-advised by Prof. Debdeep Jena and Prof. Grace Xing. The title of Fang's dissertation was "Carrier Transport in Graphene, Graphene Nanoribbon and GaN HEMTs," and he is employed as a device engineer at First Solar in Perrysburg, Ohio.
- **Joseph Herzog**, co-advised by Prof. James Merz and Prof. Alexander Mintairov. Herzog's dissertation was "Optical Spectroscopy of Colloidal CdSe Semiconductor Nanostructures." He is a postdoctoral research associate at Rice University in Houston, Texas.
- **Shashank Maiya** was advised by Prof. Thomas Fuja. His dissertation was entitled "Cooperation and Latency in Channel Coding for Wireless Communications," and he is currently a senior systems engineer at Qualcomm, Inc., in Santa Clara, Calif.
- **Krishnan Padmanabhan** was advised by Prof. Thomas Fuja. The title of Padmanabhan's dissertation was "Multi-user Communication over Wireless Channels with Unknown Fading." He is currently working for a start-up technology company in Silicon Valley.
- **Chris Seibert**, advised by Prof. Doug Hall. Seibert's dissertation was "Properties and Characterization of Deeply-Etched High-Index-Contrast Ridge Waveguide Structures." He is employed by Intel Corp. in Albuquerque, N.M.
- **Sunil Srinivasa**, advised by Prof. Martin Haenggi. The title of Srinivasa's dissertation was "Statistical Mechanics for Wireless Systems: Applications of Exclusion Processes to the Modeling and Analysis of Multihop Networks," and he is currently a senior systems engineer at LSI Corporation in Milpitas, Calif.
- **Madagama Sumanasena**, advised by Prof. Peter Bauer. Sumanasena's dissertation was "A Multidimensional Systems Approach to Grid Sensor Networks." He is currently employed as a research engineer at the University of California at Davis.
- **Kristof Tahy** was advised by Prof. Debdeep Jena. The title of Tahy's dissertation was "2D Graphene and Graphene Nanoribbon Field Effect Transistors," and he is employed by Intel Corp. in Hillsboro, Ore.
- **Badri Tiwari**, advised by Prof. Wolfgang Porod. The title of Tiwari's dissertation was "Antenna-Coupled Unbiased Detectors for LW-IR Regime," and he is currently working for Intel Corp. in Albuquerque, N.M.
- **Sundeep Venkatraman** was advised by Prof. Daniel J. Costello Jr. The title of Venkatraman's dissertation was "Information Rates and Capacity for Multi-antenna Cellular Systems with Fading," and he is currently a senior systems engineer at LSI Corporation in Milpitas, Calif.
- **Ze Zhang**, advised by Prof. Patrick Fay. Zhang's dissertation was entitled "Sb-Heterostructure Backward Diodes for Direct Detection and Passive Millimeter-wave Imaging," and he works for IBM Corp. in Essex, Vt.

In addition to 13 doctoral degrees, the Department of Electrical Engineering also awarded 18 Master of Science degrees in the 12 months ending May 2012.

## Schrader Named Chancellor of Missouri University of Science and Technology

**Cheryl B. Schrader** (MS, '87; PhD, '91) was appointed chancellor of Missouri University of Science and Technology (Missouri S&T) on April 2, 2012. Schrader received her MS and PhD degrees in electrical engineering from the University of Notre Dame under the direction of the late Professor Michael Sain.

A former dean of engineering at Boise State University, Schrader is one of the few female engineers to ascend to the top leadership position of a college or university in the United States. She will become the 21st leader in Missouri S&T's 141-year history.



*(Photo courtesy of B.A. Rupert/Missouri S&T)*

## Thibault Receives GE Award, Directs Fellowship Proceeds to Notre Dame



**Jean-Baptiste Thibault** (PhD, '06) was one of seven General Electric scientists and engineers to be named a recipient of the Edison Pioneer Award in 2011.

The award, which was presented by GE chairman and CEO Jeffrey Immelt honors mid-career scientists and engineers for contributions that have impacted the vitality of the company. Thibault was honored for his efforts in iterative reconstruction for computed tomography, a breakthrough technology for low-dose, high-quality CT scans.

Thibault began his work in iterative reconstruction for CT when he was a graduate student working with Ken Sauer, associate professor of electrical engineering. He and Sauer and their Purdue collaborator, Charles A. Bouman, the Birck Professor of Electrical and Computer Engineering, saw the development of the technology from its initial research through its recent deployment in the United States and abroad under the name Veo.

As part of the award, GE donated \$10,000 to an academic or philanthropic organization of Thibault's choosing, and Thibault chose Notre Dame's Department of Electrical Engineering to be the beneficiary of the award. As a result, one of Notre Dame's EE graduate students will be supported next year by the Thibault Fellowship.

"I owe much of this success to my graduate studies at Notre Dame and the great support and collaboration from my adviser, Ken Sauer," says Thibault. "I am proud that I can now in turn help another student achieve his or her goal of getting a great education at the start of a new career."



## ALUMNA PROFILE

## Danielle (Walker) Merfeld

When **Danielle Walker** arrived on the Notre Dame campus in August 1990, she didn't know that she was starting what would be almost a decade of higher education — and a career that

would take her to a senior leadership position in one of the most respected companies in the world.

One of five children raised in an Air Force family, Walker moved regularly throughout her childhood; in fact, her four years in Pasquerilla West was, at the time, the longest stretch she kept the same address. Like many female EE students of the '90s — and, unfortunately, even today — she found herself in classrooms surrounded by young men.

"There was only one other woman in my graduating class of around 30, and she was not an EE but a computer engineer," recalls Merfeld.

She remembers one undergraduate class in particular as especially intriguing — semiconductor physics. "Professor Gary Bernstein was pretty new then," she says, speaking of the current holder of a Freimann Chair who had joined the department in 1987. "And his description of electrons and holes sounded crazy to me."

But Merfeld knew she wanted to learn more about those "crazy" electrons and holes, so when she graduated from Notre Dame in 1994, Merfeld moved to Evanston, Ill., where she pursued graduate studies in electrical engineering at Northwestern University. Like many graduate students, she found her life shrinking to an ever-smaller universe centered on her laboratory, where she spent long hours trying to coerce light from gallium nitride devices.

Fortunately, her proximity to Chicago also meant proximity to plenty of Notre Dame classmates — newly minted professionals who would occasionally convince her to abandon her research for just one night and join them for a beer.

Merfeld received her PhD from Northwestern in 2000; her dissertation was titled, "Aluminum Gallium Nitride Ultraviolet Photodetectors: Device Design, Fabrication and Characterization," and she began her career with General Electric at its Global Research Center in Niskayuna, N.Y., outside of Schenectady.

"I was working at one of the last remaining corporate research centers and the most technically diverse research center in the world," says Merfeld. "I was in heaven. I got to use my PhD in wide bandgap semiconductor devices to develop new products for GE based on LEDs, sensors, and power electronics."

Danielle's trajectory at GE had a strongly positive slope. Within a year of joining GE Global Research, she was

named the manager of its Semiconductor Technology Laboratory, where her group focused on the development of wide bandgap devices such as UV light emitters, harsh environment sensors, high frequency power devices, and high power/high temperature electronic devices. In 2007 she became GE's Solar Technology Platform leader, and subsequently she was tapped to run GE's solar business from its Schenectady headquarters — a position she held until very recently.

Leading the charge of one of the world's largest and most respected corporations into the dynamic world of solar power required a wide bandwidth, and making the transition from a technology leader to a business leader has meant there was rarely a dull moment.

"A typical day would include interactions with the leaders across my team in the solar business," says Merfeld. "We would talk through engineering programs to develop or

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***"I'm very excited about this opportunity," says Merfeld. "It gives me a chance to drive the technology strategy across GE businesses globally. It also means I am the corporate champion for solar, so I get to maintain a strong tie to that business."***

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improve products. I worked with our execution and fulfillment teams to ensure that our customers were getting what they wanted from us, and I spoke with potential new customers about why they should buy utility scale solar plants from GE."

In August 2012 Merfeld was promoted to a new role within GE Corporate at the Global Research Center when she was named the Technology Director for Electrical Technologies and Systems, one of GE's six technical domains. (The others are chemistry, materials, medical diagnostics, propulsion, and software.) This move propelled her into the role of a senior executive at GE, with more than 500 technologists in four countries reporting to her.

"I'm very excited about this opportunity," says Merfeld. "It gives me a chance to drive the technology strategy across GE businesses globally. It also means I am the corporate champion for solar, so I get to maintain a strong tie to that business."

She is married to Glenn Merfeld, and they have three children — twin seven-year-old girls and a son who is four. She can be reached at [Danielle.Merfeld@ge.com](mailto:Danielle.Merfeld@ge.com).



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