

# eee

## ELECTRICAL ENGINEERING AT THE UNIVERSITY OF NOTRE DAME

### Through Its LEAST Center, ND Leads the Way in Low-Power Microelectronics

The largest research award ever made to Notre Dame is now almost two years old – and its results could reshape the microelectronics industry.

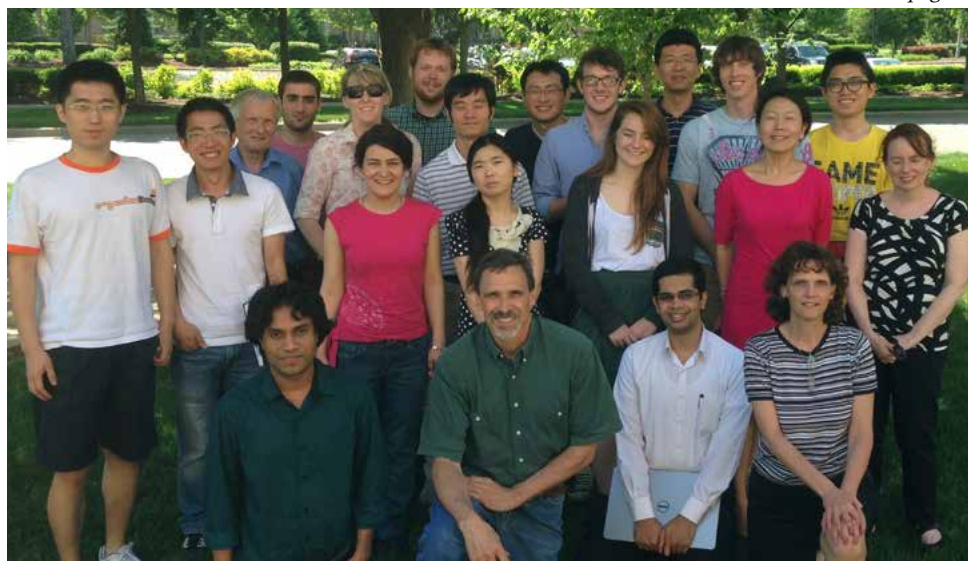
It was in January 2013 that it was announced that Notre Dame had been selected to lead one of six new university-based microelectronics research centers co-sponsored by the industry consortium Semiconductor Research Corporation (SRC) and the U.S. Defense Advanced Research Projects Agency (DARPA). The Notre Dame initiative, called the Low Energy Systems Technology (LEAST) center, was established as part of the five-year, \$194 million STARnet program, designed to support the continued growth and leadership of the U.S. semiconductor industry.

The LEAST Center, led by Notre Dame Professor of Electrical Engineering Alan Seabaugh, receives funding of approximately

\$6 million per year. The Center's 26 faculty members work at Notre Dame and ten partner universities: Carnegie Mellon, Georgia Tech, Illinois Institute of Technology, Penn State, Purdue, UC Berkeley, UC San Diego, UC Santa Barbara, UT Austin, and UT Dallas. As the lead institution, Notre Dame is home to more researchers than any other university in the consortium and also receives the largest share of the external funding.

The focus of LEAST is the development of new electronic materials, devices, and architectures that enable ultra-low power operations. The motivation behind LEAST is that the "workhorse" digital switching technology for the last 40 years

*Continued on page 4*



## A LETTER FROM THE CHAIR



### Undergraduate Numbers

When I came to Notre Dame in 1998 from a faculty position at the University of Maryland, I was surprised by the relatively small number of EE undergraduates. At Maryland – and most universities I was familiar with – Electrical Engineering and Mechanical Engineering were the “Big Two” among engineering departments, attracting far more students (and employing far more faculty members) than the “lesser” disciplines. (I can write that because this Newsletter only goes to EE alumni.)

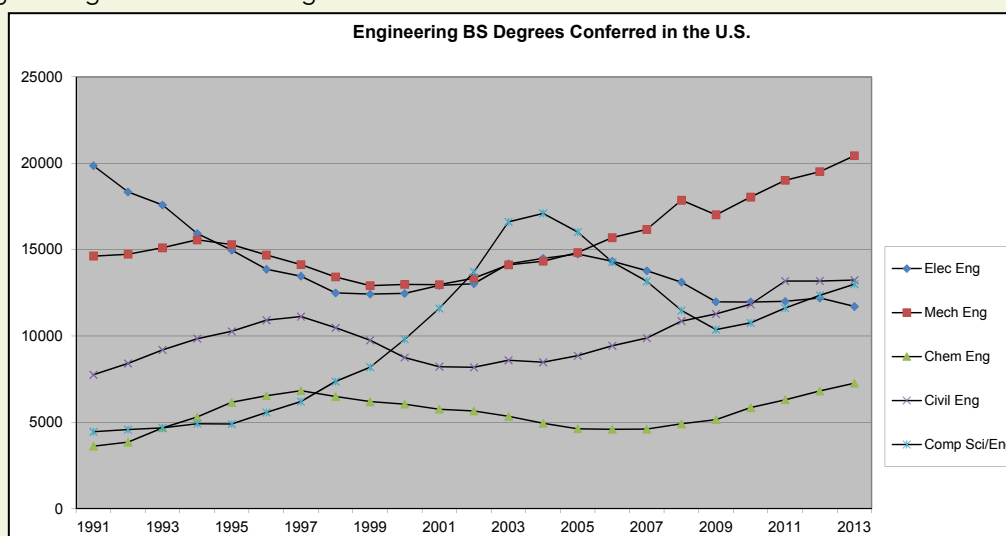
But that wasn’t true at Notre Dame in 1998. Not only did Mechanical Engineering have (many) more undergraduates enrolled than EE, so did Chemical Engineering, Civil Engineering, and Computer Science & Engineering.

It had not always been that way. In the mid-1980s, the Department of Electrical Engineering had by far the largest undergraduate enrollment of any engineering program at Notre Dame. In 1986, for example, of the 333 undergraduate engineering degrees awarded, 138 of them – more than 40% – were BSEE degrees. However, over the next fifteen years, the number of engineering degrees awarded at Notre Dame declined, and EE’s “share” of those degrees declined even faster. By 2001, only 172 engineering baccalaureate degrees were

awarded at Notre Dame, and only 20 of them – barely 11% – were BSEE degrees.

Of course, we asked ourselves why this was happening, and we had answers that seemed plausible, if less than satisfying. Some blame was attached to the establishment of the Department of Computer Science & Engineering in the early 1990s – a “rival” for the affection of undergraduates interested in information technology. There was also some discussion about the perception of Mechanical Engineering as the most “generic” engineering degree – something that students pursuing an engineering degree as a *credential* (rather than drawn by interests) may be attracted to. And finally, there was some feeling that we were part of a national trend.

And we were part of a national trend – and maybe even in front of that trend. The figure below<sup>1</sup> shows the number of BS degrees awarded in five engineering disciplines in the U.S. over the last 25 years. As late as 1991, EE was the most popular undergraduate engineering degree by a substantial margin. However, by 1995, EE and ME were “tied” for that role and remained tied for most of the next decade. (The “tech boom” of the 1990s created a three-year window where Computer Science/Engineering outpaced both.)



<sup>1</sup>Taken from data in the yearly report, “Engineering and Technology Degrees,” compiled by the Engineering Workforce Commission of the American Association of Engineering Societies, Inc.

However, for the last ten years, something has happened that has befuddled those of us who attend the yearly meeting of the Electrical & Computer Engineering Department Heads Association (ECEDHA). Mechanical Engineering has become, by a considerable margin, the most popular choice for undergraduates pursuing engineering degrees. In 2005, there were approximately as many BSEE degrees awarded as BSME degrees; however, eight years later, there were 75% more ME degrees awarded than EE degrees. And moreover, some of those "lesser" disciplines – like Civil Engineering – are now (slightly) more popular than EE.

Why is that?

There are theories. One is that the very pervasiveness of electronic information technology makes it less exciting and "sexy" – it's become part of the wallpaper of life. (Conversely, the "hot" technology niches – biomedical technology, clean energy, environmental engineering, etc. – appear to the uninformed to be areas that have little to do with electrical engineering, even though we know that's not true.) Another theory I've heard is that incoming students (and their parents) see information technology jobs as less stable and more susceptible to being lost through "offshoring." (Your iPhone may be built in China, but it's unlikely that the next Chicago high rise will be assembled there.) And still another theory is that some of today's most visible technology success stories – Facebook, Amazon, Google – have more of a software orientation than the success stories of 15-20 years ago, which suggests that the increase in CS degrees over the last five years may have come at least in part at the expense of EE.

Plus, EE is a hard major. But it's always been a hard major.

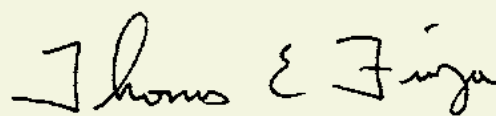
Whether employment prospects are behind the slow growth of EE grads relative to other engineering disciplines is a little hard to discern. Close to home, almost all of our department's undergraduates have a job lined up by the time they graduate, many with multiple offers – and that was true throughout "The Great Recession." Nationally, the Bureau of Labor Statistics (BLS) lists EE job growth over

the next decade as "Slower than Average" – but it also labels Mechanical Engineering and Chemical Engineering with that same "Slower than Average" assessment. (Conversely, Civil Engineers and Software Engineers can expect growth rates that are "Faster than Average" and "Much Faster than Average," according to the BLS.) More broadly, it seems unlikely that students are avoiding EE because they think they will have a hard time finding a job with an EE degree.

Regarding the state of engineering at Notre Dame today, I mentioned that ND's engineering enrollment hit its nadir in 2001 when we awarded 172 bachelor degrees. Through the leadership of Engineering Deans Frank Incropera and Peter Kilpatrick – and a lot of hard work by the faculty and staff – that number has climbed dramatically; in 2013 and 2014, we graduated 338 and 331 BS degrees, respectively, and our incoming First Year group of "Engineering Intents" is the largest ever. There has been some corresponding growth in EE enrollment, although not as much as we would like; we're typically still closer to 10% of the undergraduate degrees awarded than 15%. (On the other hand, our graduate program is thriving; we now regularly graduate about 15 PhD degrees per year and are well positioned to hit our goal of 20+ per year going forward.)

So what do you think? Is the slight decline in BSEE degrees awarded nationally over the last 10 years symptomatic of something fundamental? Is industry well served by the current "production" of BSEE grads? And what can Notre Dame do to ensure that our undergraduate program thrives and EE graduates are valued and sought after when they venture into "the real world"? As our alumni, you can provide us with a non-academic perspective that will help guide us through the interesting times ahead.

Please feel free to send me an email at [tfuja@nd.edu](mailto:tfuja@nd.edu) or to call me at 574-631-7244.



*Continued from page 1 (LEAST Center)*

– silicon-based CMOS – is fast approaching a point where it cannot be scaled any smaller due to limits on heat dissipation. Therefore, to extend Moore’s Law – and to continue making electronic devices that are smaller, cheaper, faster, and more pervasive than what came before – requires developing a new switching technology based on (potentially) different material systems.

From a technical perspective, part of the impetus for LEAST’s research agenda was the work done on *tunneling field effect transistors* (TFETs) in an earlier Notre Dame research center. The Midwest Institute for Nanoelectronics Discovery (MIND) was established at Notre Dame in 2008 with funding from the SRC and the National Institute of Standards and Technology (NIST). Like LEAST, its predecessor MIND addressed “post-CMOS” technologies, and TFET research was one of the pillars of MIND’s research agenda. TFETs use a different phenomenon to effect switching than conventional MOSFET technology – quantum tunneling *through* a barrier rather than thermionic emission *over* a barrier – and so TFETs can exhibit a steep “subthreshold swing” that enables operation at less than 0.4 V, thus reducing power consumption dramatically.

Ultimately, the TFET research carried out as part of MIND was a victim of its own success. The industry partners funding MIND decided that TFETs were *so* promising that they would take them “in house” – i.e., continue their development internally, rather than as part of a shared and relatively-open research collaboration.

However, the MIND research also indicated that the ultra-low voltages and steep transitions associated with TFETs were not *limited* to TFETs, so the proposal that ultimately resulted in the LEAST award set forth a multi-pronged research agenda dedicated to other technologies exhibiting steep transitions between their on and off states – i.e., less than 60 mV/decade of current at room temperature.

“Anyone with a laptop feels the heat it generates,” said LEAST Director Alan Seabaugh. “In data centers, this heat requires a costly cooling system. Heat prevents us from packing more transistors onto a computer chip. The mission of LEAST is to discover devices which will run cooler and pack tighter. This will change the rules limiting how many transistors we can put on a chip and how fast we can operate them.”

There are four technical “themes” that LEAST uses to organize its research agenda.

1. Materials, interfaces, and surfaces – with sub-themes that include oxide-based and nitride-based materials as well as two-dimensional crystals.
2. Quantum engineered steep transistors – aimed at understanding and demonstrating steep slope tunneling devices in 2D graphene and dichalcogenide crystals,

III-Nitrides, and complex oxides.

3. Transduction components – exploring transduction mechanisms beyond tunneling to further lower subthreshold swing and add new functionality to steep devices.
4. Benchmarks, circuits, and architectures – providing benchmarking activities for the Center and exploring applications for steep technologies, including low-power digital logic, low-power analog, high-frequency mixed signal, security, non-von-Neumann machines, and non-Boolean computing.

In the year and a half since LEAST took flight, both the *quantity* and the *quality* of the sponsored research has been staggering. In just seventeen months, LEAST researchers have already submitted over 300 technical papers – a rate of about four per week. Moreover, the LEAST research is “spinning off” ideas that are launching other NSF and Department of Defense proposals, including a recent successful NSF proposal to develop two-dimensional memory technology. LEAST faculty members continue to be recognized for their research success. (See the related stories under “Faculty News”.)

Undergraduates are also playing a substantial role in LEAST. One of Notre Dame’s EE undergrads won a STARnet summer internship to work at UT Dallas in the summer of 2014, while another four undergraduates received Undergraduate Research Fellowships from the Notre Dame Center for Nano Science and Technology.

In August 2014, LEAST held its first review, bringing to campus researchers from its industrial partners at Applied Materials, Intel, IBM, Texas Instruments, GLOBALFOUNDRIES, Micron, Raytheon, and United Technologies. The review featured both talks by faculty on the latest transistor demonstrations and a large poster session with more than 50 posters by graduate students and post docs. Fundamental theory for four new transistors was developed this year and presented at the meeting, and circuit simulation models have been developed for the TFET and another ND-invented transistor, the SymFET (symmetric graphene TFET). One of these TFET models was implemented on Android and iPhone platforms and will be available soon, allowing anyone to explore TFET circuit designs on the application AIMSPICE.

The development of new device and circuit models have, in turn, enabled new directions for research in computing, pattern recognition, imaging, energy harvesting, sensor networks, and security. Five patents from LEAST-sponsored research are in process.

Anyone interested in learning more about Notre Dame’s LEAST Center is invited to visit its home page at <http://least.nd.edu/>.

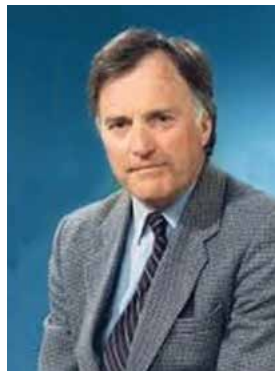


## Two Funds Established to Honor Former ND Electrical Engineering Faculty Members

The University of Notre Dame has established named funds to honor the memory of two former EE faculty members – James L. Massey and Kenneth (“Kenny”) Kempf. The funds were launched by former students who admired the dedication that the two men brought to their time at Notre Dame. They had very different careers – the world-famous information theorist who would spend his last 36 years abroad, and the circuits “drill sergeant” who wanted his undergraduate students to know that engineering was “more than what you read in a textbook” – but they both touched a generation of Notre Dame students fifty years ago.

Details on how to donate are provided below.

*James L. Massey* (1934-2013) received the B.S.E.E. from Notre Dame in 1956. Jim was Notre Dame’s valedictorian that year; his twin brother Jerry, who majored in philosophy, was the class salutatorian. After three years of active service in the U.S. Marine Corps, Jim attended the Massachusetts Institute of Technology (MIT), earning M.S. (1960) and Ph.D. (1962) degrees in electrical engineering.



For the next 15 years, from 1962 until 1977, Jim taught at Notre Dame, where he was ultimately appointed the Frank M. Freimann Professor of Electrical Engineering, earning the distinction of filling Notre Dame’s first endowed chair. Jim then taught briefly at MIT and the University of California at Los Angeles before accepting a position at the Swiss Federal Institute of Technology (ETH) in 1980, where he worked until his 1998 retirement. From 1998 until his death, he held an adjunct research appointment at Lund University (Sweden). He continued to be a productive researcher, scholar, and sought-after lecturer to the end of his life.

Jim Massey was a pioneer in digital communications, having received virtually every honor and award available to communications

engineers. He was a member of the U.S. National Academy of Engineering, the European Academy of Sciences and Arts, the Swiss Academy of Engineering Sciences, the Royal Swedish Academy of Sciences, and the Hungarian Academy of Sciences. In 1988, Jim received the Claude E. Shannon Award from the Institute of Electrical and Electronics Engineers (IEEE) Information Theory Society, its most prestigious prize, for “consistent and profound contributions to the field of Information Theory.” In 1992, he was the recipient of the Alexander Graham Bell Medal, awarded annually by the IEEE for “exceptional contributions to the advancement of communications sciences and engineering.” In 1999, he received the Marconi Prize for “advancements in communications.”

The James L. Massey Endowment in Electrical Engineering has been established to provide financial support to graduate students in electrical engineering at Notre Dame. An anonymous donor has pledged to match the next \$10,000 donated to the fund. To donate, please go to [donate.nd.edu](http://donate.nd.edu) and specify the James Massey Endowment as the designation for your gift. Alternately, gifts and pledges can be mailed to: Annual Fund, University of Notre Dame, PO Box 519, Notre Dame, IN 46556. Contributions will count towards the donor’s football ticket application status for the following calendar year.

*Kennth* (“*Kenny*”) *Kempf* (1921-1979) received his B.S.E.E degree and his M.S.E.E. degree from Notre Dame in 1952 and 1955, respectively. Kenny worked as an electrical engineer at Notre Dame for ten years, from 1952 until 1962, before moving to Koontz-Wagner Electric Company of South Bend. As part of his Koontz-Wagner employment, Kenny had a major role in the design of the Notre Dame power plant.



Kenny Kempf taught circuits courses in Notre Dame’s Department of Electrical Engineering from 1962 until 1966. It is three members of the Class of 1964 who have launched the effort to memorialize Kenny – Mike Ciletti, Tom Duff, and Carl Massarini.

“He really put the fear of failing into our hearts,” recalls Ciletti. “He had a ‘drill sergeant’ approach that tolerated no nonsense in the classroom. He filled the

room with a blue-collar, lunch bucket, roll up your sleeves ambience that we didn’t find in many of our other classes.”

Ciletti, who would go on to earn a PhD at Notre Dame before spending his career on the faculty of the University of Colorado at Colorado Springs, said that he and his classmates found Kempf’s demanding style to be oppressive at the time – but that over the course of their careers they would come to rely on the lessons their “drill sergeant” drilled into them.

“He really challenged us to move outside our comfort zone and helped us to develop a stronger work ethic than we would have ever thought possible.”

Contributions to the Kenneth Kempf Memorial Scholarship will be used to support undergraduate students pursuing a degree in EE. Donations of any amount are welcome, and may be pledged over a period of 3-5 years. To donate, please go to [donate.nd.edu](http://donate.nd.edu) and specify the Kenneth Kempf Memorial Scholarship as the designation for your gift. Alternately, gifts and pledges can be mailed to: Annual Fund, University of Notre Dame, PO Box 519, Notre Dame, IN 46556. Contributions will count towards the donor’s football ticket application status for the following calendar year.





Prof. Bertrand Hochwald

### Bertrand Hochwald Among World's Most Influential Minds

Bertrand Hochwald, the Frank M. Freimann Professor of Electrical Engineering, was recently included on the list "The World's Most Influential Scientific Mind: 2014," compiled by Thompson Reuters. The list of approximately 3200 researchers from around the world was based on citations to research publications; it identified the researchers who had the most highly-cited papers – in the top 1% of their discipline – over a ten-year period. Prof. Hochwald is a specialist in wireless communications, having spent much of his career at AT&T Bell Laboratories and at Beceem Communications before joining the Notre Dame faculty in 2011. He has 26 patents in wireless communications, and the results of his research have been included in the technical standards for cellular telephony. Prof. Hochwald was one of three Notre Dame faculty members to have been included on the list.



Prof. Daniel J. Costello, Jr.

### Daniel J. Costello, Jr. Receives Graduate Education Award

Daniel J. Costello Jr., the Leonard Bettex Professor Emeritus of Electrical Engineering at the University of Notre Dame, has been named the recipient of the 2015 Leon K. Kirchmayer Graduate Teaching Award by the Institute of Electrical and Electronics Engineers (IEEE). With more than 430,000 members in more than 160 countries, the IEEE is the world's largest professional association dedicated to advancing technological innovation. The Kirchmayer Award is the only IEEE award for graduate education; it honors creativity and enthusiasm in the teaching of graduate students.



Prof. Huili Xing

### Huili Xing Receives 2014 Young Scientist Award

The International Symposium for Compound Semiconductors (ISCS) has named Huili (Grace) Xing, professor of electrical engineering at the University of Notre Dame, the winner of the 2014 Young Scientist Award. Established in 1986, the award acknowledges technical achievements in the field of compound semiconductors by a scientist younger than 40 years. Xing is being recognized "for her contributions to the understanding of the fundamental properties of III-V nitrides and graphene, novel devices and demonstrations of devices exhibiting record performance." The award was presented to Prof. Xing in May 2014 at the 41st ISCS conference in Montpellier, France.



Prof. Patrick Fay

### Hochwald and Fay Receive NSF Award to Investigate Electromagnetic Exposure from "Smart Phones"

Modern smart phones have several different radio transmitters embedded in their circuitry – not only multiple cellular radios (for current 4G phones as well as legacy 2G and 3G models), but also WiFi and Bluetooth transmitters, all operating in different frequency bands at different power levels. Regulatory limits on wireless devices used close to the human body are expressed in terms of the allowable "specific absorption rate" (SAR), a measure of the absorbed electromagnetic energy. Two Notre Dame faculty members, Prof. Bert Hochwald and Prof. Patrick Fay, are leading a team of researchers from Notre Dame, Illinois, and Purdue to develop a model for assessing and controlling SAR exposure from multiple radio sources. The \$510,000 award will support research to investigate the electromagnetic coupling that occurs in such radios and methods for limiting SAR exposure in smart phones.



Prof. Susan Fullerton

### Fullerton and Seabaugh Partner with Industry to Investigate Two-Dimensional Memory Technology

Notre Dame faculty members Susan Fullerton and Alan Seabaugh have received a \$370,000 award from the U.S. National Science Foundation to develop a new memory device that relies on the movement of ions to control electron transport in graphene – a single layer of carbon atoms. Their award is part of NSF's "Grant Opportunities for Academic Liaison with Industry" (GOALI) program, which incentivizes academic/industrial collaboration. According to Research Assistant Professor Fullerton, "Our ultimate goal is to move ions back and forth between two graphene sheets that are separated by a few nanometers. In comparison, the lithium ions in your cell phone battery move more than 10,000 times this distance during charging and discharging."



Prof. Alan Seabaugh



Prof. Martin Haengggi

### Two EE Faculty Named Fellows of IEEE

EE Professors Martin Haengggi and J. Nicholas Laneman have been named Fellows of the Institute of Electrical and Electronics Engineers (IEEE). The IEEE is the world's leading professional association for advancing technology for humanity, with more than 400,000 members in 160 countries. IEEE Fellow is the highest grade of membership; no more than one-tenth of 1% of the Institute membership can be admitted to Fellow status in any year. Prof. Haengggi, who has been on the faculty since 2000, was honored for contributions to the spatial modeling and analysis of wireless networks. Prof. Laneman, who joined Notre Dame in 2002, was recognized for contributions to multi-hop relaying and cooperative communication for wireless networks.



Prof. J. Nicholas Laneman



# Graduation 2014 – Undergraduates

On Sunday, May 18, 2014, almost 2000 undergraduates took part in the University of Notre Dame's 169th commencement exercises. Included among the expanse of caps and gowns in Notre Dame Stadium were 35 graduates who received BS degrees in electrical engineering.

The main commencement speaker for Sunday's campus-wide event was Rev. Dr. Ray Hammond. Dr. Hammond entered Harvard College at the age of 15 and completed his medical degree from Harvard Medical School by the age of 23. After establishing a successful medical practice, he was called to the ministry, co-founding Bethel African Methodist Episcopal Church in Boston in 1988. Dr. Hammond spoke powerfully about the need for the graduates to remember the "grace of collective support" that helped them get to where they are today – and to "pass it on."

Dr. Hammond received an honorary degree from Notre Dame, as did five other accomplished individuals including Prof. Evelyn Hu, a professor of applied physics and electrical engineering at Harvard University and a longtime friend of Notre Dame's Department of Electrical Engineering.

After the university-wide ceremony, there was a luncheon sponsored by the College of Engineering outside of Stinson Remick Hall, 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 PM in DeBartolo Hall. The gathered students, family members, and faculty heard remarks from classmates Jane McGuinness, Calvin Belden, and Tim Bontrager. The ceremony also included a slide show of random moments captured from the last four years.

There were several awards made to honor graduating seniors who excelled academically. Those students included Jane McGuinness (recipient of the Steiner Award), Sarah Divel (James L. Massey Award), Calvin Belden (Basil R. Myers Award), Lindsey Forsberg (Arthur J. Quigley Award), and Kelsey Han (Lawrence F. Stauder Award). Also honored were the recipients of two teaching awards – the 2014 Graduate Instructor's Award, which went to graduate student Itrat Bin Shams, and the 2014 Faculty Teaching Award, which went to Prof. Gary Bernstein.

Here are the May 2014 graduates of Notre Dame's Department of Electrical Engineering, along with their immediate plans, where known:



- **Calvin Belden** of Mahtomedi, MN has accepted a position with Adage Technologies in Chicago, IL.
- **Timothy Bontrager** of Overland Park, KS will be attending graduate school at the University of Minnesota in St. Paul, MN.
- **Matthew Creehan** of Pittsburgh, PA was undecided about his future plans as of graduation day.
- **Lucas de la Fuente Munita** of Santiago, Chile was also still pondering his options.
- **Sarah Divel** of Rockville, MD will pursue a Ph.D. in Electrical Engineering at Stanford University in Palo Alto, CA.
- **Lindsey Forsberg** of St. Paul, MN has accepted a position with Pacific Gas & Electric in San Francisco, CA.
- **Denise Garcia** of Buda, TX is moving to Austin, TX where she will be employed at the General Motors Innovation Center.
- **Kelsey Han** of Omaha, NE has accepted a position with Garmin International in Olathe, KS.
- **Gian Handal** of Tegucigalpa, Honduras is working for Pacific Gas and Electric in San Francisco, CA.
- **Galen Harden** of San Diego, CA is pursuing a PhD in Electrical Engineering at the University of Notre Dame.
- **Elizabeth Huschke** of Eden Prairie, MN has accepted an offer to work with Epic Systems of Madison, WI.
- **Jung Kim** of Seoul, South Korea will be returning home to serve in his country's military.
- **Ireer Romeo Kwihangana** of Dayton, OH will be working for GE Aviation Systems in Grand Rapids, MI.
- **Ka Hin Lee** of New York City is moving to Madison, WI, where he will work for Epic Systems.
- **Fernando Lozano** of Riverside, CA was still undecided about his future plans as of graduation day.
- **Lauren Mahle** of Springboro, OH has accepted a position with Northrop Grumman in Dayton, OH.
- **Michael Manno** of Rocky River, OH will be working for Robert W. Baird & Company in Chicago, IL.
- **Veronica Martinez** of Olivehurst, CA had not yet finalized her post-graduation plans.
- **Jane McGuinness** of Killingworth, CT is moving to California where she will work in San Jose for Stryker Endoscopy.
- **John Moore II** of Vero Beach, FL has accepted a position with Pacific Gas & Electric in San Francisco, CA.
- **Case Morris** of London, OH will be starting graduate school in Electrical Engineering at the University of Wisconsin in Madison, WI.
- **Robert Mustak** of Elkhart, IN has accepted a position with QualiTECH Engineering in Chicago, IL.
- **Jaclyn Nord** of Jackson, TN will be joining the Acquity Group in Chicago, IL.
- **John O'Brien** of Columbus, OH will be joining GE Lighting in Cleveland, OH.
- **Bryce Persichetti** of El Cajon, CA will be attending graduate school at the University of Pennsylvania in Philadelphia, PA.
- **James Phillips** of St. Charles, MO will be working for Progress Rail in Omaha, NE.
- **Angela Savela** of Grand Rapids, MN will be spending the next year in Germany as part of the Congress-Bundestag Youth Exchange Program.
- **Benjamin Shenk** of Goshen, IN will be joining Kiewit Power in Lenexa, KS.
- **Jacob Thorndahl** of Albuquerque, NM is returning to his hometown where he will work for MZA Associates Corporation.
- **Joshua Vahala** will begin his graduate studies at the University of Washington in Seattle, WA.
- **Shane Verploegh** of Northville, MI was still sorting out his options as of graduation day.
- **Alexander Wentzel** of Downingtown, PA was undecided about his future options.
- **Patrick Whalen** of Wescosville, PA will be joining Epic Systems in Madison, WI.
- **Justin Yoder** of Middlebury, IN has accepted a position with Accenture in Chicago, IL.
- **Nicholas Yulan** of Houston, TX was still undecided about his future plans as of graduation day.



## Notre Dame Department of Electrical Engineering Graduates 14 PhDs

The 2014 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 twelve months – including fourteen graduating with a Ph.D. in electrical engineering.

The principal speaker was Dr. Kerry Ann Rockquemore, who received her PhD in Sociology from Notre Dame in 1999 and was presented with the Graduate School's Distinguished Alumna Award at the ceremony. Dr. Rockquemore is President and CEO of the National Center for Faculty Development & Diversity, an independent faculty development center providing external mentoring for over 30,000 graduate students, post-docs, and faculty members in the United States. She spoke to the graduates about the importance of developing their own vision of success.

The Doctor of Philosophy degree is awarded after a prolonged and deep course of graduate study and research. Notre Dame's Ph.D. requirements in EE mandate 36 course credits beyond the B.S. degree, in addition to the completion of a Ph.D. dissertation – a document that makes a substantive contribution to the theory and/or practice of electrical engineering. The Ph.D. 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.

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

- **Ke Chen**, advised by Prof. Jay Brockman. The title of Dr. Chen's

dissertation was "Modeling and Designing High-Performance and Power-Efficient 3D DRAM Architectures," and he is employed by Oracle in Santa Clara, CA.

- **Lichun Li**, advised by Prof. Michael Lemmon. Dr. Li's dissertation was entitled, "Event Triggered State Estimation and Control with Limited Channel Capacity," and he has accepted a post-doctoral appointment at Georgia Tech.

- **Jai Verma**, advised by Prof. Debdeep Jena. The title of Dr. Verma's dissertation was "Polarization and Band Gap Engineered III-Nitrate Optoelectric Device Sculptures" and he is a SRAM FI Engineer at Intel Hillsboro, Oregon.

- **Po Wu**, advised by Prof. Panos Antsaklis. Dr. Wu's dissertation was "Symmetry and Dissipativity in the Design of Large-scale Complex Control Systems." He is employed by Amazon in Seattle, WA.

- **Wenjie Chen**, advised by Prof. Patrick Fay. Dr. Chen's dissertation was entitled "Defects in Emerging III-V Materials for Electronic and Optoelectronic Applications," and he is currently a Senior Engineer at Micron Technology in San Jose, CA.

- **Zhanwei Sun**, advised by Prof. J. Nicholas Laneman. The title of Dr. Sun's dissertation was, "Performance Metrics, Sampling Schemes, and Detection Algorithms for Wideband Spectrum Sensing." He is currently working for Qualcomm as a Senior Engineer in Santa Clara, CA.

- **Xinchen Zhang**, advised by Prof. Martin Haenggi. Dr. Zhang's dissertation was "Managing Randomness in Wireless Networks: Random Power Control and Successive Interference Cancellation." He is working as a post-doctoral researcher at the University of Texas in Austin, TX.

- **Satyaki Ganguly**, advised by Prof. Debdeep Jena. The title of Dr. Ganguly's dissertation was "High Performance III-Nitrate Heterostructure Devices

Exploiting Polarization, Isotope Physics, and Integrating with Silicon," and he is currently a Senior Processing Engineer at Intel in Hillsboro, OR.

- **Mostafa Khoshnevisan**, advised by Prof. J. Nicholas Laneman. Dr. Khoshnevisan's dissertation was "Intermittent Communication." He is currently employed as a Senior Systems Engineer at Qualcomm in San Diego, CA.

- **David Kopp**, advised by Prof. Patrick Fay. The title of Dr. Kopp's dissertation was "Microwave Performance and Fabrication of Quilt Packaging, a Novel Chip-to-Chip Interconnect Technology."

- **Peng Li**, advised by Prof. Gary Bernstein. The title of Dr. Li's dissertation was "Enhanced Permeability Dielectrics in Nanomagnet Logic," and he is currently a post-doctoral researcher at Colorado State University in Ft. Collins, CO.

- **Mohammad Siddiq**, co-advised by Prof. Gary Bernstein and Prof. Michael Niemier. The title of Dr. Siddiq's dissertation was "Clock Line and Field-Coupled Input for Nanomagnet Logic," and he is currently employed by Everspin Technologies in Chandler, AZ.

- **Timothy Vasen**, advised by Prof. Alan Seabaugh. Dr. Vasen's dissertation was entitled "Investigation of III-V Tunneling Field-Effect Transistors," and he works for TSMC and Lund University in Lund, Sweden.

- **Feng Zhu**, advised by Prof. Panos Antsaklis. Dr. Zhu's dissertation was "Passivity Analysis and Passivation in the Design of Cyber-Physical Systems," and he is employed as a Research Scientist at Amazon in Seattle, WA.

In addition to fourteen doctoral degrees, the Department of Electrical Engineering also awarded thirteen Master of Science degrees in the twelve months ending May 2014.



## ALUMNUS PROFILE

### Joe Sifer

When Philadelphia native Joe Sifer graduated from Notre Dame in 1987, he was one of 126 students to receive a B.S.E.E. degree from Our Lady's University that year – not an unusually large class in the mid-80's, but one that dwarfs today's enrollments.

A resident of Fisher ("Go Green Wave!") Hall, Joe was part of the team that started the Fisher Regatta, the wildly popular race of student-built boats across St. Mary's Lake that continues to draw crowds every April. Joe spent his senior year as an RA working with Brother Edward Luther, CSC, Rector of Fisher Hall, and he credits Brother Luther as having been a powerful and positive influence on not only him but many of his Fisher brethren.

As an undergrad, Joe was drawn to the "systems" side of electrical engineering, and he fondly remembers taking classes from Professors Mike Sain, Panos Antsaklis, Dan Costello, and Art Quigley. Joe's academic advisor – and research mentor – was Prof. John Uhran, who encouraged Joe to pursue graduate study and helped him hone his graduate school applications.

Upon graduation from Notre Dame in 1987, Joe was offered several attractive opportunities for graduate study, including Stanford, MIT, UC-Berkeley, Wisconsin, and Illinois. He ultimately decided to pursue his M.S.E.E. at Berkeley under the tutelage of Prof. Charlie Desoer and Prof. Shankar Sastry, two internationally prominent researchers in system and control theory. (Sastry is currently the Dean of Engineering at Berkeley; Desoer died in 2010.)

"While I was a graduate student, I had the opportunity to work at NASA-Ames Research Center on control system design for advanced

aircraft," said Joe. "After Berkeley, in 1989, I went to work for The Aerospace Corporation in El Segundo, CA, where I worked as an engineering analyst on the avionics, electronics, control, and communications systems for various space vehicles and satellites."

Sifer's work for The Aerospace Corporation took him to Washington DC, where he picked up a second MS degree – this one in Science, Technology, and Public Policy from George Washington University – before ultimately landing at Booz Allen Hamilton (BAH) in 1996.

Joe is currently a Senior Vice President at BAH with a portfolio that includes all of the firm's business with the U.S. Army; in that role, he leads a team of about 2,000 BAH employees and 1,000 subcontractors. Describing his responsibilities, Joe said, "At the highest level, it's my responsibility to make sure that Booz Allen's business portfolio with our Army clients operates at a very high level in all dimensions –

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*"While I was a graduate student, I had the opportunity to work at NASA-Ames Research Center on control system design for advanced aircraft. After Berkeley, in 1989, I went to work for The Aerospace Corporation in El Segundo, CA, where I worked as an engineering analyst on the avionics, electronics, control, and communications systems for various space vehicles and satellites."*

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client satisfaction, finances, contracts, technical performance, personnel matters, and risk reduction. This requires full lifecycle engagement in the business, from sales, through execution, to close out of work, and back to sales again."

Asked what a typical day at the office entails, Joe said, "A typical day for me now involves dealing with the exceptions – those items that might not be going as well as they should and are not operating at the high level we expect. I work with my colleagues to resolve these exceptions as smoothly and as quickly as we can. A typical day

also usually includes a healthy dose of planning the business for the periods ahead, including working on proposals that bring new business to the firm. Finally, a typical day would also include leader and staff development and mentorship. At Booz Allen, our people are our most important resource, so developing the leaders and staff is essential. I do this one-on-one, in small group settings, or through larger town hall meetings.”

Asked what advice he would give today’s undergraduates, Joe said this: “I think that the most important thing my EE education did for me, both at Notre Dame and at Berkeley, was to teach me how to think critically, how to decompose a problem into its core pieces, how to posit and experiment with solutions to each piece, and how to synthesize this into a complete solution – how to problem solve in an exacting way. So I would encourage graduates to step back and see the big picture of what you have learned, and realize that having a strong foundation in solving problems using rigor and discipline is a huge advantage.”

However, Joe would also encourage new engineers to develop their non-technical skills as well.

“The professional world is made up of people, not just institutions or companies,” he observed. “So work on your people skills and your presentation skills. Be humble. Be engaging. Use humor. Be respectful. Understand the human dynamics at work and your place in them. Work on your mannerisms and appearance, and your ability to have interesting things to say about interesting topics. The ability to get along, the ability to socialize with a wide array of people and to put people at ease and understand what drives them – these are essential ingredients to success. No matter how good an engineer – or

lawyer or doctor or manager or professor – you are, the ability to master the people dimension is, to me, the greatest determinant in how successful you will be and how far you can go in your career.”

When he’s not working, Joe can often be found pursuing his eclectic tastes in music and culture, traveling to art festivals and concerts featuring jazz, blues, folk, alternative rock, and Americana. He also dedicates time and effort to a number of charities, and he is the proud papa of two rescue cats named Tawkie and Lucky.

Joe has maintained close ties with his alma mater and his ND ’87 classmates. He expects to make it to every Notre Dame football game this year, and when he does he will be connecting with a network of about 20 classmates who have stayed in touch over the years.

“Their families are part of mine, and I am part of their families,” he said. “This is one of the best parts of being in the Notre Dame family.

In 2014, Joe will also begin his third year of service on Notre Dame’s EE/CSE Industry Advisory Council, a small group that meets yearly to offer an industry perspective on the operations of Notre Dame’s Department of Electrical Engineering and Department of Computer Science & Engineering.

If any of Joe’s old friends would like to reconnect, he can be reached at [jsifer@aol.com](mailto:jsifer@aol.com).



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