AUGUST 2012

RESEARCH HIGHLIGHTS

$$x' = f(x, p^*) + B_1 w$$
$$y = G_1(x, p^*)$$

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

learn **invent** impact

Department Chair:
David C. Jiles

Editor:
Brock Ascher

Faculty Portraits Photographer:
Grant Steinfeldt

Contributing Writers:
Brock Ascher
Kenzie Brennan
Thane Himes

Designer:
Brock Ascher

@ ISU_ECpE
ISU Department of Electrical and Computer Engineering
YouTube *ECpEdepartmentISU*

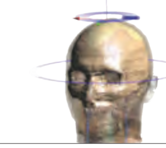
Research Highlights is published biennially by the Department of Electrical and Computer Engineering.

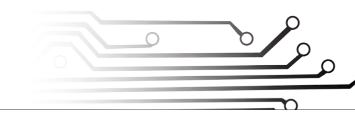
Department of Electrical and Computer Engineering
2215 Coover Hall
Iowa State University
Ames, IA 50011-3060
(515) 294-5929
ascher@iastate.edu
www.ece.iastate.edu

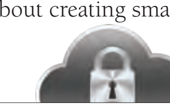
CONTENTS

$$x' = f(x, p^*) + B_1 w$$

$$y = G_1(x, p^*)$$







LETTER FROM THE CHAIR

It is my pleasure to present you with our 2012 *Research Highlights* biennial report. Our faculty members have advanced the department with a number of research grants, awards, and honors and we are pleased to include highlights of their accomplishments within these pages.

The department continues to concentrate research in five strategic areas: bioengineering; cyber infrastructure; distributed sensing and decision making; energy infrastructure; and materials, devices, and circuits. This focus continues to guide our research efforts and direct the advancement of our department.

Four faculty members: **Santosh Pandey**, **Aditya Ramamoorthy**, **Umesh Vaidya**, and **Joeseph Zambreno** were awarded National Science Foundation (NSF) CAREER Awards in 2012, bringing the department's CAREER award total to 11 in the last five years (page 8). **Suraj Kothari** and **Dionysios Aliprantis** were awarded sizeable grants (page 4), while three of our faculty were named fellows of their respective professional associations.

Many of our faculty have made major advancements in their fields. **Degang Chen** has developed an algorithm to dramatically reduce testing time and production costs for high-performance semiconductors (page 24). Our faculty members are researching transcranial magnetic stimulation for use in treating Post Traumatic Stress Disorder and other brain disorders in veterans. Zambreno is advancing the march toward exascale computing, among other things (page 20), while Vaidya is developing algorithms to identify uncertainties in network systems (page 16).

We remain committed to our educational goals, as well. This fall, the nation's first Wind Energy Science, Engineering, and Policy (WESEP) Ph.D. program will begin at Iowa State (page 6). Harpole Professor James McCalley will lead the program, which is designed to advance wind energy knowledge and develop leaders in the wind energy field.

Overall, the department continues to succeed. We hope you find this report of our most recent accomplishments informative and useful.

Best regards,

David Jiles

David C. Jiles
Palmer Department Chair in Electrical and Computer Engineering
Anson Marston Distinguished Professor

DEPARTMENT FACTS

FAST FACTS
- Established: 1909
- Alumni: More than 11,000
- Research Centers & Institutes: 11
- Endowed Professorships & Chairs: 11

NEW FACILITIES & EQUIPMENT (2010-12)
- Mixed-signal processing lab acquired
- Processing equipment for solar cells acquired
- Laser lithography system acquired

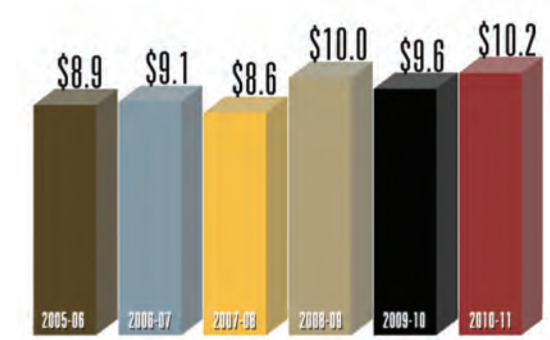
HONORS (2010-12)
- New IEEE Fellows: 3
- Best Paper Awards: 4
- Patents Awarded: 17
- Journal Editorships: 39
- Conference Keynote Speakers: 5

FUNDED RESEARCH PROPOSALS
- FY10: $22.3 million
- FY11: $9.8 million
- FY12: $14.4 million

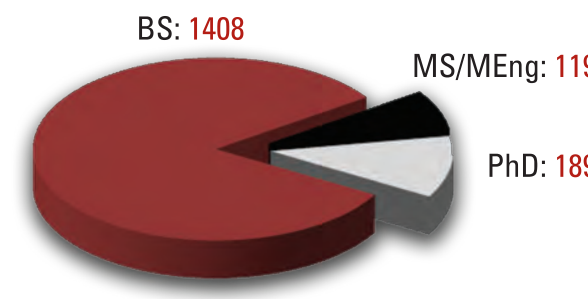
PRIVATE FUNDING (2010-12)
- Organization Gifts: Nearly $1.2 million
- Individual Gifts: Nearly $450,000 annually
- Scholarships Awarded: Nearly $400,000 annually

FACULTY/STAFF DETAILS
- 54 faculty
- 18 NSF CAREER Award winners
- 13 fellows (out of 17 full professors)
- 1 ACM Distinguished Engineer
- 20 staff

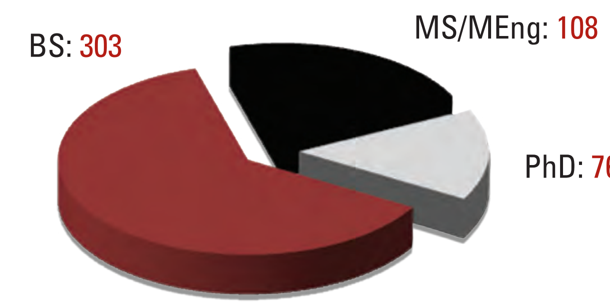
FULL-TIME EQUIVALENT (FTE) FACULTY DATA (2010-12)
- Faculty FTE: 48.8
- PhD degrees awarded per FTE: 1.55
- MS/MEng degrees awarded per FTE: 2.21



RESEARCH EXPENDITURES



STUDENT ENROLLMENT (FALL 2012 PROJECTED)



DEGREES AWARDED (2010-12)

RESEARCHERS RECEIVE $1.7 MILLION TO IMPROVE ELECTRICITY MARKETS

Aliprantis, Tesfatsion represent ECpE

Three Iowa State University researchers are working to reduce costs and maintain reliability as more renewable energy is added to the nation's energy grid.

Sarah Ryan, professor of industrial and manufacturing systems engineering; Dionysios Aliprantis, assistant professor of electrical and computer engineering; and Leigh Tesfatsion, professor of economics, mathematics, and electrical and computer engineering, are developing a new approach for scheduling and pricing wholesale electric power. Their goal is to help electricity market managers meet energy demands in the face of new uncertainties arising from the growth of renewable resources such as wind and solar power.

Conventional generators have to be scheduled hours in advance because they need time to be brought on- or off-line and adjust their generation levels. As Ryan explains, today's scheduling methods use single number forecasts for demand and renewable generation for each hour of the next day.

"This is like deciding whether to go on a picnic based on a weather forecast that only says, 'yes it will rain' or 'no it will not rain,'" she says. "You can make a better decision, understanding the risks, if you know there's a 60% chance of rain. We are building information about the uncertainty of demand and renewable generation into optimization methods that can use that information."

The result will be better schedules that commit the right slow-start generators in advance and reduce reliance on more expensive fast-start generators to make up for forecast errors.

The Iowa State researchers are among the recipients of a new $3 million award from the U.S. Department of Energy (Iowa State is the lead institution, and will receive $1.7 million). Other participants include Sandia National Laboratories, University of California Davis, Alstom Inc., and the Independent System Operator of New England (ISO-NE). The intended users of the new formulation are seven U.S. wholesale electric power markets encompassing more than 60 percent of U.S. generation.

Ryan will lead the effort at Iowa State. A specialist in stochastic optimization, she will develop inputs and scheduling problem formulations to incorporate power grid uncertainties. Aliprantis and Tesfatsion will work with Ryan and other participants to develop and test the new stochastic formulation using an integrated retail and wholesale power system test bed they have constructed. Alstom will then conduct more intensive development


Dionysios Aliprantis


Leigh Tesfatsion

and testing of the formulation, with the goal of applying it more broadly in the commercial market.

Ryan notes that current U.S. market management systems for electric power cannot effectively accommodate the multiple sources of uncertainty that arise from new resources on the nation's power grid, including new wind and solar power plants. Better means for handling these uncertainties would make the entire power system more efficient and reliable, resulting in lower costs for electric power, and an increased ability to maintain the balance of supply and demand essential for the physical operation of the power grid.

It could also lead to broader economic benefits. "Once we create an integrated power grid that makes the best use of alternative energy sources, I think you'll see jobs and industries grow as a result," she says. ■

Contributed by Engineering College Relations

PODS FEATURES THREE PAPERS BY ECPE'S TIRTHAPURA

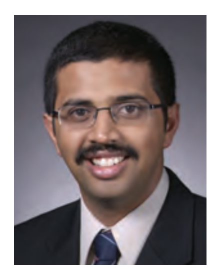
Total represents the most from any researcher at the conference

The annual Association for Computing Machinery (ACM) SIGMOD/PODS conference, held May 20-24 in Scottsdale, Ariz., featured three papers by **Srikanta Tirthapura**, associate professor. Tirthapura's three entries represented the most of any researcher invited to this year's conference.

Tirthapura's papers propose new methods for processing queries over subsampled data streams, find the optimal clustering number for space-filling curves in data structures, and give new algorithms for organizing databases of rectangle streams to answer standard queries.

Of special note, his paper, "On Optimality of Clustering Through a Space Filling Curve," proved that the Hilbert curve was optimal for the class of queries of a constant size.

The ACM's Special Interest Group on Management of Data (SIGMOD) holds its symposium on Principles of Database Systems (PODS) every year. The SIGMOD/PODS conference is a leading international forum for database researchers, practitioners, developers and users to explore cutting-edge ideas and results and to exchange techniques, tools and experiences.


Srikanta Tirthapura

Tirthapura's three accepted submissions give him four PODS-accepted papers to his credit. His previous work, "Time-Decaying Aggregates in Out-of-order Streams," was accepted to PODS in 2008. ■

KOTHARI DEVELOPING MALWARE DETECTION FOR ANDROID PHONES

Funded by $4.1 million DARPA grant


Suraj Kothari

Suraj Kothari, professor, is leading a research project that will increase the security of Android phones. Funded by a $4.1 million, 3.5-year grant from the Defense Advanced Research Projects Agency (DARPA), the project's objective is to develop a tool to detect malware placed unknowingly within applications on the mobile devices.

According to Kothari, malware apps silently leak sensitive information without revealing themselves. Mobile malware presents several sophistications that need special attention. "We are looking at malicious software that leaves a scattered footprint and that exhibits behaviors that blend with legitimate functionalities of a given application," he said.

The tool Kothari and his team are designing also includes a framework that gathers important information about an app as it scans code for malware. This data is presented in a digestible form that can be analyzed by a human, allowing for more accurate assessments about an app's intentions than systems currently in place.

"Detecting malware on mobile devices using a completely automated process hasn't been successful in producing consistent, valuable results," said Kothari. "We needed a solution that included human interaction, but we also needed to ensure the person analyzing the results could do so without having to parse enormous amounts of information."

Kothari has partnered with **Xuxian Jiang**, assistant professor of computer science at North Carolina State University, and Jeremias Sauceda, chief technology officer at EnSoft Corp., on the project. ■

Contributed by Engineering College Relations

THREE FACULTY NAMED IEEE, AAAS FELLOWS

Chu, Kamal, Dalal honored

Chris Chu, **Ahmed Kamal**, and **Vikram Dalal** were selected as IEEE or AAAS Fellows. Chu and Kamal were honored by IEEE, while Dalal was honored by AAAS.

Chu was selected for his "contributions to physical design of integrated circuits." He has developed two notable algorithms, along with other contributions in the physical design field, that have led to design circuits with better performance, lower costs, and lower energy consumption.

Kamal was selected as a 2012 IEEE Fellow for "contributions to optical networks provisioning for multipoint traffic." He has spent the last 15 years focused on provisioning multi-point connections, such as TV broadcasting and e-Science applications, in optical networks.

Dalal, who also is director of Iowa State's Microelectronics Research Center and an associate of the Ames Laboratory, was recognized "for distinguished contributions to research in solar energy conversion materials and devices and for invention of industrially important photovoltaic devices." ■


Chris Chu


Ahmed Kamal


Vikram Dalal

JILES NAMED HONORARY FELLOW

By Indian Society for Non-Destructive Testing

David C. Jiles, distinguished professor and Palmer Department Chair of Electrical and Computer Engineering, traveled to Chennai, India, to receive recognition as the 2011 Honorary Fellow of the Indian Society for Non-Destructive Testing (ISNT).


David C. Jiles

Jiles was elected for his work on magnetic methods for non-destructive evaluation (NDE). Over the last ten years, he has collaborated on research projects with NDE professionals in India including Dr. Amitava Mitra of the National Metallurgical Laboratory in Jamshedpur; Dr. Anil Prabhakar, professor at the Indian Institute of Technology in Chennai; and Dr. T. Jayakumar of the Indira Gandhi Center for Atomic Research (IGCAR) at Kalpakkam.

Led by Baldev Raj, former director of IGCAR and Advisor to the Prime Minister of India, ISNT is an international organization geared toward coordinating and informing professionals in NDE. As this year's elected Honorary Fellow, Jiles will be attending regular ISNT meetings to collaborate with NDE experts in India.

"It was a great pleasure to go to Chennai to receive this recognition from ISNT," Jiles said. "It was also a rather humbling experience," he added when referring to taking his place as the next in a long line of distinguished ISNT honorary fellows. ■

by Kristene Dontje

$3.1 MILLION GRANT WILL CREATE PHD PROGRAM FOR

WIND ENERGY

DEGREE WILL BE FIRST OF ITS KIND IN THE NATION

by KENZIE BRENNAN

Iowa State University will soon become the first institution to award students Ph.D. degrees in Wind Energy Science, Engineering, and Policy (WESEP) thanks to a $3.1 million, five-year grant from the National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) program

James McCalley, Murray J. and Ruth M. Harpole Professor in Electrical Engineering, is leading the program, which aims to advance wind energy knowledge, develop high impact wind leaders, and impact the wind energy community. His team is comprised of four co-principal investigators and 15 faculty members from Iowa State's College of Liberal Arts and Sciences, College of Agriculture and Life Sciences, and College of Engineering, including fellow ECpE faculty members Assistant Professor Dionysios Aliprantis and Associate Professor Nicola Elia.

The program, which is a collaborative effort with the University of Puerto Rico – Mayagüez, will support a total of 28 domestic Ph.D. students over the next five years, and will provide them with multidisciplinary training in the skills required for conducting research in engineering, science, and policy-related disciplines.

According to McCalley, the program's research is focused on increasing wind energy growth rate, reducing costs, and extending penetration limits of wind energy. "Our nation's most pressing problem today is arguably meeting energy needs while reducing global climate impacts. Because wind energy emits no greenhouse gases and is relatively low-cost, broad consensus exists that the future U.S. energy portfolio must contain a large wind energy component," McCalley says. "The vision is to strengthen the nation's wind energy resources by producing technical experts, effective communicators, and ethical decision-makers who lead the U.S. transformation to a high wind energy portfolio."

Because the team believes that effective leaders in the wind energy community will need to have a broad perspective to address wind energy challenges, the program will broaden students' academic exposure through three distinct types of experiences: interdisciplinary, industry, and international.

Interdisciplinary: The interdisciplinary features of the program will promote systems thinking from an array of skills rooted in engineering, agronomy, agriculture, economics, environmental science, sociology, and statistics.

"These topics will be reinforced through hands-on experience with hardware and field data via access to one or more of ten wind plants near Ames; wind turbine data from one or more of five large wind plant owners in Iowa; developing Iowa State-owned turbines near campus; access to manufacturers; and coursework activities in on-site labs, including the Wind Tunnel, Alternative Energy Grid Infrastructure Systems (AEGIS), and Wind Energy Manufacturing Lab," McCalley says.

The program also will use a three-level curriculum structure and team-based research projects to provide a foundation of interdisciplinary skills and knowledge for career-long learning and problem solving. The first level includes two newly-designed interdisciplinary courses that all WESEP students will take as early as possible in their program, aimed at exposing students to the full spectrum of science, engineering, and policy issues that pertain to wind energy.

The second level includes a group of courses from the relevant disciplines of each of the program's five research thrusts: wind resource characterization and aerodynamics of wind farms; wind energy conversion system and grid operations; manufacturing, construction, and supply chain; reliability and health monitoring; and wind economics, policy, and public perception.

"Students are required to take five courses from a 'major' thrust area, providing disciplinary depth, and three courses from one other thrust area, providing interdisciplinary breadth," McCalley says. "Students can take additional courses within the other thrust areas as needed for their research, but the requirement ensures students are research-capable in two thrust areas."

Two additional advanced "specialization" team-taught courses will be developed for the third curriculum level. The courses will provide students with depth in the research areas most closely aligned with their dissertation topic.

Additionally, a real-time research collaborative course will be required of all WESEP students and faculty each semester and will serve to integrate teams and develop research skills. Research teams of three to four students and their supervising faculty will address a research objective that corresponds with the students' objectives.

Industry/international: The industrial features of the program will include strong interaction with industry and national labs via the Project Advisory Board as well as a three to six month internship, while the international features will include a 3+ month visit to one of the program's international partner universities in Ireland, Germany, Denmark, China, or Spain.

"The internship and international experiences will provide practical applications for students' research without extending their time-to-degree since students will be able to continue work on their dissertation topics," McCalley says.

IGERT fellows will receive an annual stipend of $30,000, as well as tuition, fees, and health insurance for two years. Additional support will be available for textbooks, journals, short courses, and professional travel. In the following years, they will be supported via research grants and other funding sources and/or as teaching assistants. The expectation is that all IGERT fellows will be provided a total of three to five years of support depending on the nature of their research and contingent on adequate progress toward the degree.

While there is currently a lot of wind energy research being done at Iowa State right now, the WESEP program is still in its initial stage of recruiting students. "The key to the program is the ability to recruit highly capable domestic students to enter a Ph.D. program," McCalley says. "To this end, Iowa State WESEP faculty have developed a multifaceted recruiting plan that engages with the very best students in universities around the nation through frequent faculty recruiting trips, campus recruiting events, and summer undergraduate research programs."

Co-principal investigators on the project include Lisa Brasche, scientist at the Center for Nondestructive Evaluation; John Jackman, associate professor in industrial and manufacturing systems engineering; Partha Sarkar, professor in aerospace engineering; and Gene Takle, professor in agronomy and geological and atmospheric sciences.

Other Iowa State faculty members involved include Bruce Babcock, professor in economics; Carmen Bain, assistant professor in sociology; Bill Gallus, professor in geological and atmospheric sciences; Mike Kessler, associate professor in materials science and engineering; Catherine Kling, professor in economics; Bill Meeker, distinguished professor in statistics; Frank Peters, associate professor in industrial and manufacturing systems engineering; Lulu Rodriguez, professor in journalism and mass communication; Sri Sritharan, distinguished professor in civil, construction, and environmental engineering; Judy Vance, professor in mechanical engineering; and Lizhi Wang, assistant professor in industrial and manufacturing systems engineering. ■

NSF CAREER AWARDS LIVE HERE

SINCE 2007, 11 IOWA STATE RESEARCHERS HAVE EARNED THE PRESTIGIOUS AWARD

Over the past five years, researchers from the Iowa State department of Electrical and Computer Engineering have received 11 National Science Foundation Faculty Early Career Development (CAREER) awards, the most over any five-year period in the department's history. Here is a look at the 11 researchers and their contributions to the department's research portfolio.

TIM BIGELOW
Ultrasound Cancer Treatment
2007

Bigelow received his award to research the applications of ultrasound technology with regard to cancer treatment. Bigelow is working on methods to use ultrasounds to destroy cancerous tumors without surgery or thermal ablation. His methods can provide a less-invasive process that allows patients to recover more quickly and with fewer side effects.

YONG GUAN
Wireless Security
2007

Yong's award was to develop techniques to verify locations of mobile wireless devices and ensure the integrity of information provided by sensors and other devices. With location-based access control, an employee dealing with sensitive materials could access classified documents only from a designated work computer, helping prevent classified information from being leaked.

DIONYSIOS ALIPRANTIS
Electric Motor Design
2009

Aliprantis won a CAREER award to research methods to decrease the weight and size of motors and generators and improved their efficiency and cost-effectiveness. He is exploring how electric motors can be improved by optimizing performance in a preferred direction of rotation and wrote a computer modeling program that incrementally changes the design of the motors and calculates when the surface shape is just right.

LIANG DONG
Photonic Circuits
2010

Dong's award was for developing a state-of-the-art, universal photonic circuit platform that will advance smart sensor applications in fields such as photonic computing, optical communication, environmental monitoring, bichemical defense, and lab-on-a-chip technology. His proposed high-speed photonic circuits could help reduce production costs, as well as the size, weight, and power consumption. This would lead to lower-cost, smaller, and more energy efficient electronic devices.

JAEYOUN KIM
Optical MEMS
2010

Kim plans to create an ultra-wide field-of-view imaging system inspired by biological systems. His research could advance technology that doctors use for endoscopic imaging. The military and other organizations could use his optical system for safety monitoring. Eventually the technology could create a foundation for developing an artificial eye for humans or be used for assistive devices such as sensors to help guide individuals who have visual impairments.

LEI YING
Wireless Networking
2010

Ying is establishing a new approach for building wireless networks for mission-critical applications, including wireless mesh networks that are used for emergency response and public safety, and wireless sensor networks used for medical technologies and unmanned surveillance of U.S. borders. His research will help address and provide solutions for three long-standing weaknesses of wireless communication: bandwidth, channel fading, and interference.

SUMIT CHAUDHARY
Polymer Solar Cells
2011

Chaudhary's project continues his effort to improve organic solar cell efficiency and also improve the technology for widespread applications. In the short term, he hopes to increase the efficiency of the cells from 5 percent to almost 10 percent, which would be useful in charging small electronic devices. By introducing ferroelectrics into the organic layers used to fabricate polymer solar cells, Chaudhary hopes to make the technology available to consumers in the near future.

ADITYA RAMAMOORTHY
Atomic Force Microscopy
2012

Ramamoorthy is researching atomic force microscopy, which uses a thin cantilever to examine materials at high resolutions. With soft or fragile materials, observers use what is called tapping mode.

This mode involves oscillating the cantilever at a certain frequency and observing the effects of oscillation without damaging the medium. Ramamoorthy's research involves the use of signal processing algorithms to characterize and image soft materials in a fraction of the time taken by conventional methods.

JOSEPH ZAMBRENO
Computer Architecture
2012

Zambreno is researching ways to combine CPU and GPU processors into a single, hybrid chip. Traditional computer architecture includes a CPU and a GPU handling separate tasks. Today's "fused" chips feature integrated CPU/GPU designs, which promote faster interfacing and more efficient use of processor power. However, today's model utilizes a CPU and a GPU performing the same roles they always did, just in closer proximity. Zambreno wants to combine the two chips to get the best of both.

SANTOSH PANDEY
Bio-microfluidics
2012

Pandey is developing a new engineering platform to observe, sense, and modulate interactions between plant roots and pathogens. His research aims to develop effective and sustainable control strategies against plant diseases. He plans to develop a plant-in-chip system for the growth of *Arabidopsis* plants, realize chemical schemes for sensing and modulating auxin in plants, and build on-chip electrical schemes for sensing root health and manipulating pathogenic interactions with roots.

UMESH VAIDYA
Network Efficiency
2012

Vaidya's work identifies uncertainties within network systems and then proposes ways to make those systems run as efficiently as possible given the uncertainties.

Vaidya is applying aspects of ergodic theory to identify critical factors that are responsible for complex changes in a network system. Vaidya finds uncertainty in network systems and determines how that uncertainty affects the system as a whole in order to make the system run more efficiently. ■

QUANTIFYING

CASCADING FAILURE

ANY NUMBER OF UNPREDICTABLE FACTORS CAN COMBINE TO CAUSE ROLLING BLACKOUTS. ONE ECpE RESEARCHER IS WORKING TO PREDICT THE UNPREDICTABLE.

by BROCK ASCHER

Around 2 p.m. on August 14, 2003, an overhead transmission line carrying 345 kilovolts of electricity near Walton Hills, Ohio sagged too close to a nearby tree and shorted out. By 4 p.m., more than 50 million people were affected by one of the largest blackouts in history.

In September 2011, an Arizona Public Works employee, performing a routine procedure at the North Gila substation near Yuma, tripped off a 500-kilovolt line and began a series of failures that left more than 2 million people without power in the Southwest United States.

Both trigger events were small, seemingly inconsequential incidents. Both resulted in massive power outages by setting off an effect called cascading failure, a topic of considerable study for **Ian Dobson**, Arend J. and Verna V. Sandbulte Professor in Engineering.

"What happens is, a failure occurs somewhere and weakens the system a bit," Dobson says. "On a bad day, something else happens. Usually it doesn't, but on that day, let's say, it does. If it's a really bad day, then a third thing happens and the system becomes degraded. You're in a situation where it's more likely that the next failure is going to happen because the last failure already happened. That's the idea of cascading failure."

The failure of the Walton Hills line, a relatively minor occurrence given the size and scale of the power grid, reverberated through the network and helped cause a series of events that brought down a sizable chunk of the nation's power infrastructure. The initial point of failure in Ohio shifted the power burden to other points down the line and made a malfunction in these points much more likely – a classic case of cascading failure.

"What we're talking about is the big power grid that stretches from here to Florida and Maine and Canada – everything east of the Rockies is all connected together, all humming together," Dobson says. "Everything in the power system is protected so it doesn't fry when something goes wrong. Things can disconnect to protect the equipment, but if you disconnect enough things, you get a blackout."

Those disconnects are usually the very thing keeping the grid from destroying itself during a large-scale cascading event. Failures in the grid are rare and typically unanticipated because, as Dobson says, everything that can be anticipated has usually already been integrated into the grid.

"Something trips out the line and the power system wobbles a little bit," Dobson says. "Under normal operation you've already designed for normal faults. With anything that commonly goes wrong with the system, engineers and everyone in the utility industry rushes around and makes sure that it doesn't happen again. Most common, understandable, or easy to figure out things are already mitigated. Unusual stuff – rare interactions, unusual combinations of things when the system is already degraded – is a lot harder to control."

Dobson's research goes beyond what can be anticipated and attempts to figure out the overall likelihood of large-scale blackouts, like the events in 2003 and 2011, by studying the interactions between various points in the system using a series of math equations and simulations. In effect, Dobson is using models to simulate the "perfect storm" in the power grid, though he disputes the terminology.

"People always say 'It was the perfect storm.'" Dobson says. "But these large blackouts happen because of the

IAN DOBSON

Sandbulte Professor, Electrical and Computer Engineering

Ian Dobson joined ECpE last fall as the inaugural recipient of the Arend J. and Verna V. Sandbulte Professorship in Engineering. He has a bachelor's degree in mathematics from Cambridge University and a Ph.D. in electrical engineering from Cornell University. He was a faculty member in the electrical and computer engineering department at the University of Wisconsin for more than 20 years. He is a Fellow of IEEE, and is a member of ISU's electric power and energy systems research group and energy infrastructure strategic research area. ■

cascading effect. You're never going to get 20 different independent failures to happen at the same time because that's vanishingly unlikely. But if the first couple events make the next events more likely, then those events happen and make the next ones more likely – then you get those rare events happening. This is the typical way that large complicated systems have catastrophic failures, and it is not really a perfect storm."

Cascading failure is difficult to analyze because of the huge number of unanticipated variables. In other words, researchers don't know what they don't know. In addition, the dependence of individual failures on previous failures and their effect on subsequent failures creates an incredibly complex system of dependent variables. Large blackouts involve the failure of many interconnected variables, each of which affect how variables down the line interact with each other.

> If the first couple events make the next events more likely, then those events happen and make the next ones more likely – then you get those rare events happening.

"Imagine you're very, very tightly scheduled on a certain day," Dobson says. "Then, things start getting delayed in the morning and things get worse and worse throughout the day. Because your first appointment was delayed, It's more likely that the next one will be delayed. Pretty soon you start missing appointments altogether in the afternoon. That's a very small example of cascading failure."

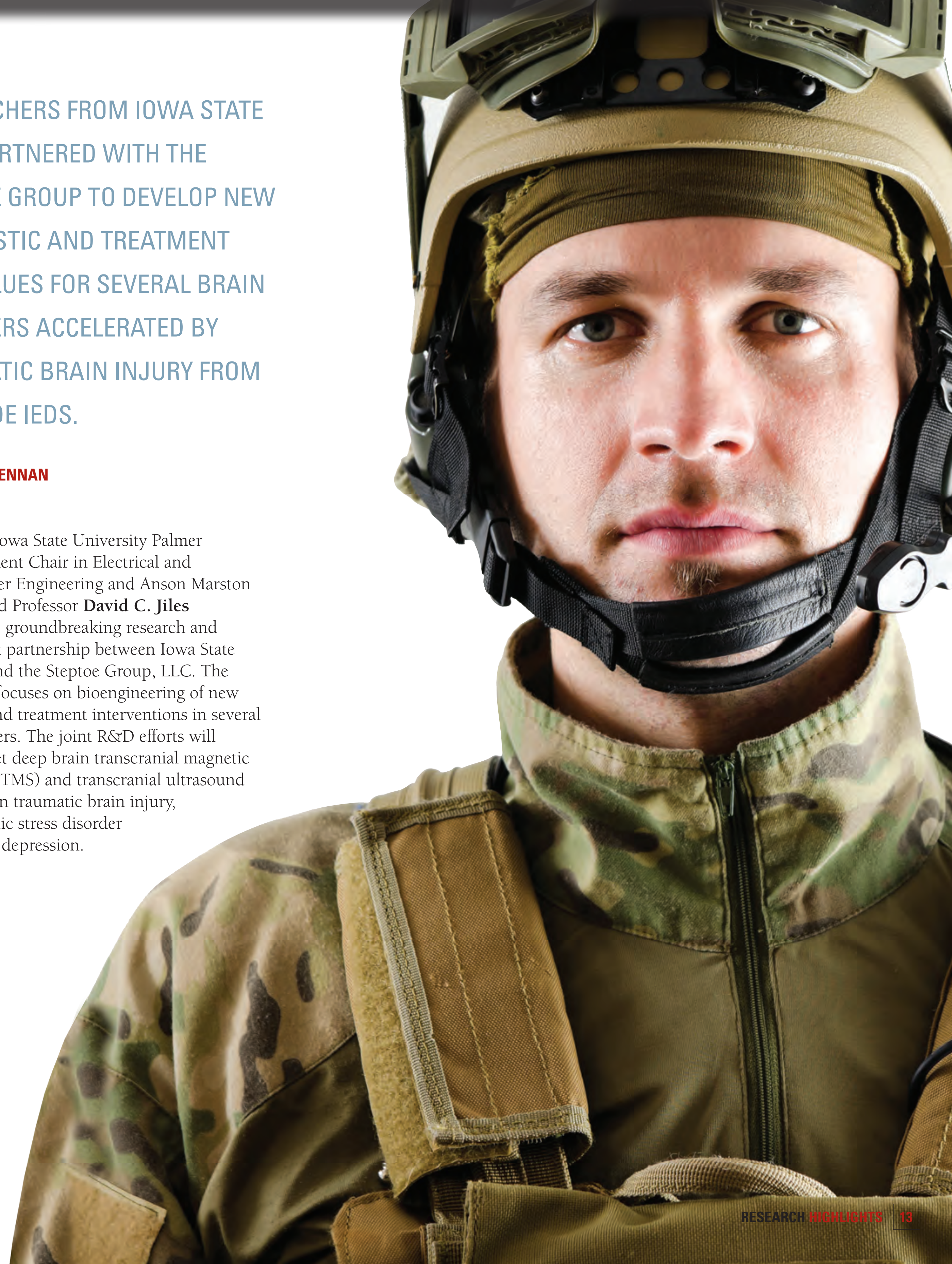
There are a few common attributes, like critical loading, that researchers can look for when studying cases of cascading failure. A power grid's critical loading can be defined as a point somewhere between a very low load and a very high load where the risk of a blackout increases sharply. If the amount of electricity flowing through the system is higher than the power grid critical load, the likelihood of a blackout spikes. The power grid's critical load acts as a reference point for cascading failure; stay below it and the system will likely be fine. Go above it, and the risk of a blackout is more severe.

"If a transmission line carrying its usual load fails, other lines can pick up the slack without much trouble," he says. "But if the power grid as a whole is carrying a load that is above its critical loading, its burden has a much greater effect on the other lines. That's something we look for."

Dobson uses a number of models and power system simulations of cascading failure to develop risk analysis methods for the power grid. Much like businesses use risk analysis procedures to identify and assess potential shortcomings within a project or account, Dobson uses his models to quantify the size and cost of a blackout given data on the power grid and its internal interactions. His findings can eventually be used to recommend upgrades in the power grid and determine the value and necessity of those upgrades.

"There's a difference between recommending power grid upgrades and recommending prudent and cost-effective power grid upgrades," Dobson says. "We have to figure out the best places to upgrade and focus resources there." ■

TREATING OUR TROOPS



RESEARCHERS FROM IOWA STATE HAVE PARTNERED WITH THE STEPTOE GROUP TO DEVELOP NEW DIAGNOSTIC AND TREATMENT TECHNIQUES FOR SEVERAL BRAIN DISORDERS ACCELERATED BY TRAUMATIC BRAIN INJURY FROM ROADSIDE IEDS.

by KENZIE BRENNAN

Last fall, Iowa State University Palmer Department Chair in Electrical and Computer Engineering and Anson Marston Distinguished Professor **David C. Jiles** announced a groundbreaking research and development partnership between Iowa State University and the Steptoe Group, LLC. The partnership focuses on bioengineering of new diagnostic and treatment interventions in several brain disorders. The joint R&D efforts will initially target deep brain transcranial magnetic stimulation (TMS) and transcranial ultrasound stimulation in traumatic brain injury, post-traumatic stress disorder (PTSD), and depression.

TMS TEAM

DAVID C. JILES
Palmer Department Chair
Anson Marston
Distinguished Professor

RAVI HADIMANI
Postdoctoral Research
Associate

IKENNA NLEBEDIM
Postdoctoral Research
Associate

LAWRENCE CROWTHER
Graduate Assistant

AHMET UNSAL
Graduate Assistant

As of 2008, more than two million soldiers had served in Iraq and Afghanistan. Of those two million soldiers, more than 320,000 have some degree of traumatic brain injury and over 300,000 have PTSD.

"Traumatic brain injury can occur when improvised explosive devices (IEDs), or roadside bombs, go off. The IEDs radiate shock waves that can travel through the brain, causing skull movement and the loss of brain function," **Ron Steptoe**, CEO of the Steptoe Group, says. "Traumatic brain injury can speed up the development of disorders, such as PTSD, depression, Parkinson's disease, vascular dementia, stroke, and more."

The Steptoe Group, LLC, based in Ellicott City, Maryland, was founded in 2008 as a Service Disabled Veteran Owned Business whose objective is to create sustainable partnerships with government agencies and private organizations in order to improve access and delivery of quality health, science, and education services to military veteran and servicemen families.

According to Steptoe, their research focuses on individualized patient care. "Our major issue is that what works for some people doesn't work for everyone. We are looking to find new ways, and developing a training program, to look at patients based on characteristics such as their age, gender, ethnicity, work, environment, and more."

Currently, the company is working to increase awareness of the growing and detrimental impact mental health and behavioral mental health conditions are having on the military and veteran communities, as well as deliver unique technologies to improve injury recuperation.

"What we're doing is developing transcranial magnetic stimulation for deep brain stimulation—a non-invasive, non-surgical method for examining and treating the brain with minimal associated risk," Jiles explains. "It is very promising because it enables you to treat someone's brain without doing any surgery. It is not going to solve every problem that is out there, but our objective is to find out what it works for and to improve technology to treat brain disorders."

Jiles' research on TMS began about three years ago at Cardiff University. "I was interested in finding out how magnetics could be used in the biomedical field, and an opportunity came up when Magstim, a company that provides instrumentation, got a TMS device and needed some help to improve it," Jiles says. "The device was relatively new and wasn't doing quite what they wanted, so Magstim came to me and set up a research program to look at things like coil development, my area of expertise."

According to Jiles, the coils, which are put on the patient's head to stimulate the outer part of the brain, were working, but overstimulated the surface when they tried to get deep brain stimulation. This was not only painful, but caused more effects on the outer part of the brain than they wanted and did little to stimulate the inside.

After two years, Jiles and team members **Lawrence Crowther**, graduate student in electrical engineering; **Ravi Hadimani**, postdoctoral research associate; and **Paul Williams** of Cardiff University, came up with a coil design and published their findings. While they found that the field penetrated very differently than they initially expected, they were able to rework their coil designs to reach inside the brain, increasing the field strength by a factor of four at 70 mm.

When the coils were tested on a number of patients suffering from several different brain disorders, the results showed some interesting effects. "By stimulating the brain, you can cause involuntary movement in the limbs, which is beneficial for stroke rehabilitation," Jiles explains. "When paralysis occurs, muscle tone deteriorates. You can stimulate muscles using TMS to recover some of the muscle toning."

In an ischemic stroke, the blood supply to the brain is cut off. If the individual survives, the blood supply is restored but the victim will suffer from brain damage. "TMS can be used to treat this because it 'bathes' the entire brain in a magnetic field, which stimulates the entire brain and not just the outer region," Jiles says.

Preliminary results also suggest that TMS could be used as an alternative or even a possible replacement for

Transcranial Magnetic Stimulation (TMS) employs a rapidly changing magnetic field designed to induce electric currents in the brain using electromagnetic induction. The currents trigger activity in targeted areas of the brain, allowing researchers to study the functions of the brain's different regions. Over time, and with repeated treatments, TMS could be used to treat a number of different brain conditions.

electroconvulsive therapy (ECT), a method for treating severe depression. Tests done in hospitals showed that TMS worked just as well as ECT, but seemed to cause fewer side effects, which can include confusion and memory loss.

In addition, they found that stimulating certain parts of the brain can cause interruptions in individuals' speech, while stimulation of other regions significantly improves individuals' ability to perform simple mathematics on a temporary basis.

More recently, Jiles and his team have developed a new coil that has not yet been tested—the larger "Halo coil." "The difference between the old and new coil is the distance between the field and the coil. When you stimulate the brain, the most stimulation occurs where the field is largest," Jiles says. "On the old coil, the field decreases quickly as it goes into the brain, but the configuration of the new coil enables the magnetic field to penetrate even deeper into the brain."

While the group has uncovered several useful findings and continues to make new discoveries, Jiles says that the interaction between the field and the brain is only crudely understood. "A lot of interesting things go on there that are not fully understood. The stimulation causes a voltage in the brain that causes polarization. Some of the neurons go right from the brain, and the voltage goes down the neuron," Jiles explains. "It is also interesting that the head provides almost no hindrance to the passage of the field, which is very different from almost any other kind of technology."

Other Iowa State faculty members working on the project include **Anumantha Kanthasamy**, a distinguished professor of biomedical sciences and the W. Eugene and Linda R. Lloyd Endowed Chair in Neurotoxicology at the Iowa State University College of Veterinary Medicine, and **Timothy Bigelow**, assistant professor in electrical and computer engineering.

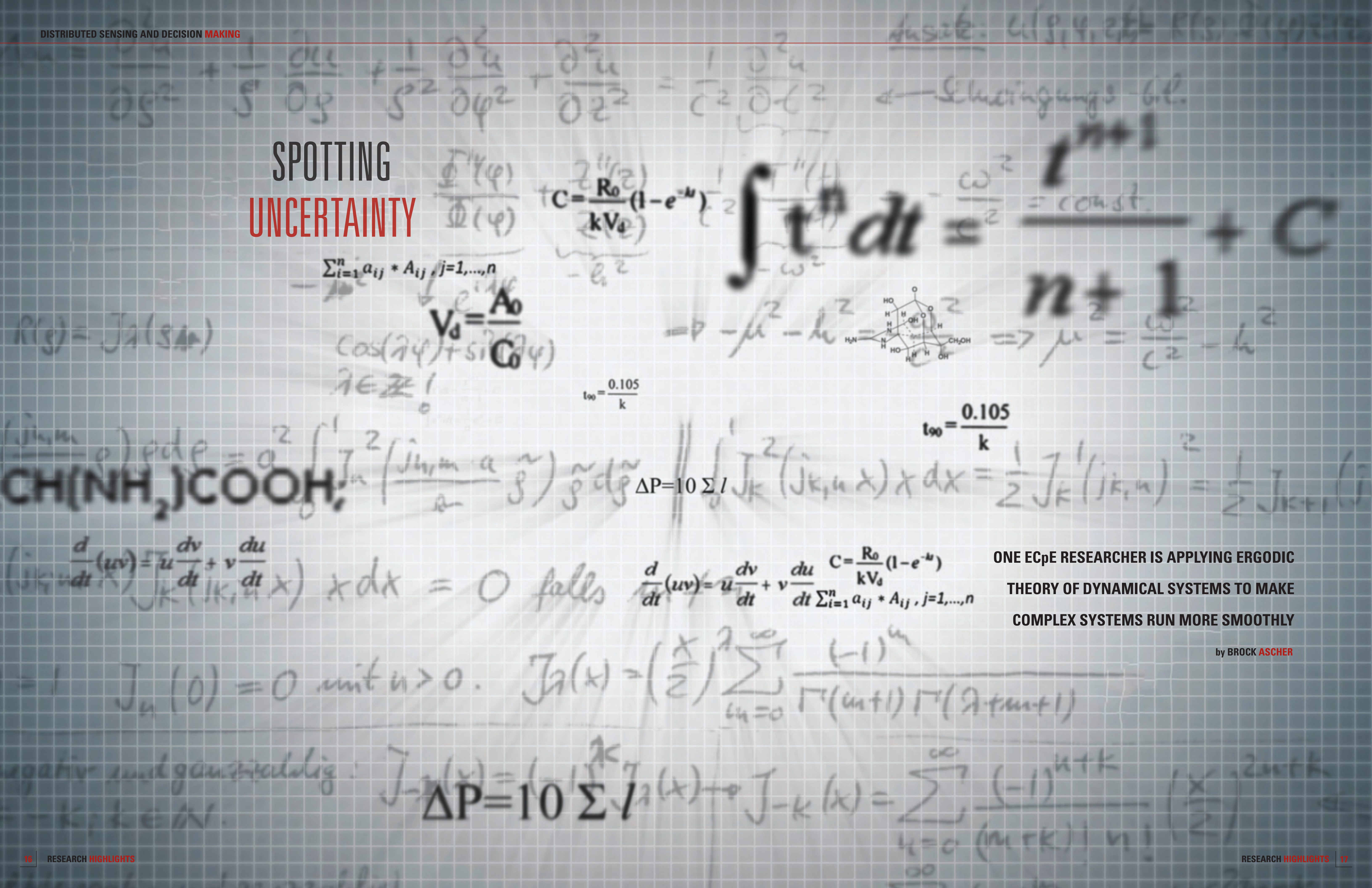
Kanthasamy, an expert on animal diseases—specifically Parkinson's disease and other neurodegenerative disorders—will aid in the research by testing the efficacy of the non-invasive magnetic field in an animal model of Parkinson's disease, while Bigelow will investigate transcranial ultrasound stimulation in the treatment of traumatic brain injury.

"We will determine the ultrasound thresholds for brain stimulation both with and without an accompanying electromagnetic field," Bigelow says. "While considerable work has been done showing that it is possible to stimulate neurons with ultrasound, the thresholds have not been explored when a magnetic field was also applied. Therefore, we will systematically explore the ultrasound parameters necessary for brain stimulation in both *in vitro* and *in vivo* models both with and without a magnetic field."

Jiles adds that the potential benefits of the research and development partnership with the Steptoe Group are enormous. "Let's find out what we can do non-invasively, optimize that, and bring it to its best capabilities," Jiles says.

While the partnership is still in its early stages, the team members are already hard at work pursuing additional funding sources, including the U.S. Department of Defense, National Institutes of Health (NIH), National Science Foundation (NSF), and Roy J. Carver Charitable Trust, among others. ■

TMS team member and ISU postdoctoral research associate Ikenna Nlebedim has been all over the world. Scan the code to see where he's been and for his take on treating post-traumatic stress disorder and other brain disorders in our troops using transcranial magnetic stimulation.



SPOTTING UNCERTAINTY

ONE ECpE RESEARCHER IS APPLYING ERGODIC THEORY OF DYNAMICAL SYSTEMS TO MAKE COMPLEX SYSTEMS RUN MORE SMOOTHLY

by BROCK ASCHER

Umesh Vaidya, Associate Professor in Iowa State University department of Electrical and Computer Engineering thrives on uncertainty. In fact, it's what he is working on.

"I work to design complex network systems that are robust to uncertainty," Vaidya says. "If you know the sources of uncertainty within a network system, what is the best performance you can get out of it, given some bounds on uncertainty?"

Vaidya's work identifies uncertainties within network systems, the power grid, or a building for example, and then proposes ways to make that system run as efficiently as possible given the uncertainties.

"In a power system, for example, there are various sources of uncertainty," Vaidya says. "The system loads of renewable energy sources, such as wind and solar, are some of the major sources of uncertainties. The sources of uncertainties are beyond control and cause output power to vary. If the electric grid is not designed properly, it will also cause power interruption."

Though the uncertainties of wind and solar are identifiable, they cannot be mitigated. Clouds will always be in the sky and the wind will never blow at a constant speed. These variables create uncertainty in the network, and have to be taken into account when the system is designed.

"We can't avoid uncertainty," Vaidya says. "You want to design the modern electric power grid that is robust to these various sources of uncertainty and provide an uninterrupted, quality power supply, even though some important part of the network is uncertain."

Funded by a National Science Foundation CAREER Award, Vaidya is applying methods and tools from ergodic theory of dynamical systems to identify critical uncertain parameters that are responsible for complex behavior in the electric power grid. Loss of synchronism among generators, voltage collapse, and blackouts are examples of this behavior. In other words, Vaidya finds uncertainty in network systems and determines how that uncertainty affects the system as a whole in order to make the system run more efficiently and reliably.

"My research is theoretical but is motivated by real-life engineering problems," he says. "We are using tools from ergodic theory of dynamical systems to develop approaches to answer several key questions. 'How does uncertainty propagate in systems leading to complex dynamics in the network? Which locations in the network are most vulnerable to uncertainty amplification? What are the fundamental limitations for designing robust network systems? What controller designs are most robust to uncertainty? The research can be used to design all kinds of network systems that are more robust and efficient. We can use it to make buildings more energy efficient, for one."

Vaidya's research can locate uncertainties in network systems, such as buildings, and help those systems run more efficiently

A building system, which contains different rooms that are connected through corridors, vents, and ducts, also can be considered a network system. Opening and closing doors or moving people in and out of rooms, for example, can change the air temperature within those rooms. These factors are seen as sources of uncertainty within building systems.

"When you design the system, the building in this case, you include where to place ducts and vents in a room so you have desired level of comfort and temperature," Vaidya says. "Energy is one of the most pressing problems of this century, and we would like to minimize waste in its usage. In the United States, Building systems account for 39 percent of total energy consumption, so it is important to design these buildings to be more energy efficient. Our proposed research will help determine optimal locations of ducts and vents to minimize energy usage and make building systems robust to uncertainties."

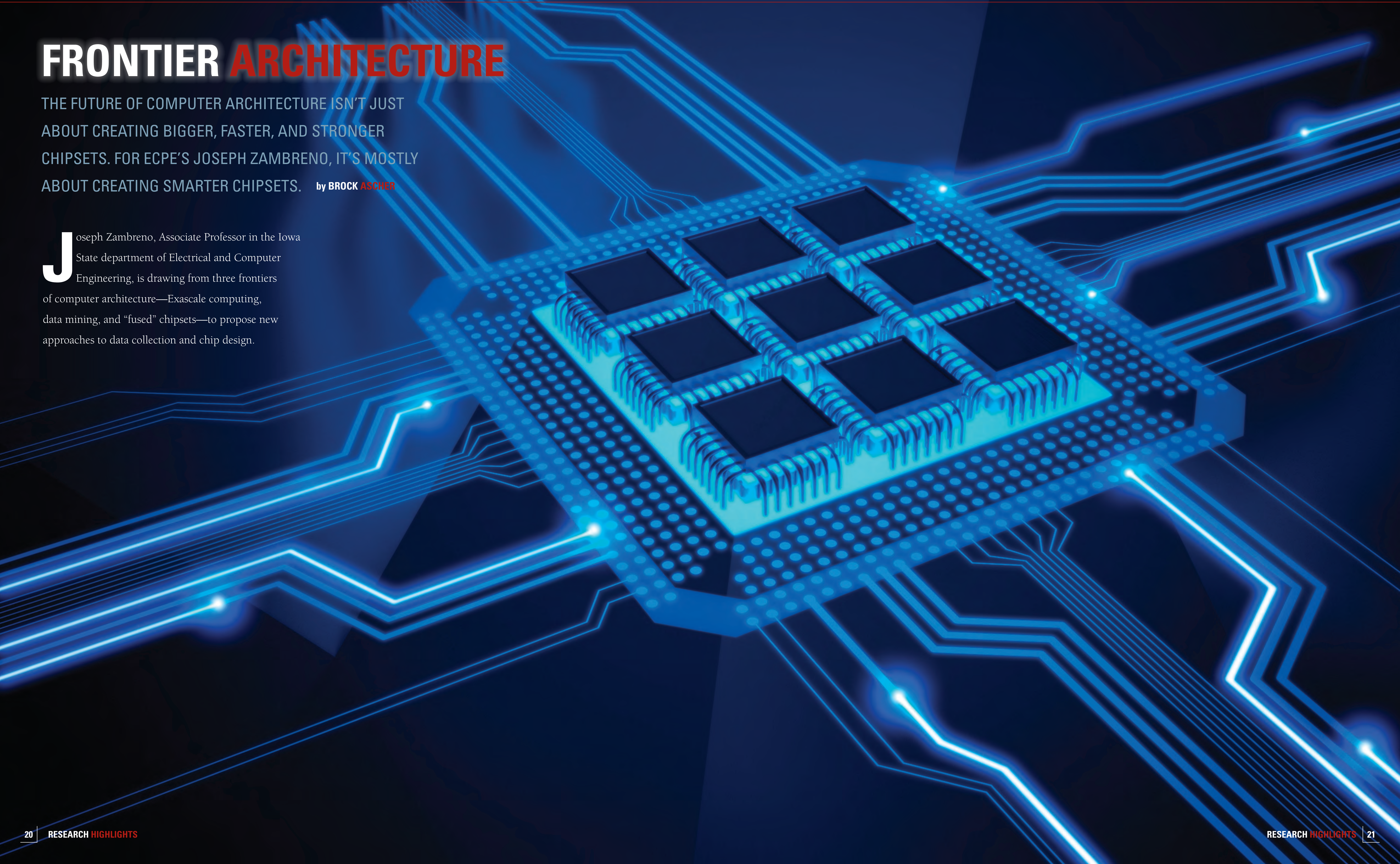
Though much of Vaidya's research concerns energy systems, his methods aren't limited to the electric power grid and building systems. His approach can be applied to a number of large-scale systems that contain uncertainties and exhibit complex behavior, including social and biological networks. Vaidya proposes that his research can be used to help understand the consequences of genetic modification in biological organisms and to provide conditions for the prevention or spread of disease.

"I work with power systems and building systems, but the research isn't limited to one kind of system," he says. "We can use this for many different things." ■

UMESH VAIDYA

Associate Professor, Electrical and Computer Engineering

Umesh Vaidya earned his B.E. degree in electrical engineering from Victoria Jubilee Technical Institute in 1997 and his Master's in systems and control engineering from the Indian Institute of Technology in Bombay, India in 1999. He received a Ph.D. in mechanical engineering from the University of California, Santa Barbara in 2004, and came to Iowa State in 2006. He is a recent recipient of the National Science Foundation (NSF) CAREER award (2012) and heads the Dynamical Systems and Control Theory research group in the ECpE department. ■



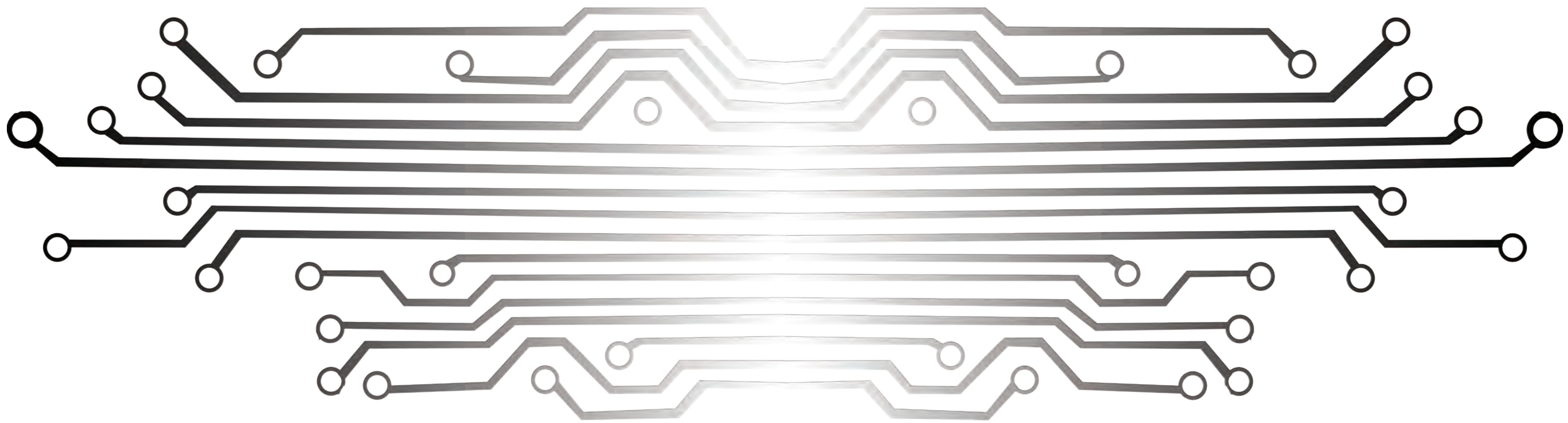
FRONTIER ARCHITECTURE

THE FUTURE OF COMPUTER ARCHITECTURE ISN'T JUST ABOUT CREATING BIGGER, FASTER, AND STRONGER CHIPSETS. FOR ECPE'S JOSEPH ZAMBRENO, IT'S MOSTLY ABOUT CREATING SMARTER CHIPSETS.

by BROCK ASCHER

Joseph Zambreno, Associate Professor in the Iowa State department of Electrical and Computer Engineering, is drawing from three frontiers of computer architecture—Exascale computing, data mining, and "fused" chipsets—to propose new approaches to data collection and chip design.

“Computer engineering is considered an enabling discipline,” Zambreno says. “We have the physicists, the chemists, the people who work on bioinformatics, who need us. They have algorithms that need as much computing power as they can get. If we can provide them efficient, scalable chips, that could be what leads to the breakthrough that eventually cures cancer or something of that nature.”



THE EXASCALE ERA

Today, most computer users measure space in terms of gigabytes and, more recently, terabytes. Large-scale data users like Google and Facebook measure their server farms in terms of petabytes, equal to 1,024 terabytes. A petabyte is a staggeringly large unit of measurement. To watch one gigabyte of high definition video, for example, you would have to watch for about seven minutes. To watch one petabyte of HD video, you would have to watch for 13 years and four months.

“We can build petascale systems now if we are willing to expend significant amounts of money to do so,” he says. “But what do we need to do to be able to build that next generation system, the exabyte system, that’s even a thousand times bigger than that? That’s what we’re working toward.”

Some of the world’s largest databases have already begun to break the exabyte (1,024 petabytes) barrier, but computing performance has lagged behind the rate of data expansion. In short, we have all this data, but not enough computing power to sort through it.

Zambreno is setting his sights on rectifying that situation, one step at a time. With funding provided by a National Science Foundation Computer Systems Research Grant Using a field-programmable gate array (FPGA)-based machine programmed to act like an exascale-era chip, Zambreno can run numerous tests to find strengths and weaknesses for multiple architectural setups.

“We’re testing out architecture ideas that won’t be ready to market for 10 years, if that,” Zambreno says. “We have software that simulates what the chip would look like and what its characteristics would be. We tend to optimize for either performance or power consumption, but other aspects like programmability or security are common, too.”

Though the actual creation of an exascale system is likely several years away, the push toward the exascale era has resulted in many useful breakthroughs.

“If you look at the processor in the iPhone or the Samsung Galaxy – they have processors that would have been state-of-the-art desktop processors just a few years ago,” Zambreno says. “By pushing to make state-of-the-art desktop processors that much better and power-efficient, you get those really nice little side effects. It trickles down, and now your mobile phone is faster than your previous desktop.”

> As transistors get smaller and smaller and we can fit more and more on a chip, what do we do with them?

He doesn’t consider his goal of aiding in the design of exascale-era chips as an accomplishment by itself, though. Zambreno is much more interested in what those future exascale chips could be used for.

DATA MINING AT EXASCALE

When processors are powerful enough to sort through exabytes of data, finding useful patterns in that data—data mining—will be vital to businesses and future researchers.

“Data mining, as an application, is still in its infancy,” Zambreno says. “People have written a whole bunch of software algorithms, but they haven’t really focused that much on what the architecture should look like for those algorithms.”

Data mining has an enormous number of potential uses; from businesses using it to predict the buying habits of potential customers, to scientists employing it to map relationships between strands of DNA and study disease. Today, however, the gap between the amount of data available and the amount of data that processors are able to handle is widening. Zambreno’s work involves shrinking that gap and figuring out how to build computer architecture that takes every advantage of its increased power.

“As transistors get smaller and smaller and we can fit more and more on a chip, what do we do with them?” he asks. “We can add extra cores, so we go from eight cores to 16, for example, but there are diminishing returns to where we can go with regard to that kind of acceleration. If we have all these transistors, let’s allocate some to work on data mining. We might as well spend part of these chips on something that could be really useful once we need it.”

Creating ever-larger and ever-faster chips will always be the goal of computer engineers, but creating a smarter chip is another part of Zambreno’s research.

FUSED CHIPS

Traditional computer architecture revolves around a central processing unit (CPU) carrying out instructions, handling logic and performing computations while a graphics processing unit (GPU) renders graphics, handles display output, and works with multi-threaded tasks. Today’s “fused” chips, including the AMD Fusion, the Intel FMA HD, and the NVIDIA Tegra, feature integrated CPU/GPU designs, which promote faster interfacing and more efficient use of processor power. However, today’s “fused” chip model utilizes a CPU and a GPU performing the same roles they always did, just in closer proximity. Zambreno wants to turn this line of thinking on its head.

“The trend now is the so-called ‘fused architecture,’ or a CPU and a GPU on the same die,” Zambreno says. But it’s kind of just glued together at this point. In the past, your CPU would be in one place, your GPU would be somewhere else and they’d be connected with a fairly high-speed bus. It’s better now, they’re physically closer together so things like locality are better and power efficiency is improved. But architecturally, it’s not that interesting. It’s sort of a logical consequence of what has been happening for years now.”

Funded by a National Science Foundation CAREER Award, Zambreno is working on a proposal for a hybrid chip, one that is the best of both a CPU and a GPU.

“We’re looking at what CPUs do very well and what GPUs do very well and figuring out how we can get the best of both worlds in terms of memory efficiency, computational density, and in terms of power efficiency,” he says.

Zambreno’s work in exascale computing, data mining, and “fused” chip design represents the cutting edge of computer architecture. Still, Zambreno defines his work in terms of service to other fields.

“Our innovations [as computer engineers] are not very broadly impacting just by themselves,” he says. “Increasing processor power isn’t important unless you’re saying ‘now that we have that extra computing power, maybe that enables us to do things that we didn’t think were possible.’” ■

JOSEPH ZAMBRENO

Associate Professor, Electrical and Computer Engineering

Joseph A. Zambreno has been with the Department of Electrical and Computer Engineering at Iowa State University since 2006. He currently is co-director of the Reconfigurable Computing Lab (RCL). Prior to Iowa State he was at Northwestern University in Evanston, Ill., where he graduated with his Ph.D. degree in electrical and computer engineering in 2006, his M.S. degree in electrical and computer engineering in 2002, and his B.S. degree summa cum laude in computer engineering in 2001. He is a recent recipient of a National Science Foundation (NSF) CAREER award (2012), the ISU Award for Early Achievement in Teaching (2012), and the ECpE Warren B. Boast Undergraduate Teaching Award (2009, 2011).

SPEED TEST

DEGANG CHEN HAS DEVELOPED AN ALGORITHM TO DRAMATICALLY REDUCE TESTING TIME AND PRODUCTION COSTS FOR HIGH-PERFORMANCE SEMICONDUCTORS.

by THANE HIMES

High-performance semiconductors are individually tested to guarantee quality before they can be shipped to customers. This is done by inputting precisely known data values into a part and measuring accurately how the part responds to the input data. As Moore's law continues to push up performance and push down prices, test time has become a significant part of the semiconductor manufacturing cost. For certain high performance parts, the test cost can be as high as 75-percent of the overall cost of build.

"We use high-performance semiconductors for things like medical instruments and defense applications, so when you test these parts, you want the test to be very accurate, in both the total value and in the small increments," says Degang Chen, professor of electrical and computer engineering. "This roughly corresponds to integral non-linearity (INL) and differential non-linearity (DNL)."

The INL and DNL test is the most time consuming among many parameters to be tested. Many researchers from both academia and industry have been working on various methods to reduce INL/DNL test time. After years of trying various ideas, Chen and graduate student June Yu developed a new algorithm for an analog-to-digital INL/DNL test that is hundreds of times faster and far more precise than the current test method, known as the standard histogram test.

"The standard histogram test has two hidden, gross inefficiencies," Chen said. "The first is that it treats all the hundreds of thousands of INL/DNL errors as independent random quantities, whereas in reality they are all determined by the much smaller number of circuit components. Also, the most precise quantity in the INL/DNL test set-up is the input source, but the standard histogram test throws away the input information."

Through innovative use of statistical signal processing and system identification, Chen's new algorithm effectively removed these two gross inefficiencies, thus greatly reducing test time while improving test accuracy.

Chen submitted his findings to the IEEE International Test Conference, but his paper was rejected because his results were deemed "unbelievable." This led Chen to contact Texas Instruments. Chen allowed TI to try the technology, hoping that their findings would provide "credibility" to the "unbelievable" results.

At the invitation of the chief technologist of the company's High Performance Analog division, Chen went to Texas Instruments last summer after collaborating with them via email during the spring 2011 semester.

"After seeing the initial measurement data, they thought the algorithm had great potential, and they asked me to come down," Chen said. "I was there for about eight weeks to teach them the new algorithm and help their engineers to implement and validate the algorithm."

Chen was successful. His algorithm was significantly more precise than the standard histogram tests that use 64 to 256 times more data than Chen's algorithm required. Since test time is dominantly data acquisition time, the new method was much faster.

> Chen submitted his findings to the ITC premium conference, but his paper was rejected because his results were deemed "unbelievable."

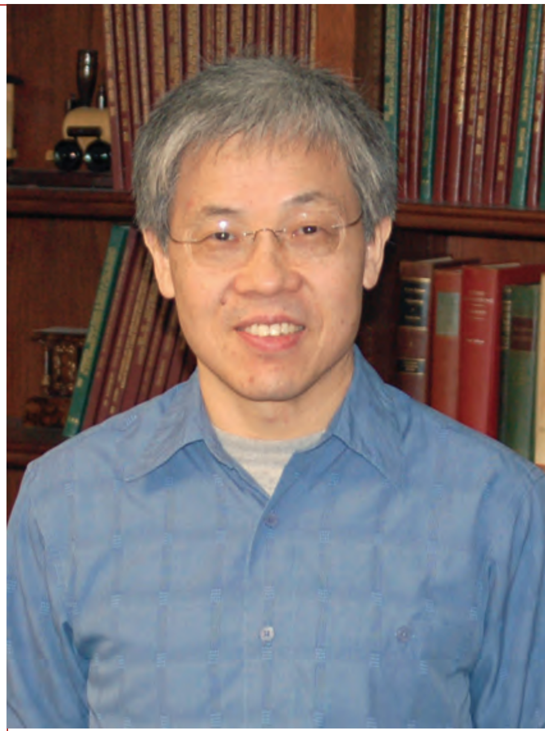
"Our method takes about 0.4 percent of the original test time, but our result is more accurate," Chen said.

One of the ways Chen validated his algorithm's accuracy was by using the servo loop method, a method that is very accurate but takes a very long time to conduct. Using the servo loop method to test a high-performance 16-bit SAR ADC took 18 minutes. Using Chen's new algorithm, the same test was finished in less than one-tenth of a second, and the test results matched those from the servo loop extremely well.

The next step for Chen's research is to introduce the new algorithm to technology producers. TI is doing additional statistical evaluations before using the new method in mass production. They are currently working on implementing the new algorithm in several of their product groups, including touch screen technology.

"Technology adoption is a serious matter and involves a pretty slow process. It will probably take more than a year," Chen said. "Once one company adopts the new algorithm and shows good results, others will follow."

Chen will return to TI periodically to continue working on the project. He also has submitted a new paper with his results to the ITC, and is waiting for a reply. ■



DEGANG CHEN

Associate Professor, Electrical and Computer Engineering

Degang Chen arrived at Iowa State in 1992 after serving as the John R. Pierce Lecturer at the California Institute of Technology during the 1992 academic year. Chen received a Bachelor's degree in instrumentation and automation from Tsinghua University, Bejing, China in 1984. He earned his Master's degree in robotics in microelectronics in 1988 and his Ph.D. in systems and control in 1992 from the University of California, Santa Barbara. Chen is the recipient of the NSF Research Initiation Award (1994), the SRC Technology Invention Award (2003), and the Warren B. Boast Outstanding Teaching Award (2009).

GRADUATE RESEARCH

CLOUD COVER

ECpE GRADUATE STUDENT JOE IDZIOREK IS WORKING TO PROTECT DATA IN CLOUD-BASED APPLICATIONS AND PREVENT THOSE APPLICATIONS FROM BEING EXPLOITED.

by THANE HIMES

Researchers in the department of ECpE have been looking into ways to enhance security on the web from external threats.

Joe Idziorek, a Ph.D. student in ECpE; Doug Jacobson, University Processor in ECpE; and Mark Tannian, an ECpE Ph.D. candidate, collaborated to look for solutions to the problem of fraudulent uses of cloud resources on the internet.

Idziorek was first drawn to the idea for the challenge of finding something new.

"It has only been in recent years that all these technologies have matured to the point where a synthesis of these components could be realized," Idziorek said. "Therefore, the challenge in this research area is finding genuinely new problems that cloud computing presents and not simply relabeling old problems."

Fraudulent Resource Consumption (FRC) attacks, the exploitation of the utility pricing model, are able to inflict direct monetary cost on the victim of the attack.

Idziorek went to Jacobson to pitch this problem as his dissertation topic. He presented the idea that the utility pricing model in a cloud computing web application was easy to exploit. Jacobson was immediately intrigued.

"Because this is an open, impactful, and challenging problem that has not been previously addressed by the security research community, Dr. Jacobson and I agreed that this was a research problem worth exploring," Idziorek said.

In a utility price model in a cloud computing application, consumers only pay for the resources they consume (i.e., storage, bandwidth, and computer hours), similar to public utilities like electricity and water. However, this pricing system can be exploited by external attackers.

In a cloud utility model, botnets consisting of bot clients can infiltrate a cloud network and consume resources by mimicking the behavior of legitimate clients. The application itself isn't aware of the bot's intentions, and the cost of addressing those bots is assessed to the legitimate cloud consumers. This would be meaningless if it was only a one-time attack. But this subtle method of resource consumption can be quite costly in the long term.

One of the research team's biggest challenges was accurately and concisely describing the vulnerability of the utility pricing model. Defending against an FRC attack is quite a challenge to a cloud consumer due to the subtle, unassuming nature of the attack.

"Once the problem was defined and accepted, the second main challenge of this research was to formulate prevention, detection, attribution, and mitigation solutions for a new problem, which itself had no direct body of previous research," Idziorek said.

The biggest goal of this research was to create awareness of FRC attacks, given that there have been no known public acknowledgements of an FRC attack occurring on the public cloud. By identifying the problem and offering foundations for potential solutions, further research can be conducted. Idziorek is happy with the results of the research, but plans to continue making improvements.

"Methodologies can always be improved, algorithms can always be more efficient, and detection and attribution schemes can always be more accurate," Idziorek said. "Because I thoroughly enjoy my research topic and there is an incredible amount of work that is still to be done in this space, I plan to continue this research as a life-long challenge." ■

UNDERGRADUATE RESEARCH

KINECT TREATMENT

A TEAM OF ECpE STUDENTS IS DEVELOPING A SYSTEM TO UTILIZE THE XBOX KINECT TO HELP COMBAT PARKINSON'S DISEASE

by THANE HIMES

Microsoft's 2012 Imagine Cup competition was designed around the theme of technology solving the world's biggest problems. Teams designed their projects to address one of the competition's several stated goals, which included ending world hunger, reducing child mortality, fostering environmental sustainability, and more.

Entering the competition as "Team Exsolvo," ECpE undergraduate students Andrew Kies, Tushar Vashisth, Gavin Monroe, and Michael Naughton decided to focus on combatting Parkinson's disease.

Team Exsolvo quickly came up with the idea to experiment with the Xbox Kinect, one of the specific technologies the contest required use of, to help combat Parkinson's.

"When we were brainstorming for a project, the idea of using the Kinect for a purpose other than playing games came up over and over," said Andrew Kies, senior in computer engineering and leader of the project. "We knew that ISU's Kinesiology department conducts research into motor control and learning, and realized that perhaps we could find a project related to their work, which would let us collaborate directly with experts in the field."

According to Ann Smiley-Oyen, an associate professor of kinesiology who has conducted extensive research on Parkinson's disease at Iowa State, one of the biggest challenges of doing research with Parkinson's patients is the repetitive nature and the frequency of therapeutic exercises. Patients are often unable to come to a lab frequently, and sending researchers to patients' homes is costly.

Team Exsolvo worked with Smiley-Oyen to design a system using the Kinect to help solve this logistical problem.

"Our team had very little knowledge about Parkinson's or physical therapy, but thankfully Dr. Smiley-Oyen was extremely enthusiastic and helpful in providing us with all the information we needed," Kies said. "We collaborated with her a great deal when designing the system."

The team named their system "Exsolvo Kinetics." Using an intuitive interface, patients can utilize the Kinect to conduct their movement therapy in the form of movement-centric games, all in the comfort of their own homes. If a patient is involved in research, they can transmit the results of their exercise performance data to the researchers in real time.

Using an intuitive interface, patients can utilize the Kinect to conduct their movement therapy in the form of movement-centric games, all in the comfort of their own homes.

The patient takes control of an avatar in the game, with each level of the game revolving around the completion of certain tasks, like drawing inside the lines of a box. The patient's performance is recorded and measured to standards set by the researcher. The games are designed and coded to be easily customizable to better serve a particular patient or researcher's needs.

Diane Rover, professor of electrical and computer engineering, supervised the team as a faculty advisor, helping the students manage the complexity of the competition and of their project.

"This is the first time the ECpE department has entered a senior design team in the Imagine Cup competition," Rover said. "It was a challenge to navigate the logistics of the competition as well as initiate from scratch a novel project of major significance in relation to a global issue."

Microsoft liked the project, and Team Exsolvo received positive feedback. Team Exsolvo didn't make it to the final round of the competition, but the team plans to continue developing the system and enter it again next year.

"Two team members, Andrew and Gavin, will be working for Microsoft after graduation, and thus they may serve as Microsoft advisors," Rover said. "We will be proposing this as a continued project in the senior design course."

Team Exsolvo gained a lot of good experience in the competition, and their exposure will benefit future ECpE teams interested in the competition. ■

BIOENGINEERING

SRINIVAS ALURU
MEHL PROFESSOR
PhD, Computer Science, Iowa State (1994)
- IEEE Fellow
- AAAS Fellow

RESEARCH INTERESTS: High-performance computing, bioinformatics and systems biology, combinatorial scientific computing, applied algorithms.

SELECTED PUBLICATIONS:
- Yang, X., K. S. Dorman, and S. Aluru. "Reptile: Representative tiling for short read error correction." *Bioinformatics*, Vol. 26, No. 20, pp. 2526-2533. 2010.
- Schnable, P. S., D. Ware, ... , S. Aluru, R. A. Martienssen, S. W. Clifton, W. R. McCombie, R. A. Wing, and R. K. Wilson. "The B73 Maize Genome: Complexity, Diversity, and Dynamics." *Science* Vol. 326, No. 5956, pp. 1112–1115. 2009.

TIMOTHY BIGELOW
HARPOLE-PENTAIR ASSISTANT PROFESSOR
PhD, Electrical Engineering, Illinois (2004)

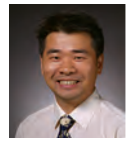
RESEARCH INTERESTS: Ultrasound systems to treat cancer, brain imaging/stimulation, physical properties of tissue using backscattered ultrasound signals, bioeffects for ultrasound safety and therapy.

SELECTED PUBLICATIONS:
- J. Xu and T.A. Bigelow, "Experimental investigation of the effect of stiffness, exposure time, and scan direction on the dimension of ultrasound histotripsy lesions", *Ultrasound Med. & Biol.*, Vol. 37, pp. 1865–1873. 2011.
- Y. Labyed and T.A. Bigelow, "A theoretical comparison of attenuation measurement techniques from backscattered ultrasound echoes". *J. Acoust. Soc. Am.*, Vol. 129, pp. 2316-2324. 2011.

JULIE DICKERSON
PROFESSOR
PhD, Electrical Engineering, Southern California (1993)

RESEARCH INTERESTS: Systems biology, bioinformatics, pattern recognition, data visualization, gene regulatory networks.

SELECTED PUBLICATIONS:
- Van Hemert, J.L., J.A. Dickerson, "Discriminating response groups in metabolic and regulatory pathway networks". *Bioinformatics*, 2012.
- Fu, Y., L.R. Jarboe, J.A. Dickerson, "Reconstructing genome-wide regulatory network of E. coli using transcriptome data and predicted transcription factor activities". *BMC Bioinformatics*, Vol. 12, pp. 233. 2011.



LIANG DONG
HARPOLE-PENTAIR ASSISTANT PROFESSOR
PhD, Electronics Science and Technology, Tsinghua University, China (2004)

RESEARCH INTERESTS: Lab on a chip, micro-electro-mechanical systems, microfluidics, nanophotonics, photonic integrated circuits, controlled drug delivery, high-throughput screening for drug discovery, multicellular organismal biomechanics, fabric light-emitting and energy harvesting devices.

SELECTED PUBLICATIONS:
- H. Yang, W. Hong, and L. Dong, "A controlled biochemical release device with embedded nanofluidic channels". *Applied Physics Letters*, Vol. 100, No. 153510. 2012.
- H. Yang, C.R. Lightner, and L. Dong, "Light-emitting coaxial nanofibers". *ACS Nano*, Vol. 6, pp. 622-628. 2012.

SANTOSH PANDEY
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Lehigh (2006)

RESEARCH INTERESTS: Microfluidics, bioelectronics, bioMEMS, behavioral neuroscience.

SELECTED PUBLICATIONS:
- John Carr, Archana Parashar, Richard Gibson, Alan Robertson, Richard Martin, Santosh Pandey. "A microfluidic platform for high-sensitivity, real-time drug screening on C. elegans and parasitic nematodes". *Lab on Chip*, Vol. 11, pp. 2385-2396. 2011.
- Archana Parashar, Santosh Pandey. "Plant-in-chip: Microfluidic system for studying root growth and pathogenic interactions in Arabidopsis". *Applied Physics Letters*, 98, 263703. 2011.

NAMRATA VASWANI
ASSOCIATE PROFESSOR
PhD, Electrical and Computer Engineering, Maryland (2004)

RESEARCH INTERESTS: Statistical and sequential signal processing, recursive sparse reconstruction and compressive sensing, medical imaging.

SELECTED PUBLICATIONS:
- Wei Lu and Namrata Vaswani. "Exact Reconstruction Conditions for Regularized Modified Basis Pursuit" *IEEE Trans. Signal Processing.* May, 2012.
- Wei Lu and Namrata Vaswani. "Regularized Modified BPDN for Noisy Sparse Reconstruction with Partial Erroneous Support and Signal Value Knowledge". *IEEE Trans. Signal Processing.* January, 2012.

*Position titles reflect the faculty or staff member's status as of August 16, 2012.

CYBER INFRASTRUCTURE

MORRIS CHANG
ASSOCIATE PROFESSOR
PhD, Computer Engineering, North Carolina State (1993)

RESEARCH INTERESTS: Wireless network protocols, computer security, embedded systems, power-aware computer systems.

SELECTED PUBLICATIONS:
- Z. Abichar and J. M. Chang."A Medium Access Control Scheme for Wireless LANs with Constant-Time Contention". *IEEE Transactions on Mobile Computing* , Volume 10, No. 2, pp.191-204. Feb. 2011.
- Kuo-yi Chen, J. M. Chang, and T. W. Hou. "Multi-threading in Java: Performance and Scalability on Multi-core Systems". *IEEE Transactions on Computers*, Volume 60, Issue 11, pp. 1521-1534. Nov. 2011.

THOMAS DANIELS
SENIOR LECTURER
PhD, Computer Science, Purdue (2002)

RESEARCH INTERESTS: Intrusion detection, network attribution, computer engineering, problem solving education.

SELECTED PUBLICATIONS:
- Wang, W. and T. E. Daniels. "A Graph-based Approach Towards Network Forensic Analysis". *ACM Trans. Information System Security* 12, no. 1, October 2008.
- Al-Kofahim, M., S. Chang, and T. E. Daniels. "SCWIM: An Integrity Model for SOA Networks". *In Proc. IEEE International Conference on Web Services*, Beijing, China, September 23-26, 2008.

JAMES A. DAVIS
ASSOCIATE PROFESSOR
VICE PROVOST FOR INFORMATION TECHNOLOGY
CHIEF INFORMATION OFFICER
PhD, Computer Science, Iowa State (1984)

RESEARCH INTERESTS: Enterprise information security strategies, risk management, computer security education.

MANIMARAN GOVINDARASU
PROFESSOR
ASSOCIATE DEPARTMENT CHAIR
PhD, Computer Science and Engineering, Indian Institute of Technology, Madras (1998)

RESEARCH INTERESTS: Cyber-physical security of the smart grid, cyber security, real-time systems.

SELECTED PUBLICATIONS:
- S. Sridhar, A. Hahn, and G. Manimaran. "Cyber-Physical Security for Electric Power Grid," *Proceedings of the IEEE*, vol. 100, no. 1, pp. 210-224, Jan. 2012.
- Hahn and G. Manimaran. "Cyber Attack Exposure Evaluation Framework for the Smart Grid," *IEEE Trans. on Smart Grid*, vol. 2, no. 4, pp. 835-843, Nov. 2011.

YONG GUAN
ASSOCIATE PROFESSOR
PhD, Computer Science, Texas A&M (2002)

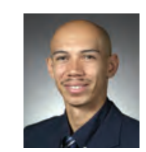
RESEARCH INTERESTS: Digital forensics, wireless security, privacy-enhancing technologies for the Internet.

SELECTED PUBLICATIONS:
- T. Myneedu, and Y. Guan. "Evidence Collection for Forensic Investigation in Peer to Peer Systems". *8th Annual IFIP WG 11.9 International Conference on Digital Forensics*, University of Pretoria, Pretoria, South Africa, January 3-5, 2012.
- Amariucai, G., Bergman, C., and Y. Guan. "Adopted-Pet (AP): An Automatic, Time-Based, Secure Pairing Protocol for Passive RFID". in *Proceedings of RFIDSec 2011*, Northampton, Massachusetts, June 26-28, 2011.

DOUG JACOBSON
UNIVERSITY PROFESSOR
PhD, Computer Engineering, Iowa State (1985)
- IEEE Fellow

RESEARCH INTERESTS: computer and network security, security testbeds, high school STEMrur education.

SELECTED PUBLICATIONS:
- J. Rursch, D.W. Jacobson. "The Building of Teams During an IT Competition: Success with Combining Multiple Schools into Teams to Perform Collaborative Challenges During a Two-Day Competition". In *Proceedings of the 2011 ASEE Annual Conference.* Vancouver, B.C. 26-29 June, 2011.
- J. Idziorek, M. Tannian, and D.W. Jacobson. "Modeling Web Usage Profiles of Cloud Services for Utility Cost Analysis". In *Proceedings of the 2011 Winter Simulation Conference (WSC).* Phoenix, AZ. 11-14 Dec. 2011.



PHILLIP JONES
ASSISTANT PROFESSOR
PhD, Computer Engineering, Washington (2008)

RESEARCH INTERESTS: Adaptive computing systems, reconfigurable hardware, embedded systems, specialized hardware for application acceleration, fault-tolerant systems.

SELECTED PUBLICATIONS:
- S. Sun, M. Monga, P. Jones, and J. Zambreno. "An I/O Bandwidth-Sensitive Sparse Matrix-Vector Multiplication Engine on FPGAs". *IEEE Transactions on Circuits and Systems-I (TCAS-I)*, Volume 59, no. 1, pp. 113-123, January 2012.
- Moinuddin Sayed and Phillip Jones. "Characterizing Non-Ideal Impacts of Reconfigurable Hardware Workloads on Ring Oscillator-based Thermometers". *EEE International Conference on Reconfigurable Computing and FPGAs (Reconfig)*, Cancun, Mexico, Nov 3-Dec 2, 2011.

DISTRIBUTED SENSING & DECISION MAKING

AHMED KAMAL
PROFESSOR
PhD, Electrical Engineering, University of Toronto, Canada (1986)
- IEEE Fellow

RESEARCH INTERESTS: High-performance networks, optical networks, wireless and wireless sensor networks, performance evaluation.

SELECTED PUBLICATIONS:
- A.E. Kamal. "1+N Network Protection for Mesh Networks: Network Coding-Based Protection Using p-Cycles". *IEEE/ACM Trans. Networking* 18, no. 1, pp. 67–80. Feb., 2010.
- Saleh, M. and A. E. Kamal. "Approximation Algorithms for Many-to-Many Traffic Grooming in Optical WDM Networks". To appear in the *IEEE/ACM Transactions on Networking*, 2012.

SURAJ C. KOTHARI
PROFESSOR
PhD, Mathematics, Purdue (1977)

RESEARCH INTERESTS: Analysis and assessment of software for safety and security, domain-specific tools for software development and evolution.

SELECTED PUBLICATIONS:
- Kang Gui, Suraj Kothari. "An empirical study to discover patterns for checing the matching pair property". *IEEE International Conference on Computational Intelligence and Software Engineering*, Wuhan, China, December, 2010
- Suraj Kothari, and Jeremias Sauceda. "How tracking Byzantine bugs in the Linux kernel led to a new way of thinking about complex software," *Embedded World Conference*, Germany, March, 2011.

TIEN NGUYEN
ASSOCIATE PROFESSOR
PhD, Computer Science, Wisconsin (2005)

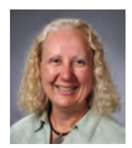
RESEARCH INTERESTS: software engineering, software maintenance and evolution, program analysis, mining software repositories, web engineering.

SELECTED PUBLICATIONS:
- Ahmed Tamrawi, Hoan A. Nguyen, Hung V. Nguyen, and Tien N. Nguyen. "Build Code Analysis with Symbolic Evaluation". in *Proceedings of the 34th ACM/IEEE International Conference on Software Engineering (ICSE 2012),* June 2-9, 2012.
- Anh T. Nguyen, Tung T. Nguyen, Hoan A. Nguyen, Ahmed Tamrawi, Hung V. Nguyen, Jafar Al-Kofahi, and Tien N. Nguyen. "Graph-based Pattern-Oriented, Context-Sensitive Source Code Completion". in *Proceedings of the 34th ACM/IEEE International Conference on Software Engineering (ICSE 2012),* June 2-9, 2012.

DIANE ROVER
PROFESSOR
PhD, Computer Engineering, Iowa State (1989)
- ASEE Fellow

RESEARCH INTERESTS: Embedded systems, reconfigurable hardware, integrated program development and performance environments for parallel and distributed systems, visualization, performance monitoring and evaluation, engineering education.

SELECTED PUBLICATIONS:
- C. Rehmann, D. Rover, M. Laingen, S. Mickelson, and T. Brumm. "Introducing Systems Thinking to the Engineer of 2020". *Proc. 2011 ASEE Annual Conference*, June 2011.
- R. Mercado, Z. Cao, and D. Rover. "Mixture Models for System-Level Communication Analysis at Higher Levels of Abstraction". *Proc. 2010 IEEE Int'l Conf. on Electro/Information Technology*, pp. 1-6. May 2010.



JULIE A. RURSCH
LECTURER
PhD, Electrical Engineering, Iowa State (2012)

RESEARCH INTERESTS: Engineering education, IT-Adventures.

SELECTED PUBLICATIONS:
- J. A. Rursch, A. Luse, D. Jacobson, "IT-Adventures: A Program to Spark IT Interest in High School Students Using Inquiry-Based Learning With Cyber Defense, Game Design, and Robotics". *IEEE Trans. on Education*, vol. 53, iss. 1, pp.71–79. 2010.
- J. A. Rursch, B. Burkhardt, and D. Jacobson. "Training Non-IT Teachers to Advise and Facilitate Inquiry-Based Learning in IT: A Pilot Study". *Conference on Frontiers in Education*, pp. 1-5. 2009.

ARUN K. SOMANI
ANSON MARSTON DISTINGUISHED PROFESSOR
JERRY R. JUNKINS CHAIR
PhD, Electrical Engineering, McGill University, Montreal, (1985)
- IEEE Fellow
- ACM Distinguished Engineer

ARUN K. SOMANI PHOTO COURTESY OF CRAIG CARROLL PHOTOGRAPHY

RESEARCH INTERESTS: Critical infrastructure monitoring and protection, optical fiber networking, reliability-performance-energy tradeoffs in dependable computing and networking systems.

SELECTED PUBLICATIONS:
- N. D. P. Avirneni, V. Subramanian, and A. K. Somani. "Low Overhead Soft Error Mitigation Techniques for High-Performance and Aggressive Systems". *IEEE Transactions on Computers*, Vol. 61(04), pp. 488-501. April 2012.
- A. K. Somani, V. M. Vokkarane, and B. H. Ramaprasad. "Dynamic Advance Reservation with Delayed Allocation over Wavelength-Routed Networks". in *Proc. of ICTON*, held at Stockholm, Sweden, pp. Tu.A.3.1 (5 pages). June 27-30, 2011.

AKHILESH TYAGI
ASSOCIATE PROFESSOR
PhD, Computer Science, Washington (1988)

RESEARCH INTERESTS: Embedded systems, trusted computing base, private circuit synthesis.

SELECTED PUBLICATIONS:
- A. Baumgarten, Akhilesh Tyagi, and Joseph Zambreno. "Preventing IC Piracy Using Reconfigurable Logic Barriers". *IEEE Design and Test of Computers* 27, no. 1, pp. 66–75. February 2010.
- K. Keung and Akhilesh Tyagi. "State Space Reconfigurability: An Implementation Architecture for Self Modifying Finite Automata". *Journal of Low Power Electronics* 6, no. 1, 18–31. April 2010.

JOSEPH ZAMBRENO
ASSOCIATE PROFESSOR
PhD, Computer Engineering, Northwestern (2006)

RESEARCH INTERESTS: Reconfigurable computing, graphics processing and architecture, embedded systems.

SELECTED PUBLICATIONS:
- M. Steffen and J. Zambreno. "Improving SIMT Efficiency of Global Rendering Algorithms with Architectural Support for Dynamic Micro-Kernels". *Proceedings of the International Symposium on Microarchitecture (MICRO),* pp. 237-248, December 2010.
- A. Pande and J. Zambreno. "Poly-DWT: Polymorphic Wavelet Hardware Support For Dynamic Image Compression". *ACM Transactions on Embedded Computing Systems (TECS),* vol. 11, no. 1, 2012.

ZHAO ZHANG
ASSOCIATE PROFESSOR
PhD, Computer Science, College of William and Mary (2002)

RESEARCH INTERESTS: Computer architecture, parallel and distributed computing, hardware support for security.

SELECTED PUBLICATIONS:
- Kun Fang, Long Chen, Zhao Zhang, and Zhichun Zhu, "Memory Architecture for Integrating Emerging Memory Technologies" . *In Proc. of the 12th PACT*, October 10-14, 2011.
- Jiang Lin, Hongzhong Zheng, Zhichun Zhu, and Zhao Zhang, "Thermal Modeling and Management of DRAM Systems." *Preprint, IEEE Transactions on Computers.* 2011

ALEKSANDAR DOGANDZIC
ASSOCIATE PROFESSOR
PhD, Electrical Engineering and Computer Science, University of Illinois at Chicago (2001)

RESEARCH INTERESTS: Statistical signal processing theory and applications.

SELECTED PUBLICATIONS:
- K. Qiu and A. Dogandzic. "Sparse signal reconstruction from quantized noisy measurements via GEM hard thresholding". *IEEE Trans. Signal Processing*, vol. 60, pp. 2628-2634, May 2012.
- A. Dogandzic and K. Qiu. "Decentralized Random-field Estimation for Sensor Networks Using Quantized Spatially Correlated Data and Fusion-center Feedback". *IEEE Trans. Signal Processing,* vol. 56, no. 12, pp. 6069–6085 December 2008.

NICOLA ELIA
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Massachusetts Institute of Technology (1996)

RESEARCH INTERESTS: Networked control systems, communication with feedabck, control with communication constraints, network distributed optimization systems, advanced controller design methods.

SELECTED PUBLICATIONS:
- J. Wang and N. Elia, "Distributed averaging under constraints on information exchange: Emergence of Levy flights". *IEEE Transaction on Automatic Control*, to appear Aug. 2012.
- N. Elia, and J. N. Eisenbeis, "Limitation of Linear Control over packet Drop Networks". *IEEE Trans. Automatic Control*, vol. 56, no. 4, pp. 826 – 841, 2011.

SANG W. KIM
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Michigan (1987)

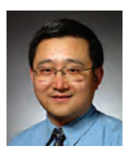
RESEARCH INTERESTS: Cooperative communications, network coding, wireless security, code division multiple access, MIMO, cross-layer design.

SELECTED PUBLICATIONS:
- Sang W. Kim, T.Khalaf, and S.M.Kim. "MAP detection of misbehaving relay in wireless multiple access relay networks". *IEEE Communications Letters*, pp.340-342, March 2011.
- Sang W. Kim and Y.J.Chun. "Reliability-rate tradeoff in large scale multiple access relay networks with random network coding". *IEEE Journal on Selected Areas in Communications* (accepted), May 2012.

RATNESH KUMAR
PROFESSOR
PhD, Electrical and Computer Engineering, Texas (1991)
- IEEE Fellow

RESEARCH INTERESTS: Control, diagnosis, and verification of distributed and networked event-driven, real-time and hybrid systems, and their applications to cyberphysical systems, embedded systems and software, sensor and embedded networks, web-services, precision farming, power systems.

SELECTED PUBLICATIONS:
- M. Li and R. Kumar. "Stateflow to Extended Finite Automata Translation", *2011 IEEE International Computer Systems and Applications Conference, Munich*, July 2011.
- C. Zhou, R. Kumar, and S. Jiang. "A Formal Analysis Approach of Runtime Data-Log for Embedded Software-Fault Localization" *2011 American Control Conference*, pp. 5127-5132, San Francisco, June 2011.



DAJI QIAO
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Michigan (2004)

RESEARCH INTERESTS: Wireless networking and mobile computing.

SELECTED PUBLICATIONS:
- Sunggeun Jin and Daji Qiao. "Numerical Analysis of the Power Saving Operation in 3GPP LTE Advanced Wireless Networks." *In IEEE Transactions on Vehicular Technology (TVT)*, pp. 61(4), May 2012.
- Xi Chen, Prateek Gangwal, and Daji Qiao. "RAM: Rate Adaptation in Mobile Environments." *In IEEE Transactions on Mobile Computing (TMC)*, 11(3), March 2012.

ADITYA RAMAMOORTHY
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, UCLA (2005)

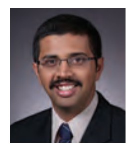
RESEARCH INTERESTS: Network information theory, error control coding and signal processing with applications to nanotechnology and data storage.

SELECTED PUBLICATIONS:
- Shurui Huang, Aditya Ramamoorthy and Muriel Medard, "Minimum cost mirror sites using network coding: Replication vs. coding at the source nodes", *IEEE Trans. on Information Theory* vol. 57(2), pp. 1080-1091, Feb. 2011.
- Kumar, Naveen, Pranav Agarwal, Aditya Ramamoorthy, and Murti V. Salapaka. "Maximum Likelihood Sequence Detector for Dynamic Mode High Density Probe Storage." *IEEE Trans. Communications* 58, no. 6, June 2010.

ALEXANDER STOYTCHEV
ASSISTANT PROFESSOR
PhD, Computer Science, Georgia Tech (2007)

RESEARCH INTERESTS: Developmental robotics, autonomous robotics, machine learning, computational perception.

SELECTED PUBLICATIONS:
- J. Sinapov, V. Sukhoy, R. Sahai, and A. Stoytchev. "Vibrotactile Recognition and Categorization of Surfaces by a Humanoid Robot," *IEEE Transactions on Robotics*, Vol. 27, No. 3, pp. 488-497, June 2011.
- J. Sinapov, T. Bergquist, C. Schenck, U. Ohiri, S. Griffith, and A. Stoytchev. "Interactive Object Recognition Using Proprioceptive and Auditory Feedback," *International Journal of Robotics Research*, Vol. 30, No. 10, pp. 1250-1262, 2011.



SRIKANTA TIRTHAPURA
ASSOCIATE PROFESSOR
PhD, Computer Science, Brown (2002)

RESEARCH INTERESTS: Stream computing, algorithms for massive data, anomaly detection in streams, databases, parallel and distributed computing.

SELECTED PUBLICATIONS:
- Pan Xu and Srikanta Tirthapura. "On Optimality of Clustering Through a Space Filling Curve", *in Proceedings of the ACM Symposium on Principles of Database Systems (PODS)* 2012.
- Bibudh Lahiri and Srikanta Tirthapura. "Identifying Frequent Items in a Network using Gossip", *Journal of Parallel and Distributed Computing 70* (12), pages 1241-1253, 2010.

UMESH VAIDYA
ASSOCIATE PROFESSOR
PhD, Mechanical Engineering, University of California, Santa Barbara (2004)

RESEARCH INTERESTS: Control of complex dynamical systems with applications to power systems, fluid flow problems, and aerospace applications, analysis and control of uncertain network systems.

SELECTED PUBLICATIONS:
- A. Diwadkar and U. Vaidya. "Nonlinear observation over erasure channels". Accepted for publication in *IEEE Trans. of Automatic Control*, 2012.
- U. Vaidya, R. Rajaram, and S. Dasgupta. "Sensors and Actuator placement in linear advection PDE with building systems application". *Journal of Mathematical Analysis and Applications*, In Press, 2012.

ZHENGDAO WANG
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Minnesota (2002)

RESEARCH INTERESTS: Wireless communication, signal processing, information theory.

SELECTED PUBLICATIONS:
- H. Topakkaya and Z. Wang. "Wireless network code design and performance analysis using diversity-multiplexing tradeoff". *IEEE Trans. Commun.*, 59 (2):488-496, February 2011.
- L. Ke, A. Ramamoorthy, Z. Wang, and H. Yin. "Degrees of freedom region for an interference network with general message demands". *IEEE Trans. Inform. Theory*, January 2011

SUMIT CHAUDHARY
NORTHROP GRUMMAN ASSISTANT PROFESSOR
PhD, Electrical Engineering, University of California, Riverside (2006)

RESEARCH INTERESTS: Organic electronic materials and devices, solar cells.

SELECTED PUBLICATIONS:
- K.S. Nalwa, JA. Carr, R. Mahadevapuram, H.K. Kodali, S. Bose, Y. Chen, J.W. Petrich, B. Ganapathysubramanian, S. Chaudhary. "Enhanced charge separation in organic photovoltaic films doped with ferroelectric dipoles". *Energy & Environmental Science*, 5(5), pp. 7042-7049. 2012
- Nalwa KS, Park JM, Ho KM, Chaudhary S, "On realizing higher efficiency polymer solar cells using a textured substrate platform" Advanced Materials 2011, 23, 112-116.

ENERGY INFRASTRUCTURE

VENKATARAMANA AJJARAPU
DAVID C. NICHOLAS PROFESSOR
PhD, Electrical Engineering, University of Waterloo (1986)
- IEEE Fellow

RESEARCH INTERESTS: Power system security, voltage stability, wind and solar energy integration, real-time control of power and power electronics systems.

SELECTED PUBLICATIONS:
- Fan Menghua, Wang Cheng Shan and V. Ajjarapu. "Power system equilibrium tracing and bifurcation detection based on the continuation of recursive projection method". to appear in *IET*. 2012.
- S. Sarkar and V. Ajjarapu. "MVar Resource Assessment Model for a Hybrid Energy Conversion System with Wind & Solar Resources". *IEEE Transactions on Sustainable Energy* , Vol. 2, no.4, pp. 383-391, October 2011.

DIONYSIOS ALIPRANTIS
ASSISTANT PROFESSOR
PhD, Electrical Engineering, UCLA (2005)

RESEARCH INTERESTS: Electric machines and drives, power systems, electric vehicles, wind and solar photovoltaic energy, smart grid applications

SELECTED PUBLICATIONS:
- D. Wu, D. C. Aliprantis, and L. Ying."Load scheduling and dispatch for aggregators of plug-in electric vehicles". *IEEE Trans. Smart Grid* (Special Issue on Transportation Electrification and Vehicle-to-Grid Applications), Vol. 3, No. 1, pp. 368–376, Feb. 2012.
- A. M. Cramer, B. P. Loop, and D. C. Aliprantis, "Synchronous machine model with voltage-behind-reactance formulation of stator and field windings," to appear in *IEEE Trans. Energy Conv.* 2012.

VIKRAM DALAL
WHITNEY PROFESSOR
PhD, Electrical Engineering, Princeton University (1969)
- IEEE Fellow
- AAAS Fellow
- APS Fellow

RESEARCH INTERESTS: Photovoltaic energy conversion, electronic and optical materials and devices, plasma processing.

SELECTED PUBLICATIONS:
- R. Biswas ,J. Bhattacharya, B. Lewis, N. Chakravarty, V.L. Dalal, "Enhanced Nanocrystalline Silicon Solar cell with a Photonic Crystal Back Reflector". *Solar En. Mater. And Solar Cells.* 2010.
- J. Bhattachary, N. Chakravarty, S. Pattnaik, D.Slafer, R. Biswas and V. L. Dalal. "A photonic-plasmonic structure for enhancing light absorption in thin film solar cells". *Appl. Phys. Lett.*, 99, No: 131114. 2011.

IAN DOBSON
SANDBULTE PROFESSOR
PhD, Electrical Engineering, Cornell (1989)
- IEEE Fellow

RESEARCH INTERESTS: Cascading failure and risk analysis, blackouts, phasor measurements, power grid stability, complex systems, self-organized criticality, oscillations, nonlinear dynamics.

SELECTED PUBLICATIONS:
- I. Dobson, B.A. Carreras, V.E. Lynch, D.E. Newman. "Complex systems analysis of series of blackouts: cascading failure, critical points, and self-organization". *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 17, 026103, June 2007.
- I. Dobson, "Voltages across an area of a network". *IEEE Transactions on Power Systems*, vol. 27, no. 2, pp. 993-1002. May 2012.

JAMES MCCALLEY
HARPOLE PROFESSOR
PhD, Electrical Engineering, Georgia Tech (1992)
- IEEE Fellow

RESEARCH INTERESTS: Energy control centers, security assessment, power system dynamics, asset management, bulk energy production and transportation, energy system planning, wind energy.

SELECTED PUBLICATIONS:
- R. Dai, H. Pham, Y. Wang, and J. McCalley, "Long term benefits of online risk-based optimal power flow," *Journal of Risk and Reliability* (Part O of the Proceedings of the Institution of Mechanical Engineers): Special Issue on "Risk and reliability modeling of energy systems," Vol. 226, Issue 1, Feb, 2012.
- C. Fu, J. McCalley, and J. Tong, "A Numerical Solver Design for Extended-Term Time-Domain Simulation," to appear in *IEEE Transactions on Power Systems*. 2012.

MATERIALS, DEVICES AND CIRCUITS

JOHN R. BOWLER
PROFESSOR
PhD, Physics, University of Surrey, UK (1984)

RESEARCH INTERESTS: Analysis of electromagnetic fields, applications to nondestructive evaluation, computational methods in electromagnetics.

SELECTED PUBLICATIONS:
- Lu, Yi, N. Bowler, J. R. Bowler, Y. Huang. "Edge Effects in Four Point Direct Current Potential Drop Measurements". *Journal of Physics D-Applied Physics* 42, no. 13. 2009.
- Bowler, J. R. and T. P. Theodoulidis. "Boundary Element Calculation of Eddy Currents in Cylindrical Structures Containing Cracks". *IEEE Trans. Magnetics* 45, no. 3, pp. 1012–1015. 2009

NICOLA BOWLER
ASSISTANT PROFESSOR
PhD, Physics, University of Surrey, UK (1994)

RESEARCH INTERESTS: Electromagnetic properties of composite materials; properties by theoretical analysis and design, electromagnetic non-destructive evaluation (NDE) of dielectrics and metals; NDE techniques, four-point potential drop, eddy-current, microwave and capacitive NDE.

SELECTED PUBLICATIONS:
- T. Chen, N. Bowler and J. R. Bowler, "Analysis of Arc-electrode Capacitive Sensors for Characterization of Dielectric Cylindrical Rods", *IEEE Trans. Instrumentation Meas.*, 61, pp. 233-240. 2012.
- N. Bowler, "Topical Review: Four-Point Potential Drop Measurements for Materials Characterization", *Meas. Sci. Technol.*, 22. 2011.

DEGANG CHEN
PROFESSOR
PhD, Electrical and Computer Engineering, University of California, Santa Barbara (1992)

RESEARCH INTERESTS: Analog and mixed-signal VLSI design and testing.

SELECTED PUBLICATIONS:
- Xing Hanqing, Hanjun Jiang, Degang Chen, and Randall Geiger. "High-resolution ADC Linearity Testing Using a Fully Digital-Compatible BIST Strategy". *IEEE Trans. Instrumentation and Measurement* 58, no. 8, pp. 2697–2705. August 2009.
- He Jun, Sanyi Zhan, Degang Chen, and Randall Geiger. "Analyses of Static and Dynamic Offset Voltage in Dynamic Comparators". *IEEE Trans. Circuits and Systems I: Fundamental Theory and Applications* 56, no. 5, pp. 911–919. May 2009.

CHRIS CHONG-NUEN CHU
ASSOCIATE PROFESSOR
PhD, Computer Science, Texas (1999)
- IEEE Fellow

RESEARCH INTERESTS: Physical design of VLSI circuits.

SELECTED PUBLICATIONS:
- Jackey Z. Yan and Chris Chu. "Optimal Slack-Driven Block Shaping Algorithm in Fixed-Outline Floorplanning" *Intl. Symp. on Physical Design*, pp. 179-186, 2012.
- Yue Xu and Chris Chu. "MGR: Multi-Level Global Router". *IEEE/ACM International Conference on Computer-Aided Design*, pp. 250-255, 2011.

AYMAN FAYED
ASSISTANT PROFESSOR
PhD, Electrical and Computer Engineering, Ohio State (2004)

RESEARCH INTERESTS: Embedded power management, conversion, and delivery for RF/mixed-signal SoCs and multi-core processors; energy harvesting for power-restricted and remotely-deployed devices; and high-speed wire-line transceivers.

SELECTED PUBLICATIONS:
- Chengwu Tao and Ayman Fayed. "A GSM Power Amplifier Directly-Powered from a DC-DC Power Converter". *IEEE Microwave and Wireless Components Letters*, vol. 22, no. 1, pp. 38-40, Jan. 2012.
- Chengwu Tao and Ayman Fayed, "A Buck Converter with Reduced Output Spurs using Asynchronous Frequency Hopping," *IEEE Transactions on Circuits and Systems II*, vol. 58, no. 11, pp. 709-713, Nov. 2011.

RANDALL L. GEIGER
DOLUCA PROFESSOR
PhD, Electrical Engineering, Colorado State (1977)
- IEEE Fellow

RESEARCH INTERESTS: Analog VLSI design, VLSI testing, high-speed data converters.

SELECTED PUBLICATIONS:
- He Jun, Sanyi Zhan, Degang Chen, and Randall Geiger. "Analyses of Static and Dynamic Offset Voltage in Dynamic Comparators". *IEEE Trans. Circuits and Systems I: Fundamental Theory and Applications* 56, no. 5, pp. 911–919. May 2009.
- L.Jin, D. Chen, and R.L. Geiger. "Code-Density Test of Analog-to-Digital Converters Using Single Low-Linearity Stimulus Signal". *IEEE Transactions on Instrumentation and Measurement*, Vol. 58, pp. 2679-2685, August 2009.

DAVID C. JILES
PALMER DEPARTMENT CHAIR
ANSON MARSTON DISTINGUISHED PROFESSOR
PhD, Applied Physics, University of Hull, United Kingdom (1979)
- IEEE Fellow
- APS Fellow

RESEARCH INTERESTS: Nonlinear and hysteretic behavior of magnetic materials; magnetoelasticity, magnetostriction, and magnetomechanical effects; novel magnetic materials; applications of magnetic measurements to nondestructive evaluation.

SELECTED PUBLICATIONS:
- D.C.Jiles, P.I.Williams and L.J.Crowther. "Deep Brain Stimulation using Magnetic Fields". *Presented at the APS March Meeting*, Dallas, Texas, March 21-25, 2011.
- P.I.Williams, P.Marketos and D.C.Jiles. "An Investigation of the Performance Characteristics of Transcranial Magnetic Stimulation Coils". *IEEE Transactions on Magnetics*, 2011.

JAEYOUN KIM
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Michigan (2003)

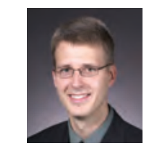
RESEARCH INTERESTS: Bio-inspired engineering, plasmonics, bio-MEMS, and micro-photonics.

SELECTED PUBLICATIONS:
- J. Lee and J. Kim. "Elastomeric microwire-based optical gas flowmeter with stretching-enabled tunability in measurement range," *Optics Letters*, v.36, 3789, 2011.
- Y. Liu and J. Kim, "Polarization-diverse, broadband absorption enhancement in thin-film photovoltaic devices using long-pitch metallic gratings," *Journal of Optical Society of America* B, v.28, 1934, 2011.

MANI MINA
SENIOR LECTURER
PhD, Electrical Engineering, Iowa State (1989)

RESEARCH INTERESTS: High-speed systems, magneto optics devices, applied electromagnetics, Physical layers, Engineering education.

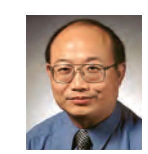
SELECTED PUBLICATIONS:
- John Pritchard, Mani Mina, Robert J. Weber, and Sasha Kemmet. "Low power field generation for magneto-optic fiber-based interferometric switches". *Journal of Applied Physics*, Volume: 111 , Issue: 7, pp. 07A941-1-07A9413. 2012.
- J. Tioh, R. J. Weber, and M. Mina, "Improved formulation of Faraday rotation characterization,". *Journal of Applied Physics*, Volume: 109 , Issue: 7, pp.07E334 - 07E334-3. 2011.



NATHAN NEIHART
ASSISTANT PROFESSOR
PhD, Electrical Engineering, Washington (2008)

RESEARCH INTERESTS: Radio-frequency analog and mixed-signal integrated circuit design, reconfigurable circuits and systems for cognitive radio applications, fabrication and application of memristors to analog and mixed signal circuit design, synthetic biology and circuits for biomedical applications.

SELECTED PUBLICATIONS:
- N. M. Neihart, J. Brown, and X. Yu, "A dual-band 2.45/6 GHz CMOS LNA utilizing a dual-resonant transformer-based matching Network," accepted to *IEEE Trans. on Circuits and Systems - I: Regular Papers*. 2012.
- X. Yu and N. M. Neihart, "A 2-11 GHz reconfigurable multi-mode LNA in 0.13um CMOS," accepted to *IEEE Radio Frequency Integrated Circuits Symposium*, June 2012.



JIMING SONG
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, Michigan State (1993)

RESEARCH INTERESTS: Fast and efficient algorithms in computational electromagnetics, modeling of VLSI interconnects on silicon, electromagnetic nondestructive evaluation, wave propagation in metamaterials, antenna analysis and design.

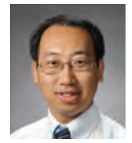
SELECTED PUBLICATIONS:
- F.G. Hu and J.M. Song, "Integral equation analysis of scattering from multi-layered periodic array using equivalence principle and connection scheme," *IEEE Transactions on Antennas and Propagation*, vol.58, no.3, pp.848-856, March 2010.
- W.W. Shu and J.M. Song. "Sommerfeld integral path for layered double negative metamaterials". *IEEE Transactions on Antennas and Propagation*, vol.60, no.3, pp.1496-1504, March 2012.

GARY L. TUTTLE
ASSOCIATE PROFESSOR
PhD, Electrical Engineering, California, Santa Barbara (1991)

RESEARCH INTERESTS: Semiconductor materials, nanoelectronics, photonic crystals, negative-index materials.

SELECTED PUBLICATIONS:

- D. Stieler, A. Barsic, G. Tuttle, M. Li, K.M. Ho. "Effects of defect permittivity on resonant frequency and mode shape in the three-dimensional woodpile photonic crystal". *Journal of Applied Physics* 105, 03019, 2009.
- D. Stieler, A. Barsic, R. Biswas, G. Tuttle, K.M. Ho. "A planar four-port channel drop filter in the three dimensional woodpile photonic crystal". *Optics Express* 17(8), pp. 6128-6133, 2009.



FAXIAN XIU
PROFESSOR
PhD, Electrical Engineering, California, Riverside (2006)

RESEARCH INTERESTS: Dilute magnetic semiconductors for spintronics devices, surface states of topological insulators for dissipationless applications.

SELECTED PUBLICATIONS:

- Faxian Xiu et al. "Electric-field-controlled ferromagnetism in high-Curie-temperature Mn0.05Ge0.95 quantum dots". *Nature Materials*, 9, pp. 337-344. 2010.
- Faxian Xiu et al. "Manipulating surface states in topological insulator nanoribbons". *Nature Nanotechnology* 6, pp. 216–221. 2011.

STAFF AND OTHER APPOINTMENTS

ADDITIONAL FACULTY APPOINTMENTS

RESEARCH PROFESSOR

- **Maneesha Aluru**, Research Assistant Professor (ECpE)
- **Jaroslaw Zola**, Research Assistant Professor (ECpE)

ADJUNCT FACULTY

- **Raj Aggarwal**, Adjunct Professor (ECpE)
- **George Amariucai**, Adjunct Assistant Professor (ECpE)
- **Rana Biswas**, Adjunct Professor (Ames Lab/Physics)
- **Brett Bode**, Adjunct Assistant Professor (Ames Lab)
- **Ruth Shinar**, Adjunct Professor (Physics)
- **Masha Sosonkina**, Adjunct Associate Professor (Ames Lab)

FACULTY COURTESY APPOINTMENTS

- **Jennifer Davidson**, Courtesy Associate Professor (Mathematics)
- **Baskar Ganapathysubramanian**, Courtesy Assistant Professor (Mechanical Engineering)
- **Brian Hornbuckle**, Courtesy Associate Professor (Agronomy)
- **Zhinqun Lin**, Courtesy Assistant Professor (Materials Science and Engineering)
- **Glenn R. Luecke**, Courtesy Professor (Mathematics)
- **James Oliver**, Courtesy Professor (Mechanical Engineering)
- **Joseph Shinar**, Courtesy Professor (Physics)
- **Sanjeevi Sivasankar**, Courtesy Assistant Professor (Physics)
- **Costas Soukoulis**, Courtesy Distinguished Professor (Physics)
- **Leigh Tesfatsion**, Courtesy Professor (Economics)
- **Lizhi Wang**, Courtesy Assistant Professor (Industrial and Manufacturing Systems Engineering)

JOINT FACULTY

- **David Weiss**, Professor (Software Engineering)
- **Samik Basu**, Associate Professor (Software Engineering)

POSTDOCTORAL APPOINTMENTS

- **Lihong Bao**
- **Ravi Hadimani**
- **Siddartha Kumar Khaitan**
- **Venkat Krishnan**
- **Ikenna Nlebedim**
- **Kai Wang**
- **Jin Xu**

SUPPORT STAFF

ADMINISTRATIVE SUPPORT

- **Ginny Anderson**, Program Assistant, IAC
- **Brock Ascher**, Communications Specialist
- **Paula Beckman**, Secretary
- **Barb Brown**, Administrative Specialist, EPRC
- **Samantha Dubert**, Administrative Specialist
- **Karin Dunn**, Grant Coordinator
- **Sara K Harris**, HR Liaison & Assistant to the Dept. Chair
- **Laurel Kelch**, Fiscal Officer

COMPUTING SUPPORT GROUP

- **Jason Boyd**, Lab Coordinator
- **Cory Farver**, Systems Support Specialist
- **Leland Harker**, Electronic Technician
- **Steven Kovarik**, Manager, Information Technology
- **Steve Nystrom**, Systems Support Specialist
- **Mark Shamblin**, Systems Support Specialist

STUDENT SERVICES

- **Lindsay Diers**, Academic Adviser
- **Deb Martin**, Academic Adviser
- **Anthony Moore**, Academic Adviser
- **Vicky Thorland-Oster**, Manager, Student Services

Seventy-six PhD students have graduated from the ECpE department in the last two years. They have been hired as faculty at major universities, as well as for various positions in industry and at national laboratories.

	NAME	MAJOR PROFESSOR
BIOENGINEERING	Bais, Preeti	Dickerson, Julie A.
	Chen, Baozhen	Pandey, Santosh
	Labyed, Yassin	Bigelow, Timothy
	Vanhemert, John	Dickerson, Julie A.
	Zhang, Lifeng	Berleant, Daniel; Dickerson, Julie A.
	Zhou, Wengang	Dickerson, Julie A.
COMMUNICATIONS AND SIGNAL PROCESSING	Das, Samarjit	Vaswani, Namrata
	Lu, Wei	Vaswani, Namrata
	Mercado, Ramon	Rover, Diane
	Qiu, Kun	Dogandzic, Aleksandar
	Xu, Songyan	Kumar, Ratnesh
	Ke, Lei	Wang, Zhengdao
	Kumar, Naveen	Ramamoorthy, Aditya
	Li, Shizheng	Ramamoorthy, Aditya
	Ramalingam, Neevan	Wang, Zhengdao
	Shi, Cuizhu	Ramamoorthy, Aditya
	Topakkaya, Hakan	Wang, Zhengdao
COMPUTING AND NETWORK SYSTEMS	Abichar, Zakhia	Chang, Morris; Kamal, Ahmed E.
	Almasaeid, Hisham	Kamal, Ahmed E.
	Chen, Xi	Qiao, Daji
	Chun, Young	Kim, Sang
	Keung, Ka-Ming	Tyagi, Akhilesh
	Long, Long	Kamal, Ahmed E.
	Pande, Amit	Zambreno, Joseph
	Park, Yong-Joon	Zhang, Zhao
	Ramesh, Prem	Somani, Arun
	Saleh, Mohammad	Kamal, Ahmed E.
	Sun, Song	Zambreno, Joseph
ELECTRIC POWER AND ENERGY SYSTEMS	Bai, Hua	Ajjarapu, Venkataramana
	Fu, Chuan	McCalley, James D.
	Gu, Yang	McCalley, James D.
	Ibanez Sopena, Eduardo	McCalley, James D.
	Krishnan, Venkat	McCalley, James D.
	Li, Juan	Liu, Chen-Ching
	Luo, Cheng	Ajjarapu, Venkataramana
	Silveira Leonardi, Bruno	Ajjarapu, Venkataramana
	Sun, Wei	Liu, Chen-Ching
	Wu, Di	Aliprantis, Dionysios C.
	Yan, Jie	Liu, Chen-Ching
	Yang, Sheng	Ajjarapu, Venkataramana
	Yu, Nanpeng	Liu, Chen-Ching
	Zhou, Qun	Liu, Chen-Ching

	NAME	MAJOR PROFESSOR
ELECTROMAGNETICS, MICROWAVE AND NDE	Chen, Tianming	Bowler, Nicola
	Gerdes, Ryan	Mina, Mani; Daniels, Thomas
	Hu, Fu-Gang	Song, Jiming
	Jain, Sidharath	Song, Jiming
	Oster, Sasha	Mina, Mani; Weber, Robert J.
	Tioh, Jin-Wei	Weber, Robert J.; Mina, Mani
	Yang, Ming	Song, Jiming
SECURE AND RELIABLE COMPUTING	Al-Kofahi, Majd	Daniels, Thomas
	Blakely, Benjamin	Jacobson, Douglas
	Chang, Su	Daniels, Thomas
	Idziorek, Joseph	Jacobson, Douglas W.
	Khalaf, Taha	Kim, Sang
	Lahiri, Bibudh	Guan, Yong
	Muthusrinivasan, M	Govindarasu, Manimaran
	Wang, Wei	Daniels, Thomas
	Wei, Yawen	Guan, Yong
MICROELECTRONICS AND PHOTONICS	Chakravarty, Nayan	Dalal, Vikram L.
	Liu, Yifen	Kim, Jaeyoun
	Nalwa, Kanwar	Chaudhary, Sumit
	Shyam, Ashutosh	Dalal, Vikram L.
	Shoeb, Juline	Kushner, Mark
SOFTWARE SYSTEMS	Gui, Kang	Kothari, Suraj
	Jia, Ming	Dickerson, Julie A.
	Kabala, David	Dickerson, Julie A.
	Sarje, Abhinav	Aluru, Srinivas
	Wehe, Andre	Aluru, Srinivas
	Yang, Xiao	Aluru, Srinivas
SYSTEMS AND CONTROLS	He, Jun	Geiger, Randall L; Chen, Degang
	Wang, Jing	Elia, Nicola
VLSI	Duan, Jingbo	Chen, Degang
	Tao, Chengwu	Fayed, Ayman
	Xu, Yue	Chu, Chris Cong-Nuen
	Yan, Zijun	Chu, Chris Cong-Nuen
	Zhang, Yanheng	Chu, Chris Cong-Nuen

MORE ONLINE
For more details on ECpE PhD production, visit
www.ece.iastate.edu/academics/phd-production-2010-12

DEPARTMENTAL STRATEGIC RESEARCH AREAS

- **Bioengineering:** This area encompasses fields such as bioinformatics and systems biology, BioMEMS, biosensing, bio-optics, and bioimaging.
- **Cyber Infrastructure:** The department's focus in this group includes computer architecture, cybersecurity, dependable and real-time systems, embedded systems, high-performance computing, high-speed networking, and software systems and engineering.
- **Distributed Sensing and Decision Making:** Faculty in this area specialize in research on compressed sensing, information theory, networked control systems, signal processing theory and applications, and wireless communications, sensors, and networks.
- **Energy Infrastructure:** Research efforts in this area focus on power electronics systems and control, energy system planning and modeling, novel photovoltaic and organic solar cells, power systems security, and wind energy.
- **Materials, Devices, and Circuits:** This area encompasses research in analog and mixed-signal VLSI design and testing, BioMEMS, computational electromagnetics and non-destructive evaluation, magnetic materials and devices, metamaterials for antenna applications, microelectronic devices, optical nanostructures for bioengineering and biomimetric optics, and power management, conversion, and delivery for electronic devices.

DEPARTMENTAL CORE RESEARCH AREAS FOR GRADUATE STUDY

- Bioengineering
- Communications and signal processing
- Computing and networking systems
- Electric power and energy systems
- Electromagnetic, microwave, and nondestructive evaluation
- Microelectronics and photonics
- Secure and reliable computing/information assurance
- Software systems
- Systems and controls
- Very-large-scale integration (VLSI)

ECpE RESEARCH LABS

- Alternate Energy Grid Infrastructure and Systems Laboratory
- Biomedical Engineering Laboratory
- Dependable Computing and Networking Laboratory
- Developmental Robotics Laboratory
- Digital Forensics Laboratory
- Discrete Event Systems Laboratory
- Distributed Sensing and Decision Making Research and Teaching Laboratory
- High-Speed Communications Carver Laboratory
- High-Speed Systems Engineering Laboratory
- iCUBE Sensors Application Laboratory
- Internet-Scale Event and Attack Generation Environment
- Micro/Nano Systems Laboratory
- Plasmonics and Microphotonics (Biophotonics) Laboratory
- Power Infrastructure Cyber Security Laboratory
- Reconfigurable Computing Laboratory
- RF/Microwave Circuits and Systems Laboratory
- Rockwell Automated/Allen Bradley Power Electronics and Drive Systems Laboratory
- Scalable Software Engineering Research Laboratory
- Software Defined Radio Laboratory

ECpE MISSION STATEMENT

The mission of the Department of Electrical and Computer Engineering (ECpE) is to:

- provide an outstanding educational program that enables our graduates to become leaders in their profession by imparting fundamental principles, skills, and tools to innovate and excel
- pursue the discovery of fundamental knowledge and its applications to position the department among the leaders in research
- respond to the needs of the State of Iowa and the nation by building a strong outreach program that serves industry and the engineering profession.

ECpE VISION AND PRIORITIES

VISION

Students will become broadly educated in the fundamentals of electrical and computer engineering principles with an emphasis on skills that enable them to adapt to the regular paradigm shifts in technological and engineering landscapes. We will aim to produce leaders who will shape the future technological arena.

The faculty will focus on research that is creative, innovative, and meaningful. The faculty vigorously will pursue and lead new emerging areas that have the potential to revolutionize the electrical and computer engineering and other related scientific and technological disciplines. The faculty will create, share, and apply the knowledge according to the land-grant mission of the university.

PRIORITIES

EDUCATION:

- Impart the ability to learn
- Encourage leadership
- Maintain high standards and an excellent international reputation
- Attract top students from reputed national and international schools
- Form strategic alliances with industry and research labs to enhance opportunities for research collaboration and student exposure

RESEARCH:

- Sustain faculty composition to have strength in core disciplines with adaptability
- Create centers of excellence in bioengineering, cyber infrastructure, distributed sensing and decision making, energy infrastructure, and small-scale technologies
- Create strategic partnerships with reputed research labs, universities, and industry
- Build strong support infrastructures
- Encourage the process of technology transfer

IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering
2215 Coover Hall
Ames, IA 50011-3060