AUGUST 2008

Research Highlights

IOWA STATE UNIVERSITY

ECE

Electrical and Computer Engineering

www.ece.iastate.edu

Department Overview

Fast Facts

- **Established:** 1909
- **Alumni:** More than 11,000
- **Research Centers & Institutes:** 13

New Facilities & Equipment (2006-08)

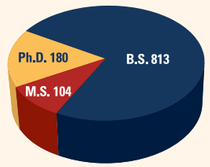
- $16.5 million building addition completed
- IBM Blue Gene/L supercomputer acquired
- CyberInnovation Institute established
- C6 virtual reality room upgraded with 16.7 million pixels per side—making it the world's most realistic
- Nation's first Internet-Scale Event and Attack Generation Environment developed
- High-Performance Computing Center being established

Honors (2006-08)

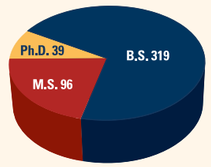
- **New IEEE Fellows:** 2
- **Best Paper Awards:** 5
- **Patents Awarded:** 5
- **Journal Editorships:** 21
- **Conference Keynote Speakers:** 4

Students

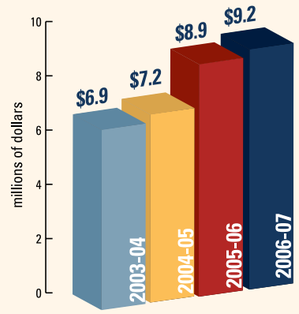
Enrollment (Fall 2007)



Degrees Awarded (2006-08)



Research Expenditures



Private Funding (2006-08)

- **Organization Gifts:** $1.5 million
- **Individual Gifts:** $5.3 million
- **Scholarships Awarded:** More than $320,000 each year

Faculty Details

- 48 faculty
- 9 endowed chairs and professorships
- 9 NSF CAREER/PYI award winners
- 8 IEEE Fellows (out of 15 full professors)
- 1 Institute of Physics Fellow
- 1 American Physical Society Fellow
- 1 American Vacuum Society Fellow
- 1 International Union of Pure and Applied Chemistry Fellow
- 1 Japanese Society for Advancement of Science Fellow
- 1 Optical Society of America Fellow
- 1 ACM Distinguished Engineer

IOWA STATE UNIVERSITY
ECpE
Department of Electrical and Computer Engineering

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Letter from the Chair

It is my great pleasure to present you a snapshot of the research accomplishments that the faculty in Iowa State University's Department of Electrical and Computer Engineering (ECpE) have made in the last two years. In our last *Research Highlights* report in August 2006, we presented our new strategic plan and ongoing activities in our five strategic research areas: bioengineering, cyber infrastructure, distributed sensing and decision making, energy infrastructure, and small-scale technologies. In this report, we highlight the accomplishments our department has made in those areas.

We are continuing to invest in our five strategic areas by hiring 12 new faculty and making investments to equip state-of-the-art laboratories in those areas. By focusing on and investing effort and funds in these areas, the department is poised to meet the challenges of the future and maintain our history of conducting cutting-edge research and education.

Many of our faculty have made major breakthroughs in their research and are conducting first-of-its-kind research in their specialty areas, too. For example, Assistant Professors **Jaeyoun Kim**'s and **Liang Dong**'s research received widespread national media attention for innovations in artificial eyes and microlens technologies (page 10) and Professor **Randall L. Geiger** and Associate Professor **Degang Chen** achieved what industry representatives told them was an impossible feat for analog and mixed signal testing (page 16).

Additionally, our department has celebrated many important milestones in research and education, including:

- the enrollment in our graduate programs reaching an all-time high—180 PhD students and 104 master's degree students;
- the completion of a $16.5 million building expansion to house research labs, teaching labs, and classrooms;
- the creation of the CyberInnovation Institute, which includes two of our department's research centers; and
- the 100-year anniversary of the department's formation.

Our department also has experienced consistent annual increases in research expenditures and two of our professors recently were elected Fellows of the Institute of Electrical and Electronics Engineers—joining seven other ECpE faculty to receive that distinction.

Overall, the department continues to excel. We hope you'll find this *Research Highlights* report of our recent accomplishments informative and useful.

Best regards,

Arun K. Somani
Anson Marston Distinguished Professor
Jerry R. Junkins Chair Professor
ECpE Department Chair

contents

Features

Iowa State Establishes IT Institute

In 2007, the Board of Regents, State of Iowa, approved the new CyberInnovation Institute, an information technology (IT) institute at Iowa State University, and provided $1 million in seed funding to get the institute up and running. The institute aims to bring together interdisciplinary research teams and industrial partners to address real-world problems in diverse areas such as biological sciences, agriculture, engineering, and business.

According to **James Oliver**, the new institute's director and ECpE courtesy professor, the CyberInnovation Institute's mission is threefold.

"Number one is bolstering research—getting us more competitive for bigger research grants. Number two is making our disciplinary colleagues more competitive, essentially by teaming with them. And the third aspect is finding different ways to commercialize that research and facilitate building the economy."

The CyberInnovation Institute answers a call from several organizations at the national and state levels. The National Science Foundation (NSF) has been a catalyst for prioritizing the development of what NSF Director Arden L. Bement calls America's "cyber infrastructure" through NSF's Cyber-enabled Discovery and Innovation Initiative (CDI). The CyberInnovation Institute embraces the CDI's expansive vision, which, in the language of its charter, seeks to "broaden the nation's capability for innovation by developing a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems."

Information technology also was one of three key areas earmarked for funding in the Iowa Department of Economic Development's 2004-05 Battelle Institute Report on Iowa's Bioeconomy, a report that provides strategic direction and action-oriented programmatic concepts for new initiatives organized around the key comparative advantages and emerging industries of Iowa.

PHOTO COURTESY OF THE IOWA STATE UNIVERSITY CYBERINNOVATION INSTITUTE

James Oliver, director of the CyberInnovation Institute

The new institute serves as an umbrella to unify several smaller IT-oriented centers on Iowa State's campus, including the Information Infrastructure Institute run by ECpE Department Chair **Arun K. Somani**; Information Assurance Center led by ECpE University Professor **Doug Jacobson**, Center for Computational Intelligence, Learning, and Discovery; Cobinatorial Sciences and Materials Informatics Collaboratory International Materials Institute; and Virtual Reality Applications Center directed by Oliver.

Oliver says the future of "traditional" academic disciplines are increasingly interdependent, and nowhere is this interdependence more evident than in the information technologies that enable them.

"We have world-class visualization, big-league, high-performance computing, and data people second to none at Iowa State," Oliver observes. "So we have all this expertise and infrastructure. And the IT part gives us a global impact." ■

— Dennis Smith and Dana Schmidt

CyberInnovation INSTITUTE

Iowa State Creates High-Performance Computing Center

Researchers in Iowa State University's ECpE department are launching a new High-Performance Computing Center (HPCC) this fall. The center will be a part of the university's new CyberInnovation Institute and will involve researchers from various disciplines.

"The goal of the center is to advance and promote high-performance computing research in all relevant fields on campus, particularly in science and engineering," says Professor **Srinivas Aluru**, the center's director and Stanley Chair in Interdisciplinary Engineering. "Other goals for the center are to have high-performance computing equipment to enable research and also act as a formal interface between Iowa State and the Great Lakes Consortium for Petascale Computation."

Aluru already is making headway on his goal for bringing high-performance computing equipment to Iowa State's campus. In 2006, he led the effort to bring CyBlue, an IBM Blue Gene/L supercomputer, to Iowa State. At the time, the computer was one of the top 100 fastest in the world. Additionally, Aluru and several colleagues recently received $1.2 million from the National Science Foundation (NSF) and matching university funds to bring a more powerful computer—a large quad-core InfiniBand cluster—to campus this fall. Aluru's co-principal investigators on this project include **Maneesha Aluru**, an associate scientist in electrical and computer engineering; **Jim McCalley**, an ECpE professor; Krishna Rajan, a professor of materials science and engineering and Stanley Chair in Interdisciplinary Engineering; and **Arun K. Somani**, an Anson Marston Distinguished Professor and ECpE department chair.

The HPCC will enable research that addresses today's grand challenges (see below for more information on specific projects). The center will be located in a facility especially designed to house it in Coover Hall's new west wing. In addition to the HPCC, Iowa State will partner with Sun Microsystems to establish a Sun Center of Excellence at Iowa State, which will be directed by Aluru. The new HPCC and Sun Center of Excellence, plus two recent grants from NSF's PetaApps program, will help position Iowa State as a leader in high-performance computing. ■

PHOTO BY MARK SHAMBLIN

This room in Coover Hall will house the High-Performance Computing Center.

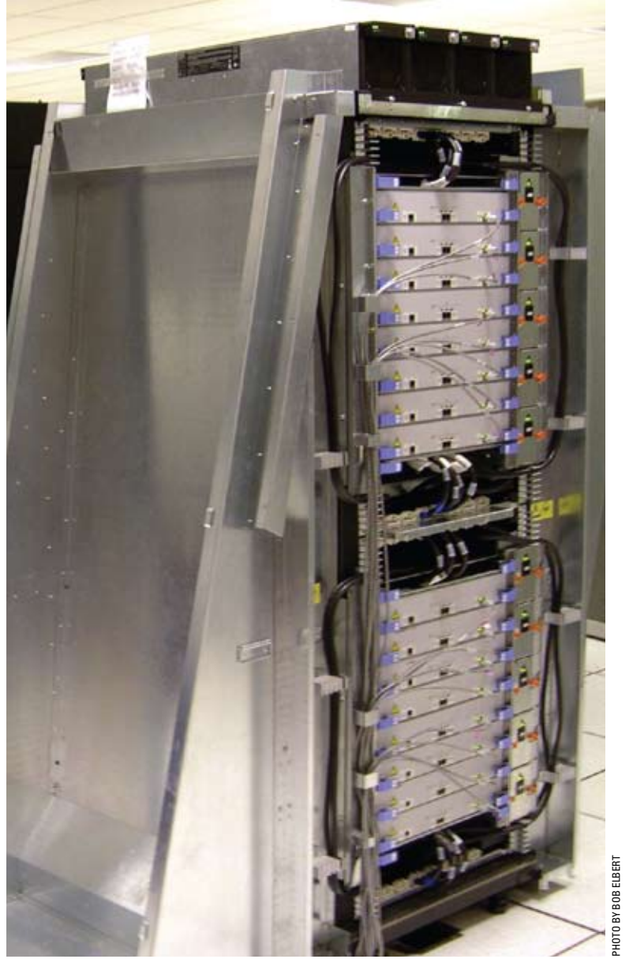


PHOTO BY BOB ELBERT

Iowa State acquired the IBM Blue Gene/L supercomputer in 2006 and purchased a new, more powerful supercomputer this year.

High-Performance Computing Center Projects

Faculty from many disciplines will use the equipment and technology at the High-Performance Computing Center (HPCC) to enhance their research. Below is a sampling of those current and future projects.

Materials informatics: The HPCC will allow materials informatics researchers to more efficiently and rapidly analyze their data gathered from Iowa State University's atom probe microscope—one of only a dozen such microscopes in the world and among the first on a university campus, according to Professor **Srinivas Aluru**. Researchers at Iowa State plan to set up a Web portal for researchers around the world to deposit their atomic-scale data and develop tools to analyze it.

Power systems: ECpE faculty, including Professors **Jim McCalley** and **Arun K. Somani**, will use high-performance computing for complex system design, analysis, and tradeoff studies in energy systems and control centers. They will investigate improving the security, reliability, and efficiency of national energy infrastructure.

Long-timescale molecular dynamics: Aluru will develop timescale parallelization techniques to rapidly advance on the timescale through tracking of multiple event trajectories. This research aims to extend molecular dynamics timescales by orders of magnitude while retaining atomic-level details.

Weather forecasting: Three Iowa State researchers who contributed to the Nobel-Prize winning Intergovernmental Panel on Global Climate Change will use high-performance computing to conduct regional weather forecasting integrated with full-scale global models. Their research could help farmers predict the best time to plant crops each year. The professors are Ray Arritt, a professor of agronomy; Bill Gutowski, a professor of geological and atmospheric sciences; and Gene Takle, a professor geological and atmospheric sciences and agronomy.

Carbon-cycle modeling: In the future, Aluru and Patrick Schnable, the Baker Professor of Agronomy and director of Iowa State's Center for Plant Genomics and Center for Carbon Capturing Crops, will work to find ways to sequester more carbon by altering cell wall composition. They also hope to integrate carbon-cycle modeling with economics and weather modeling at the HPCC.

Department Makes Strategic Research Investments

The department plans to build a test bed for cyber security of power systems as well as develop a laboratory that allows researchers to recreate a representative distributed power system.

The ECpE department at Iowa State University plans to make six investments to support interdisciplinary research in five strategic research areas: bioengineering, cyber infrastructure, distributed sensing and decision making, energy infrastructure, and small-scale technology. All research labs will be housed in the ECpE department's recently completed Coover Hall building addition. The following summarizes the department's key investments.

Cyber Security Test bed for Power Systems

To respond to the growing demand of cyber security in a comprehensive and systematic manner, engineers in the department will work with industry members of the Electric Power Research Center to build a supervisory control and data acquisition test bed. The test bed will incorporate various hardware, software, and simulation modules together to provide a realistic platform to emulate environments of electric utilities and study attack and defense mechanisms. This will advance cyber security research, as well as help power utilities comply with North American Electric Reliability Corporation's cyber security standards.

Microspectroscopy Workstation

Assistant Professors **Sumit Chaudhary**, **Liang Dong**, **Jaeyoun Kim**, and **Santosh Pandey** plan to investigate various topics that combine bioengineering, energy infrastructure, and small-scale technologies. To support these efforts, the department is investing in equipment to create a microspectroscopy workstation. Chaudhary and Kim will investigate a method to improve the efficiency of solar cells and other photovoltaic devices using surface plasmon resonance induced by placing metallic nanostructures on the semiconductor or polymer surfaces. Kim also plans to characterize the change in surface plasmons when nanostructures become functionalized with certain biomolecules. He will use the mechanism for biosensing. Dong plans to build microfluidic Lab-on-Chip systems for biomedical applications. Pandey will investigate cell population with real-time cell imaging of live biological cells.

Multi-core Processors in High-Performance Computing

To address a major trend in processor technology—integrating multiple processor cores onto a single processor chip to form multi-core processors—the department is investing in equipment to extend its research efforts in cyber infrastructure and bioengineering. The research, to be conducted by three electrical and computer engineering professors and a scientist from the U.S. Department of Energy's Ames Laboratory, covers multi-core global illumination, acceleration and efficiency exploration of cryptographic kernels on multi-core processing platforms, high-performance computing in chemistry and nuclear physics, bioinformatics programs problem-solving, and cache-partitioning for multi-core processors. The applications of researching these topics span across the arenas of image processing, cyber infrastructure security, operating system infrastructure, high-performance computing, bioinformatics, and emerging Java workloads.

Autonomous Vehicle Research

With cars today becoming so sophisticated that they can park themselves and sense objects drivers cannot see, automobile manufacturers are more eager than ever to support the creation of completely autonomous vehicles. To position the department on the forefront of this breakthrough automobile technology, the department will purchase equipment, including sensors, a laser scanner, fiber optic inertial measurement unit, and GPS unit to begin building an autonomous vehicle.

Electromechanical Energy Conversion Laboratory

To conduct state-of-the-art research on electromechanical energy conversion, the department is creating a laboratory—competitive with the best research laboratories in the nation—to develop novel power electronic converters and their associated controls, and explore new territories in electromechanical energy conversion concepts with applications in hybrid electric vehicles, solar and wind energy, and power systems. The lab will provide capabilities for testing various electric machines under different configurations and allow engineers to recreate a representative distributed power system without compromising fidelity and flexibility as well as study all the phases of a power system's life cycle.

Atomic Force Microscope

The department will add an atomic force microscope, a vital tool for studying electronic and optical materials and devices at the nano-scale, to its repertoire of laboratory tools for research in small-scale technology and bioengineering. Dong will use the microscope to investigate topographic, mechanical, and electrical properties of polymer nanocoating and zinc oxide nanowires and nanowire arrays, an important study for the realization of nanodevices for applications in biological sensing, sub-cellulous probing, and more. Researchers at Iowa State's Microelectronics Research Center will study fabricated nanomaterials to determine how efficiently the material will work as a solar cell, understand how the device grows, and understand how the electronic properties are affected as a function of growth conditions and thickness. ■

Department Invests in New Facilities

In addition to the ECpE department's research investments, the department also is investing in providing state-of-the-art education and research facilities to its students, faculty, and staff. In April 2008, a $16.5 million building expansion was completed, creating a new west wing of the department's home, Coover Hall. The department also plans to build a second addition and renovate the existing building, which was built in the 1950s. Fundraising is well underway for both efforts.

View of the completed west wing

One of the classrooms in the new addition

View of the completed west wing from the building's courtyard

Grand staircase in the building's atrium

ECpE Launches New Program: Software Engineering

Students in an entry-level software engineering course use Wii-mote video game controllers to solve problems using the sensors on the Wii-motes, practice discovering how embedded systems work, and relate the device to real systems and their coursework in computer engineering, mathematics, and physics.

After 10 years in development, the new software engineering degree program at Iowa State University has its first group of students. A joint effort between the ECpE department and the Department of Computer Science, the new program will help meet an all-time high industry demand for software engineers.

"It's the fastest growing segment of the engineering market," says Professor **Suresh Kothari**, one of the key organizers of the program. "Demand is high because nearly everything from autos and air conditioners to cell phones and watches has embedded computer systems that require software."

According to Kothari, Professor and Department Chair **Arun K. Somani** first discussed the program in 1998. Faculty and industry representatives discussed the needs and in 2005, a committee met with representatives of the Association of Computing Machinery and the Institute of Electrical and Electronics Engineers to develop an approved curriculum.

"It took two years to develop the curriculum," Kothari says. "Our main focus was the problems software engineers face in the real world and creating the kind of environment and tools that industry uses to solve those problems."

Kothari adds that faculty spent a significant amount of time developing course materials, particularly lab projects that students could complete in a limited time yet maintain a realistic flavor. The labs themselves have been set up with a range of industry hardware and software tools and about $250,000 in industry support from Guidant Corporation, IBM, Lockheed Martin, Microsoft, and Rockwell Collins.

Presently, the curriculum offers four new courses within each of the parent departments along with some preexisting courses. ECpE courses include software architecture and design, software construction and user interfaces, software project management, and software evolution and maintenance.

The Board of Regents, State of Iowa approved the degree program in May 2007 and the first students enrolled this past fall. Thirty-nine students currently are enrolled in the program and the first degrees will be awarded in 2009. ■

— Kerry Gibson

PHOTO BY DAVE GIESEKE, IOWA STATE UNIVERSITY COLLEGE OF LIBERAL ARTS & SCIENCES

Iowa State Offers Bioengineering Minor

Beginning this fall, undergraduate engineering students at Iowa State University will be able to earn credits towards a new bioengineering minor. The minor is designed to integrate principles and knowledge from basic life sciences and engineering disciplines and give engineering graduates a leg up in the fast-growing bioeconomy.

For the minor, students will take two core classes (six credits) and nine additional credits from 20 courses spread among four tracks or among eight related courses, allowing students to specialize in bioinformatics and systems biology, biomaterials and biomechanics, biomicro systems, or biosystems and environmental engineering.

Maneesha Aluru, ECpE associate scientist and staff director of the bioengineering minor program, says the program was created to provide students with better career opportunities and unique educational experiences in applying engineering skills to solve problems and develop new bio-based products and devices.

"This program is designed to realize synergies across multiple departments and make the level of educational opportunities across all engineering disciplines commensurate with existing research activity in bioengineering."

An average of 30 students are expected to enroll each year.

Faculty Entrepreneurs Take Research to Industry

Faculty in Iowa State University's ECpE department—including University Professor **Doug Jacobson** and Professor **Suresh Kothari**—are involved actively in entrepreneurship and technology transfer opportunities. Jacobson established Palisade Systems (*www.palisadesys.com*) in 1996 and Kothari founded EnSoft Corp (*www.ensoftcorp.com*) in 2002.

Palisade Systems sells network security devices with a primary focus on data loss prevention to ensure the security of data such as credit card numbers, social security numbers, and healthcare information. The company's core technology stems from a patent Jacobson earned.

"My work at Palisade allows me to bring firsthand knowledge of the security market back into the classroom," says Jacobson, who has donated Palisade's product for use in the classroom and in cyber defense exercises.

Jacobson and his company have experienced great success in recent years: He was a finalist for the Ernst and Young Iowa/Nebraska Entrepreneur of the Year Award and he has won two prestigious R&D 100 awards, helping Iowa State University maintain its status as second in the nation in the total number of R&D Awards presented by *R&D* magazine. Palisade Systems is located in Ames, Iowa, and also has an office in Dallas, Texas.

Kothari's EnSoft develops customized software tools for companies and sells three software analysis products: Rubric, SimDiff, and COBOL Total Insight. Kothari's tools stem from his research on automatic parallelization. Kothari, with support from two Grow Iowa Values Fund grants, developed tools to learn what happens inside software and analyze complex controls. The research Kothari conducts at Iowa State provides the fundamental advances in complex software that EnSoft engages to create better products.

University Professor
Doug Jacobson

Professor
Suresh Kothari

EnSoft employs eight engineers and its client base has grown from one in 2002 to 50 major clients worldwide today, including clients from most major avionics and automobile companies in the United States, Europe, and Japan. The company has worked diligently to establish relationships with large corporate customers and its Web site attracts more customers each year. In fact, 75 percent of EnSoft's customers found their SimDiff tools through Web searches at Google.com.

Additionally, EnSoft won the $25,000 top prize at Iowa's John Pappajohn Business Plan Competition in 2007 and the Technology Association of Iowa's 2008 Prometheus Award for Innovator of the Year.

Kothari believes EnSoft's success results from the highly accomplished and talented Iowa State graduates the company employs. He believes these employees have helped skyrocket his small technology company in the middle of Iowa to a major internationally known, high-tech corporation.

— ReAnn Jackson

Engineering Sight

Two ECpE professors combine nature, science, and engineering technologies to create innovative artificial eyes and microlenses.

BY **REBEKAH BOVENMYER**

It's not every day that mainstream media scamper to cover electrical engineers in their papers or magazines and on TV. But in the last few years, three magazines—*Science*, *Nature*, and *Newsweek* International Edition, two major U.S. newspapers—the *San Francisco Chronicle* and *The New York Times*, and the Discovery Channel have clamored to cover new innovations by two Iowa State researchers and their collaborators who have made breakthroughs in developing artificial eyes and microlenses. Of course, the research has been published in many well-respected academic journals, too, and the advances they have made are truly state-of-the-art.

Making life-like artificial bug eyes

Being called bug eyes wasn't a compliment when we were kids, but that's exactly what Assistant Professor **Jaeyoun Kim** is going for. He has worked for the past few years with collaborators Professor Luke P. Lee at the University of California, Berkeley, and Assistant Professor Ki-Hun Jeong at the Korea Advanced Institute of Science and Technology on a U.S. Department of Defense, Defense Advanced Research Projects Agency project to create artificial compound eyes.

The compound bug eyes contain thousands of ommatidia, an accurately aligned microlens-waveguide pair, covering the hemispherical surface of the eye. Each artificial ommatidium—a polymer microlens-waveguide complex about the size of a pinpoint—can look in different directions with a very narrow acceptance angle, creating one mosaic image—covering just about every direction and making up the field of view. In all, the entire artificial compound eye contains more than 8,000 microlenses honeycombed on a curved surface the size of a pinhead.

IMAGE REPRINTED BY PERMISSION FROM MACMILLAN PUBLISHERS, LTD.: *NATURE*, AUGUST 3, 2006.

The researchers are the first to make self-written waveguides with microlenses that are aligned automatically and adopt the waveguide-lens hybrid to mimic the compound eye structure. To do this, the researchers developed the artificial eye by dispensing drops of photopolymer in circular wells to make an array of microlenses. The surface tension automatically shaped the drop into a pre-designed lens form. After the master mold cured, the researchers replicated it several times by dropping another type of polymer on top of it. They then waited a day for it to cure before pulling it off.

Next, the researchers created a "self-writing" waveguide. Waveguides connect the microlens to the photodetector where the image is captured and transmitted. But the researchers knew they couldn't do this manually, so they developed a photopolymer.

The researchers are the first to make self-written waveguides with microlenses that are aligned automatically ...

The microlens focused light on the photopolymer. The researchers confined the light to the high index area it created instead of dispersing the light. The waveguide then was written by the trapped light.

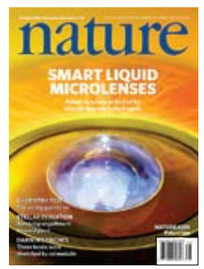
Kim and his collaborators acknowledge that although they made a major breakthrough in this research area by creating the self-writing waveguide, they still were not able to completely simulate a compound eye. Their main obstacle is getting the light to reach all the way to the photodetector and then to create one unified image.

"There's still a lot of room to explore," Kim says.

The artificial eyes could be used someday by the military in counterterrorism efforts or doctors to view inside the human body. For instance, the military could plant a tiny aircraft in a suspected terrorist's cave. This aircraft could see practically everywhere at once. A doctor could use an artificial compound eye to see a blocked artery in the heart.

Kim plans to continue with this research, which he started working on as a postdoctoral researcher at the University of California, Berkeley, at Iowa State. His next goal is to achieve real-time hemispherical imaging with commercially available detectors.

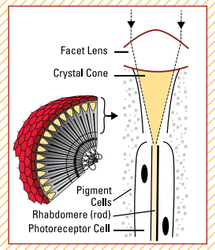
Science magazine featured Assistant Professor Jaeyoun Kim's work and *Nature* highlighted Assistant Professor Liang Dong's research.



Artificial Eyes

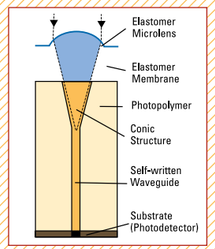
Assistant Professor **Jaeyoun Kim** and his collaborators engineered an artificial compound eye. The eye consists of more than 8,000 microlenses honeycombed on a curved surface the size of a pinhead.

Natural Ommatidium



In a natural eye, the lens catches light, cone guides light, rod transmits light, and photoreceptor cells send signals to the brain.

Artificial Ommatidium



Kim's artificial compound eye is designed to function like a natural eye.

Kim and his collaborators' research was featured in mainstream media such *Science*, the *San Francisco Chronicle*, and *The New York Times*, as well as in several academic journals.

Placing a human-eye inspired lab on a lens

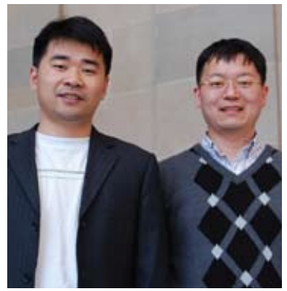
Your eyes focus on the letters on this page. Then they might focus on a tree outside your window. We don't normally think about it, but the way our eye lenses can change their shapes to focus on objects at different distances is pretty amazing.

"Nature tends to simplify complicated processes," says Assistant Professor **Liang Dong**, who's been working since 2005 with University of Wisconsin, Madison, Assistant Professor Hongrui Jiang and Professor David J. Beebe, and Northwestern University Postdoctoral Researcher Abhishek K. Agarwal, to replicate these autonomous changes with liquid microlenses driven by stimuli-responsive hydrogels. The project is supported by the National Center for Food Protection and Defense.

The lens Dong developed is formed via a water-oil interface. A water droplet (about 1 mm across) resides inside a ring made of hydrogel—a jelly-like polymer. Mineral oil covers the water to prevent evaporation and microchannels surround the hydrogel ring. The system is then covered in glass. A trigger from the environment, such as temperature or pH level, can cause the hydrogel to expand or contract like a human eye muscle, making the lens concave or convex and allowing it to focus without bulky electrical or mechanical equipment.

The uniqueness of Dong's lens lies in his use of hydrogels. The lenses can adapt intelligently to their local environment and automatically tune their focal lengths without needing any external electrical or mechanical systems, or even a power system, that other lens systems generally require.

Additionally, the researchers chemically can tune a hydrogel to respond to physical, chemical, or biological stimuli such as glucose, antigen, pH, fluorescent light, and temperature.



Assistant Professor Liang Dong, *left,* and Assistant Professor Jaeyoun Kim, *right*

"The hydrogel acts as a sensor to detect the substance of interest and responds with a programmed reaction to adjust the focal point of the microlens, providing an optical signal," Dong says.

Currently, the lens system is built on rigid, flexible, two-dimensional surfaces, but Dong hopes to move it to a sphere, creating a compound eye to achieve a larger field of view. He also would like to build a lab on a lens that could monitor various environmental factors.

This technology, Dong says, could help improve food safety by monitoring its pH and conductivity. It also could assist diabetics to know when they need to take insulin, depending upon if the lens is concave or convex. Additionally, it could advance lab-on-a-chip, optical imaging, and medical diagnostics technologies.

"If something is right for nature, it can be right for the lab," Dong says.

Dong's research has been reported in *Newsweek*'s International Edition, the *New Scientist Tech*, and featured on the Discovery Channel. It also was published in a *Nature* cover story in 2006, as well as in other prestigious journals such as *Advanced Materials* and *Applied Physics Letters*. ■

Going Green

ECpE researchers look at capturing the sun's power through solar and wind energy to break our fossil-fuel dependency and address global warming.

BY **KERRY GIBSON**

Sitting smack-dab in the middle of corn and soybean country, it's natural to think of Iowa State University's connection to bio-based energy. Ethanol and biodiesel seem to grab all the headlines, along with a sizeable amount of research funding.

But there is much more to "green" energy than processing plants of that color. An energy initiative within Iowa State's ECpE department focuses on using sunlight and wind power, which are also abundant commodities in Iowa, as low-cost, sustainable, and long-term sources of power not only here, but throughout the world.

Creating innovative thin-film solar panels

Vikram Dalal, director of Iowa State's Microelectronics Research Center and Thomas M. Whitney Professor in Electrical and Computer Engineering, has been a strong advocate of solar energy since the early 1970s. Ask him about his work and he'll matter-of-factly detail the problems—from both scientific and economic viewpoints—of fossil energy, nuclear power, and biofuels, not surprising since Dalal holds degrees in both engineering and public policy (with a major in economics) from Princeton University. Along the way, he makes a

Professor Vikram Dalal

VIKRAM DALAL PHOTO BY BOB ELBERT

convincing case for solar energy—clean (no carbon footprint), efficient (no moving parts), and economical (or at least moving in that direction).

"We want to solve it in a creative way, but also because it's the right thing to do …"

"The Earth receives more energy from the sun in one hour than we use in one year," Dalal says. "You can take one acre of land and the amount of solar energy it can produce compared to biofuel energy is 60 to one," adding that Iowa's fertile farmland is too valuable to be used for either type of energy production.

Dalal envisions vast solar farms in desert regions of the world that utilize sun-baked, uninhabitable land for producing electricity. He also sees new building construction methods that incorporate solar energy as an integral piece of a home or office building.

To move in that direction, Dalal has used funding from the National Science Foundation (NSF), Iowa Energy Center, and Micron Technology to develop thin-film (about 2 microns thick) solar panels. The technique uses plasma, an ionized gas, to deposit nanocrystalline silicon on a glass, plastic, or stainless steel substrate. The resulting solar panels, which could be installed as the windows in a home or commercial building, are much less expensive than using thicker silicon wafers and without the degradation problems experienced with thicker silicon solar cells.

Assistant Professor Sumit Chaudhary

Dalal's work differs from other researchers' in that he uses a novel device structure, based on superlattices, to improve the device performance. He also uses plasma deposition chemistry based on controlled ion bombardment to make the devices more stable against long-term degradation. He believes that researchers eventually will be able to achieve the same performance from thin-film silicon wafers as in crystalline wafers, but at a much lower cost.

"The trick is to get the cost down to that of electricity from a coal-fired power plant and we're getting close," Dalal says, adding that his motivation is ultimately humanitarian. "It feels good to work on a problem that will benefit humanity because global warming is a major problem. We want to solve it in a creative way, but also because it's the right thing to do from both an economic and environmental viewpoint."

Developing high-efficiency polymer-based solar cells

Assistant Professor **Sumit Chaudhary** shares that motivation, but approaches the problem from a slightly different direction. A recent addition to the department from the University of California, Riverside, he's using seed funding from the U.S. Department of Energy's Ames Laboratory to develop polymer-based (plastic) solar cells as the solution.

While we typically think of plastic as an insulator, such as the sheathing on electrical wires, Chaudhary uses polymers with carbon molecules arranged so that they can conduct electricity. Yet they have all the other characteristics we normally attribute to plastics.

"They're thin, lightweight, flexible, translucent, and relatively inexpensive to produce," Chaudhary says. "They can be printed similar to printing a newspaper."

Chaudhary demonstrated a novel device engineering and material processing approach to realize carbon nanotube electrodes and achieve a power conversion efficiency of 5 percent for polymer-based solar cells, the highest efficiency anyone in the field has reached. He says that number will need to jump to 8 to 10 percent before such polymers are commercially viable for ubiquitous small-scale power generation—something he's currently working to accomplish.

"I see them being used initially in consumer electronics such as a thin plastic coating on a cell phone that would recharge the device both inside and outdoors," he says.

Such a solar cell also could be woven into clothing or accessories to power a PDA device, into the fabric of a tent to supply power to a remote campsite or battlefield, or into window shades that could power the lamps in a room.

Chaudhary stresses the multidisciplinary nature of the research, saying it requires not only electrical engineering skill, but also chemistry and materials science knowledge. His focus is on using 3-D photonics to boost efficiency on hybrid solar cells of polymer and nano-porous titania. His research has been recognized as frontier research in journals of the American Chemical Society and Institute of Physics.

Harvesting wind energy

Efficiently using power is the goal of Professors **Jim McCalley** and **Venkataramana Ajjarapu** too, but their focus is wind power. Wind power offers similar benefits to solar in terms of sustainability and carbon footprint. And with funding from the NSF and two industry-funded centers—the Power System Engineering Research Center and Electric Power Research Center—McCalley and Ajjarapu are investigating how to efficiently get the power from the wind farm to homes, offices, and other places where it's needed.

"The electrical grid, the transmission and distribution lines, have a certain thermal capacity, like the circuit breaker in your home," explains McCalley, a member of the Iowa Wind Energy Association's Board of Directors. "There are a lot of other factors as well, but in looking at the existing grid in Iowa, it was evident people want to build a lot more than the system capacity will allow."

A challenge with wind energy is that no method for storing the energy currently exists. You can't take advantage of a windy day, generate excess power, store it, and then tap that supply on a calm day, although researchers elsewhere are working to convert the electricity into hydrogen gas or compressed air, which could be stored and tapped when needed.

Using sophisticated computer models, McCalley and Ajjarapu look at how demand and generating capacity affect variables in load, demand, voltage, and frequency. And because wind itself is variable, it further complicates the delicate balancing act of moving power from a generating site to the location where it's needed over a grid that can carry only limited amounts at a time.

"You've got all these energy resources, transportation systems, and conversion technologies and you can think of them as a pile of parts on the floor," McCalley says. "And you've got the existing system, a machine, on the table. How do you plug in the new parts so you build something that's optimal in terms of cost, emissions, meeting our energy needs, and reliability? That's what we're working to solve."

So far, McCalley and Ajjarapu have identified control means to alleviate frequency and voltage-related limitations to a higher level of wind penetration in transmission systems, attracting great interest from electric utilities and operators in the Midwest. ■

Professor Venkataramana Ajjarapu, *left*, and Professor Jim McCalley, *right*

Ajjarapu Elected IEEE Fellow

Professor Venkataramana Ajjarapu recently was named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). This honor recognizes outstanding IEEE members for their significant accomplishments in the advancement or application of engineering, science, or technology, and for their contributions to IEEE's mission.

Ajjarapu has served as chair of IEEE's voltage stability focus group, a member of the Korean Institute for Electrical Engineer's editorial advisory board, editor for *IEEE Power Engineering Letters*, and faculty adviser for Iowa State's IEEE student chapter. His work has been published in 112 articles, more than 40 of which are in reviewed journals, reports, or proceedings.

Ajjarapu joins seven other current ECpE professors—**Randall L. Geiger**, **Ratnesh Kumar**, **Mark J. Kushner**, **Chen-Ching Liu**, **Jim McCalley**, **Arun K. Somani**, and **Robert J. Weber**—who have been named IEEE Fellows.

Achieving the Impossible

Two ECpE professors collaborate to achieve the so-called impossible in analog and mixed signal testing.

BY **DANA SCHMIDT**

Telling ECpE Professor **Randall L. Geiger** or Associate Professor **Degang Chen** they can't achieve something won't stop them. Why? Because they recently took on one of the biggest, most challenging problems in analog and mixed signal testing and succeeded, despite critics telling them that their goals for testing high-precision devices with imprecise instruments, and ultimately reducing test costs, were impossible to achieve.

Achieving breakthroughs in ADC testing

Geiger and Chen are leading the way in the race for chip design researchers to find innovative ways to integrate more analog and mixed signal and RF functions onto a single chip, and provide consumers with high-performance, low-cost products. The researchers recently made major breakthroughs in three key areas of analog and mixed signal research that will enable on-chip testing. To start, they tackled analog to digital converter (ADC) testing.

"Researchers have been looking at ADC testing for decades, so we were told it was impossible to reduce test-signal linearity requirements to the level we did," Chen says. "Industry professionals told us our idea and initial results sounded too good to be true."

The researchers' idea was to address a critical need—System-on-chip (SoC) and analog and mixed signal built-in self-testing—labeled as one of the four "most daunting SoC challenges" of the 21st century in the *International Technology Roadmap for Semiconductors*, a report authored by worldwide leading experts in the semiconductor industry.

"Our first goal was to develop a testing method that could be incorporated on silicon so we could use it as a strategy for built-in self-test," Geiger says. "The second goal was to look at a strategy for reducing test costs by allowing testing of high-performance mixed signal circuits on dominantly digital testers rather than high-cost mixed signal testers."

The researchers—along with Texas Instruments Engineer Turker Kueyl and ECpE graduate students **Kumar Parasarathy** and **Le Jin**—developed a family of analog and mixed signal testing algorithms to test circuits more efficiently. The first algorithm allowed them to use lower linearity signal requirements for accurate ADC testing.

Industry professionals told Geiger and Chen they wouldn't believe the measurement results from academics, so the researchers enlisted industry partners Motorola (now Freescale Semiconductor) and National Semiconductors to validate the algorithms on their million-dollar testing equipment. The National Science Foundation, Semiconductor Research Corporation, and individual companies such as Texas Instruments and Conexant also supported the research.

"Using the traditional method, a 19- or 20-bit linearity test signal was required for testing a 16-bit ADC," Geiger says. "We can test a 16-bit ADC with a test signal that has 7-bit linearity or less."

"Engineers can use a device that is up to 100 times poorer in linearity metrics and still get accurate results."

Chen says this reduces the linearity test signal requirement by more than 4,000 times.

The researchers' results show that ADC testing costs for high-end data converters can be reduced significantly since engineers now can use lower-quality, inexpensive instruments to produce high-quality, accurate results that previously could be achieved only on expensive testing equipment.

"We're optimistic this will be the general approach engineers will follow for testing high-precision devices in the future," Geiger says.

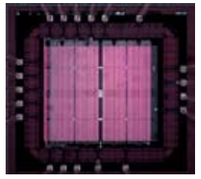
Introducing methods to reduce data acquisition time

The researchers also created a sister technique for ADC testing—an algorithm for reducing data acquisition time.

"Time equals money and the time a circuit has to stay on a test is determined by the data acquisition time," Chen says. "We introduced a method to reduce data acquisition time. You can use four or five fewer data points and achieve the same accuracy, making it four to eight times faster."

Additionally, Geiger and Chen introduced a new method for digital to analog converter (DAC) testing, a method that parallels their work on ADC testing. The DAC testing method involves using imprecise measurement devices rather than imprecise signal sources. The researchers want to preserve enough information in measuring outputs to characterize the device being tested.

"Just as in ADC testing, conventional wisdom required measurement devices to be



This image is a micrograph of a 12-bit deterministic dynamic element matching DAC with minimized current sources used as a signal generator of ADC linearity testing. Measurement results obtained at an Intel lab demonstrated that this tiny circuit generated ramp signals for ADC testing at the 16-bit linearity level, orders of magnitude better than the state of the art reported in scholarly literature. The actual size of the circuit is 1.5 x 1.4 mm.

better from a performance standpoint than the device you're testing," Geiger says.

But Geiger and Chen's research shows that instead of using a measurement device that's 10 times better to conduct tests, engineers can use a device that is up to 100 times poorer in linearity metrics and still get accurate results. This breakthrough can help reduce testing costs for high-precision parts and provide built-in self-test capability, allowing engineers to design products that perform better and improve the lifetime of a product's parts.

Developing a new dynamic element matching strategy

Geiger and Chen's achievements don't end there. The research team also developed a new strategy for dynamic element matching (DEM). Their strategy uses a simple cyclical deterministic way to perform DEM, which can enable built-in self-testing and self-calibration for ADC testing.

Chen says researchers have been trying for more than 20 years to do on-chip ADC testing, but have had little success.

"Researchers until now had reported only 11-bit linearity level for ADC test signal generation," Chen says. "We have achieved 16-bit linearity for ADC testing. For each bit of improvement, the difficulty traditionally is four times as much."

Geiger and Chen's strategy introduces a fundamental new idea for DEM: to take advantage of variability in a semiconductor process for resolution enhancement rather than use a large area to average out variability. With the new deterministic DEM method, they have reduced dramatically the matching requirements on the circuit components and eliminated the need for a randomizer.

"We have achieved 16-bit linearity for ADC testing For each bit of improvement, the difficulty traditionally is four times as much."

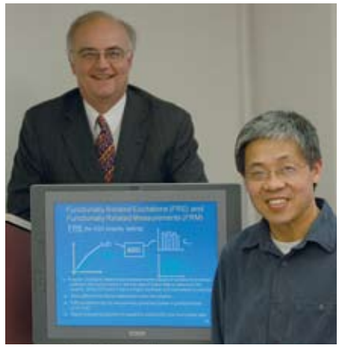
"In the past, even weak correlation in the randomizer of a DEM signal source created serious spectral spurs that could compromise the test's validity," Geiger says. "Now we've shown that with the right type of deterministic signal, you don't compromise the validity of the test."

The number and size of the components in the deterministic DEM signal sources also is very small, making them practical for on-chip testing.

This advancement means engineers can design built-in self-test circuitry that is smaller than what was used with previous DEM strategies. Plus, this could allow for self-calibration to make a marginally bad circuit into a satisfactory circuit. The circuit also is very robust and easy to boot, Chen adds.

Ultimately, this technology could improve functionality and lower prices to consumers of everyday electronics from PCs and PDAs to cell phones and MP3 players. Geiger and Chen's innovations in ADC testing, testing data acquisition, and DEM will challenge engineers to design high-performance circuits in a new way—reducing design and testing time, increasing productivity, and producing better electronic products. The researchers have earned a U.S. patent for their work and have a second patent pending. ■

Professor Randall L. Geiger, *left*, and Associate Professor Degang Chen, *right*



Catching Cyber Criminals

ECpE computer engineers improve cyber security at the physical and network layers.

BY **DANA SCHMIDT**

It's no surprise to computer engineering experts that criminals today are as likely to ravage your life through a broadband connection as in your home or on the street. As the cyber world continues to expand, so do opportunities for cyber criminals to victimize people, businesses, and even whole nations. ECpE researchers are making strides at the physical and network layers to secure our computers and networks, and capture criminals—hoping to deter cyber villains of the future.

Detecting intrusions at the physical layer

Since 2003, Assistant Professor **Tom Daniels**, Senior Lecturer **Mani Mina**, and graduate student **Ryan Gerdes** have worked on Detecting Intrusions at Layer One (DILON)—a project investigating the use of analog and digital characteristics of digital devices for intrusion detection, authentication, forensic data collection, and assurance modeling.

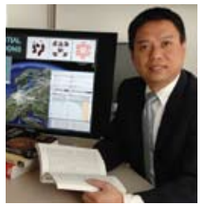
"The idea is simple: It's that when computers talk to each other, they speak digitally. The words are well-defined and absolute," Daniels says. "In real life, we can tell the difference between two people based on their voice or accent. We can tell if it's someone we've met before. This project brings that sort of familiarity to the network."

DILON, which was funded in part by the National Science Foundation's (NSF) Industry/University Cooperative Research Center at Iowa State University—the Center for Information Protection, was founded upon the belief that hardware and manufacturing inconsistencies cause minute and unique variations in the signaling behavior of all digital devices. It aims to show that those devices can be uniquely identified and tracked by analyzing variations in their analog signal caused by hardware and manufacturing inconsistencies.

Daniels and his colleagues are the first researchers to show that it is possible to distinguish between different devices and not just different models. Their work shows that wired network devices, such as Ethernet devices, cannot only hear a distinct accent between devices, but they can determine if it came from the same box. The researchers published a paper on their findings in the 2006 *Proceedings of the 13th Annual Network and Distributed System Security Symposium*.

"You could reasonably tell the difference between two devices that are supposed to be exactly same," Daniels says.

Assistant Professor Tom Daniels



Associate Professor
Yong Guan

Moving forward, Daniels says the researchers' biggest challenge is to take their work and understand what makes the computer voices different and extrapolate it to the entire world of devices. They also want to gain an understanding of how temperature and aging affects the devices, as well as formalize a method and metrics for accurately reporting results and accommodating large amounts of data.

"It's possible this research could lead to a time when you could narrow down to a certain brand of network card or laptop that was used if someone came in and did something to your network," Daniels says.

Daniels also adds that this wouldn't require changes to end devices, only to the networking environment. The results of this research could detect intruders impersonating or tampering with devices, prevent unauthorized access to the physical network, and determine if a device will or is in the process of failing. It also could help law enforcement investigate cyber criminal cases by tying a physical device to a specific network incident, allowing them to rule out or zero in on suspected criminals.

Securing network coding

Associate Professor **Yong Guan**'s research focuses on computer and network forensics, wireless and sensor network security, privacy-enhancing technologies on the Internet, and secure real-time computing and communication. In 2006, he, Professor **Ahmed Kamal**, and Associate Professor **Sang Kim** landed a $350,000 NSF grant to study secure and resilient network coding and cooperative relaying schemes for wireless sensor networks.

Although network coding has been around since the late 1990s, Guan says it is not secure enough and is vulnerable to attacks that can be exacerbated when data units are network coded and transmitted.

"If you don't have solutions to secure network coding, then it cannot be applied in real networks," Guan says.

Guan and his colleagues are developing tools, infrastructure, and methodologies to support secure and resilient network coding, making networks more robust against attacks and lowering computation and communication costs.

"Our research focuses on securing network coding against pollution attacks," he says.

The researchers have proposed the first scheme to defend XOR network coding. Their experimental results show that the solution they've developed is 200 to 1,000 times faster than existing solutions and is particularly suitable for resource-constrained wireless networks such as wireless sensor networks.

This technology can increase the capacity of networks by reliably and securely combining multiple messages, either linearly or nonlinearly, into one in order to hop through the same router instead of taking multiple different paths.

"Our philosophy is to remove the 'bad' apples as early as possible," Guan says. "This is different from many other researchers where they allow the 'bad' apples to be shipped with other 'good' apples and let the receivers decide how to deal with the 'bad' apples."

This work, and Guan's additional research in online auction fraud, click-fraud, wireless network security, and digital forensics has attracted international attention. In 2007, he received an NSF CAREER Award and in 2008 he served as the general chair for the world's top conference in security. ■

Dennis Smith contributed to this article.

Guan Earns NSF CAREER Award

In 2007, Associate Professor **Yong Guan** received a National Science Foundation CAREER Award to fund his research in wireless security. Guan's research is twofold: He's developing methods to provide practical and resilient solutions to confidential information leakage and false data reports. This includes creating techniques to verify locations of mobile wireless devices and ensure the integrity of information provided by sensors and other devices. He's also developing location-based access control so the system can verify not only who the person is, but also the location where he is logging in. This is especially important for employees who work with classified data. Overall, Guan's work aims to impact cyber security in the areas of healthcare, search and rescue operations, power grid operations, and battlefield surveillance.

Early Achievers

Two new faculty attain success in conducting innovative, practical research on various network types and in network coding.

BY **DANA SCHMIDT**

Developing practical solutions to grand engineering challenges of the 21st century is part of the mission of Iowa State University's College of Engineering. Two new ECpE faculty already are etching their way into research history by making innovations in network coding and distributed compression, mobile ad-hoc wireless, and sensor networks. Their early research achievements will help improve key communication and broadcast network technology in the coming years.

Improving data compression and transmission

Assistant Professor **Aditya Ramamoorthy** has achieved success in his research that sits at the intersection of network coding and distributed compression. He started his work as a PhD student at the University of California, Los Angeles, and during an internship at Microsoft Research. He continued it when he joined the Iowa State faculty in 2006.

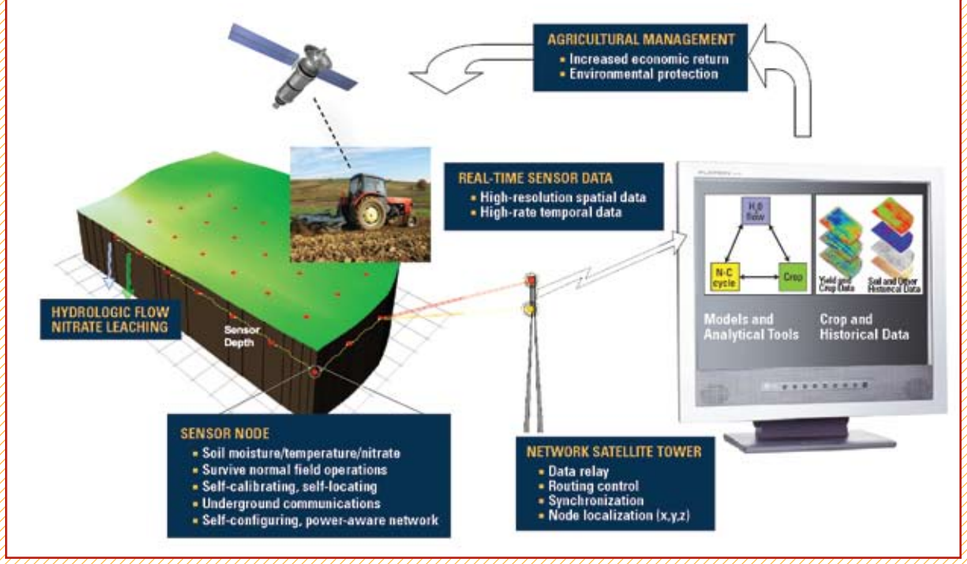
Working with Microsoft Research's Philip Chou and Kamal Jain, and the California Institute of Technology's Michelle Effros, Ramamoorthy investigated how to jointly compress and transmit data over a network in a distributed manner. Specifically, he looked at whether separating distributed compression and network information transfer could be more efficient than traditional methods. As a result, the researchers discovered that loss of optimality can potentially occur when more than two data sources or more than two end users of the data (aka terminals) are used. Additionally, if only two data sources and/or terminals, or multiple data sources and one terminal, are used, no loss of optimality occurs.

A common example for data compression occurs with video footage of sporting events. At a football game, for instance, multiple cameras film the game and some of the footage overlaps. In the traditional data compression method, the video would be sent to a central location for processing so duplicate images could be eliminated before broadcasting it. According to Ramamoorthy's research, the data stream now can be analyzed in a distributed fashion, requiring less power and bandwidth.

"We want to transfer the burden of computation to the end terminal where more resources are available," Ramamoorthy says.

PHOTO BY BOB ELBERT

Assistant Professor
Aditya Ramamoorthy



The diagram, *left*, shows an underground wireless sensor network for agricultural management and environment protection developed by Professor Ratnesh Kumar and his colleagues.

First-class Sensor Networks and Discrete-Event Systems Research

The newer faculty in the ECpE department aren't the only ones making great strides in distributed sensing and decision-making research. Professor **Ratnesh Kumar**, a Fellow of the Institute of Electrical and Electronics Engineers, recently conducted first-in-the-nation wireless soil sensor network research in agriculture for applying underground monitoring and communication. He also has become one of the first researchers to bring simulation and bisimulation of system behaviors to an event-driven control setting.

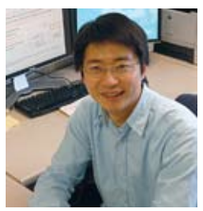
Kumar's sensor research, supported by the National Science Foundation (NSF) and the Information Infrastructure Institute, is part of an interdisciplinary effort with ECpE Professors **Ahmed Kamal** and **Robert J. Weber** and Iowa State's Department of Agriculture and Biosystems Engineering's Associate Professor Stuart Birrell and Assistant Professor Amy Kaleita. Kumar and his research team have developed a sensor network that can collect moisture data from fields with nodes sitting 20 to 30 meters apart underground—the first such underground sensor network in the United States. In the next couple of years, they plan to develop new, more accurate sensors and create new power-saving protocols for network establishment and communication, localization, and synchronization of sensor nodes. They also will add sensors for temperature and nitrogen to the network.

"One of the goals is to know the impact of fertilizers on the environment," Kumar says. "We want to make sure agriculture resources such as water and fertilizer are being used efficiently without compromising the yield or negatively impacting the environment."

Kumar's other project is in the area of event-driven systems. He was the single principal investigator on an NSF-funded project where he developed control theory for achieving simulation and bisimulation of computation tractable equivalences. The control theory addresses how nondeterminism in system models arising from unknowns, such as computation or communication delays, can be handled in an accurate manner. This is one of the first efforts of its kind in this area. The research can be applied in safety-critical systems such as in automobiles and medical devices, among other devices, to better solve and control issues due to incompletely known models.

Kumar also laid the foundation for nondeterministic control strategies where the control actions are nondeterministically chosen online from a set of choices determined offline. This work enabled polynomial solution of certain control problems known to be nondeterministic polynomial-complete (NP-complete) when deterministic controls strategies are used.

Assistant Professor
Lei Ying



To extend his research at Iowa State, Ramamoorthy began investigating how to allocate resources on networks. Previous methods allowed networks to choose paths on which to send data, but gave no freedom for data compression rates. Ramamoorthy has introduced a new algorithm that allows the network to choose the paths and the rates at which to inject the data into the network.

"It gives flexibility into the level of compression I want to put on different sources. They no longer have to be fixed for each source," he says.

For example, if data needs to be compressed to 20 MB, conventional methods would require each data source be compressed to 10 MB each. With Ramamoorthy's algorithm, one source could be compressed to 5 MB and the other to 15 MB, or in any other combination that doesn't exceed 20 MB, requiring lower resource consumption during the information transmission.

"This has the potential to influence many areas—TV broadcasts, Internet broadcasts, and sensor networks," Ramamoorthy says.

And down the road, it also could impact consumers who regularly use video and MP3 files. "It may be able to transmit the same amount of information using much less bandwidth."

Developing more efficient distributed algorithms

Another recent addition to the ECpE department, Assistant Professor **Lei Ying**, already has achieved breakthroughs in his research, which covers three areas: mobile ad-hoc networks, resource allocation in wireless networks, and sensor networks.

He, along with researchers R. Srikant and Siacho Yang from the University of Illinois at Urbana-Champaign, developed a systematic framework that helps engineers determine the best throughput they can achieve in a mobile ad-hoc network. The research, funded by the National Science Foundation and the U.S. Department of Defense's Defense Advanced Research Projects Agency's (DARPA) IT-Mobile Ad-hoc Networks (MANET) program, improves performance of the networks.

"It's a breakthrough," Ying says. "It provides an order of magnitude improvement in throughput as compared to previous algorithms."

Ying also helped develop a distributed power control algorithm for ad-hoc wireless networks. Power control in ad-hoc wireless networks has been a longstanding problem for researchers. Ying's algorithm provides a near-optimal algorithm, which can be implemented in a distributed fashion. Ying worked with Sanjay Shakkottai from the University of Texas at Austin on this project, and received funding from DARPA's MANET program.

"Our hope is to increase throughput to achieve 100 percent while lowering the communication and computation overhead at the same time," he says. Ying adds that his achievements in this area potentially could impact the design of wireless sensor networks by reducing power consumption and making them more efficient to use.

Yet another groundbreaking achievement for Ying relates to sensor networks. He developed the first distributed algorithm to consider communication, computational, *and* storage constraints in query processing in wireless sensor networks.

"It provides a systematic way to store, process, and distribute data," Ying says. It also allows engineers to optimally allow caching space, as well as communication and computation resources.

"It's an important problem to solve for high-performance networked sensing," he adds. So important and innovative, that Ying received a U.S. patent for the project. ■

Planting Success

Two computer engineers participate on research teams leading innovative efforts to help biologists understand plant genomes.

BY **DANA SCHMIDT**

Engineers at Iowa State University are co-leaders of two teams impacting plant genome research and data analysis. They are looking to the future, to a day when scientists can use high-throughput data from advances in instrumentation and biological techniques to build whole genome networks and better understand biological processes that enable organisms to function.

Developing parallel algorithms for systems biology

Srinivas Aluru, professor and Stanley Chair in Interdisciplinary Engineering, and his colleagues are conducting the first comprehensive research effort to develop parallel algorithms for systems biology, particularly for the inference of gene regulatory networks. They also made the first attempt to collectively analyze previously conducted microarray experiments from throughout the world on a large scale.

"The goal of the research is to find ways to collectively analyze all of the data, which spans to thousands of microarray experiments, to build robust whole genome networks," Aluru says. "We also want to develop ways to query such networks to make inferences on particular pathways."

For example, if scientists and engineers know some of the genomes in an organism's pathway, they can make informed guesses about what other genes might play a role by querying the whole genome network.

Because the large-scale data Aluru is analyzing is beyond the capability of sequential computers to process, he is developing high-performance parallel computing methods to solve the problems. In fact, in 2006 he led an effort to bring an IBM Blue

"The goal is to find ways to collectively analyze the data … to build robust whole genome networks."

Gene/L supercomputer, among the top 100 fastest computers in the world at the time, to Iowa State for bioinformatics research. He also recently secured $1.2 million from the National Science Foundation (NSF) and Iowa State University to purchase a large multi-core computer cluster with high-performance storage.

As part of his research, Aluru and ECpE Associate Scientist **Maneesha Aluru** studied the Carotenoid gene regulatory networks in *Arabidopsis thaliana*, a small flowering plant native to Europe, Asia, and northwestern Africa. Carotenoids are important compounds that serve crucial biological functions in many organisms from bacteria to plants and animals. In fruits and flowers, for instance, carotenoids are responsible for the plant's color and play a key role in the formation of Vitamin A.

"Understanding gene networks plays a fundamental role in virtually all biological processes," Srinvias Aluru says.

Aluru and his colleagues built an *Arabidopsis* whole genome network from publicly available microarray data and then developed an algorithm to infer novel genes involved in carotenoids metabolism using known genes and the network's topology.

"We then identified nine potential candidates," he says. "Our collaborator ordered seeds mutated in each of these nine genes. We found that three of the resulting plants had leaves with albino or pale green leaves, consistent with what is expected of a gene mutated in the pathway."

Best of the Century

Professor **Srinivas Aluru** was named a finalist for the Computerworld Honors Program's 21st Century Achievement Award in Environment, Energy, and Agriculture. The awards program recognizes individuals and organizations that have used information technology to benefit society. The program honored 50 Laureates and 10 Finalists worldwide.

"I'm very pleased to bring this honor to Iowa State University," Aluru says. "This is another example of the high-quality interdisciplinary work we're addressing in the plant sciences and information technology."

Aluru is part of a nationally funded research project to sequence the corn genome. Former ECpE graduate students **Scott Emrich** and **Ananth Kalyanaraman**, as well as Patrick Schnable, director of Iowa State's Center for Plant Genomics, collaborated on the project with Aluru.

"We've been able to do science that nobody else has been able to do," Schnable says. "We're opening up the jigsaw puzzle and now we're seeing results."

Aluru, whose work is supported by an NSF grant, has helped scientists develop a comprehensive understanding of plant pathways and how the pathways can be manipulated to increase production of certain metabolites. He also is working with Patrick Schnable, director of Iowa State's Center for Plant Genomics and Center for Carbon-Capturing Crops, to identify and understand the genes involved in plant cell-wall metabolism.

"By making plant cell walls easier for microbial digestion, we could increase the efficiency of biofuel production," Aluru says. "By making it harder, we could use plants as sequesters of atmospheric carbon and mitigate global climate change."

Professor
Srinivas Aluru

Visualizing metabolic pathways

Associate Professor **Julie Dickerson** also studies *Arabidopsis*, but with a different goal in mind. Dickerson works with Grant Cramer, a molecular biologist at the University of Nevada-Reno; Lin Yong Mao, an Iowa State postdoctoral researcher in chemical informatics; and Anne Fennell, professor of horticulture and coordinator of the Functional Genomics Core Lab at South Dakota State University, to create tools to visualize the metabolic pathways in grapes, so biologists can begin to understand the dormancy process of grapes and develop methods to make grapes more robust in colder grape-growing climates such as in Iowa and South Dakota.

The researchers mapped the differences between *Arabidopsis*—the first plant to have its entire genome sequenced—and grape, and then used Iowa State's Virtual Reality Applications Center, the world's most realistic virtual reality room, to create a 3-D network of images to visualize and manipulate the results. As part of this project, Dickerson developed plug-ins for Cytoscape, an open source bioinformatics software platform for visualizing molecular interaction networks and integrating these interactions with gene expression profiles and other state data.

"The ultimate goal of this research is to integrate visual and computational descriptions of complex metabolic and regulatory networks to aid biologists in evaluating hypotheses for how these dynamic networks function in different conditions," Dickerson says.

Two parts of the project involve data combination and interactive graph visualization.

"The sheer number of pathway databases and the diverse types of information make it essential to develop better methods of combining pathway information from different sources," Dickerson says.

The first step: identify the sources of different types of information. Dickerson and her research team are developing a collection of data source types for graph creating, such as sequencing projects, microarray inference, knockout studies, literature citations, and links or nodes hypothesized by analogy with related organisms. Integrating the information from multiple sources within the network will permit researchers to query the data sources available.

Next, the researchers plan to identify and develop efficient layout algorithms that minimize the impact of incremental changes on a displayed graph while making important changes more visible. They are applying methods from signal processing and other areas to do this and have made the algorithm more efficient. By developing visualization and modeling tools, the researchers—supported with funding from NSF—will be able to maintain literature and researcher-derived subnetworks and networks located automatically or interactively within its own tools.

"We are coming up with ways to model networks in Arabidopsis and figuring out how to deal with compartmental information in cells," Dickerson says. "And as more people use this, a biologist could come in and see the results of her test or understand the overall impact of the system. It helps them understand data and implications of data faster and more quickly find important pathways to process—something that previously could have taken months instead of days to find out." ■

Associate Professor
Julie Dickerson

PHOTOS BY BOB ELBERT

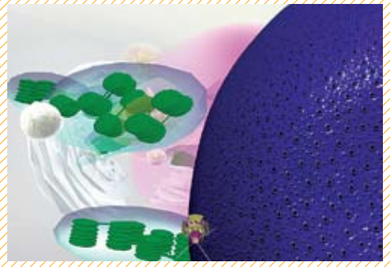
JULIE DICKERSON PHOTO BY BOB ELBERT

Having a Blast

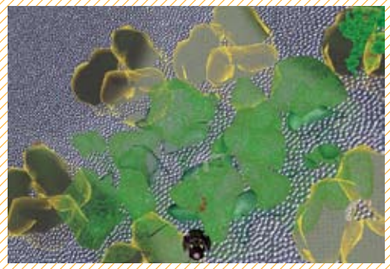
Associate Professor **Julie Dickerson** plans to incorporate modules that depict a plant's defense responses to pathogen attacks and stress to Meta!Blast, a video game Dickerson helped design to provide high school and college students with an interactive approach to understanding the inner workings of a plant cell.

"The game is designed to help students understand cell biology and its diverse biochemical processes," says Eve Wurtele, a professor of genetics, development, and cell biology at Iowa State and collaborator on the project. "Video game players absorb the structure of entire imaginary worlds. The idea is that in playing the game, students will engage in and retain the intricacies and interdependencies of the cellular world."

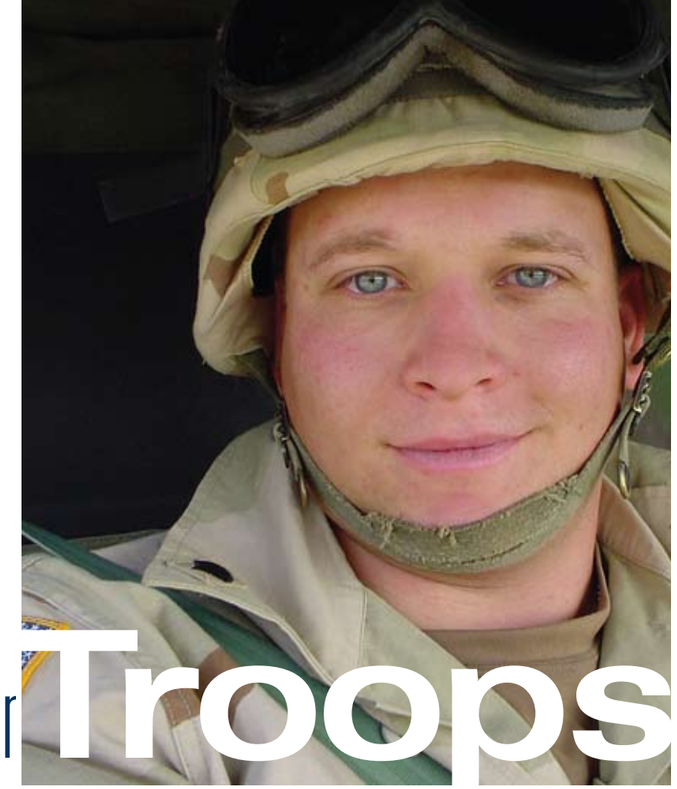
The project was supported by the National Science Foundation and Iowa State's College of Liberal Arts and Sciences. Artist and Game Designer Steve Herrnstadt, Cell Biologist Diane Bassham, and graduate and undergraduate students from several academic disciplines also contributed to the project.



The image above is a mesophyll cell with the video game's submarine (bottom center) in the foreground. The mesophyll is the soft tissue between the lower and upper epidermis inside a leaf.



This image depicts thylakoids, a saclike membrane-bound compartment inside chloroplasts and cyanobacteria, along with some of the molecules from the photosynthetic process.



John Hamre, an electrical engineering senior, served for more than one year as a solider in Iraq. He used his experience to help his senior design team create a wearable power pack for soldiers.

Helping Our Troops

Undergraduate students conduct research with real-world applications for America's soldiers on the battlefield.

BY **DANA SCHMIDT**

Computer engineering senior **John Hamre**, a former National Guard soldier who served for more than a year in Iraq, knew he wanted to work on a capstone senior design project that could make an impact. So when he learned that **Josh Murray**, a senior in electrical engineering and senior design team leader, was forming a team to work on a project for the U.S. Department of Defense's (DOD) Wearable Power Prize Program, a contest for researchers and engineers to develop a wearable power system for troops in the battlefield, he knew he had found the right senior project.

The DOD's Wearable Prize Program requires researchers to develop a system that provides an average of 20 watts of power for 96 hours and weighs less than 9 pounds. The system also is required to operate autonomously and attach to a soldier's garments, as well as provide up to 200 watts of power at multiple increments up to five minutes long.

Because of his firsthand experience in a war zone, Hamre brought a unique perspective to the senior research team, which included electrical engineering seniors **Alex Katz**, **Brian Pattison**, **Dustin Sult**, and **Jason Jirak**. Hamre's experience as a solider means he also knows how the power systems will be used and the kinds of abuse they will encounter in the battlefield.

"We burned through a lot of batteries while we were over there," Hamre recalls. "When we were on the move, we had about a half dozen different devices running off batteries and most of them ran for only a few hours. Also, all of these devices used different batteries, meaning you had to carry a supply of several different types of batteries."

PHOTOS COURTESY OF JOHN HAMRE AND JOSH MURRAY

With the new power supply pack Hamre's senior design team created, soldiers would need to carry only one type of battery that runs much longer and weighs less than batteries soldiers currently use in Iraq and Afghanistan.

"When we were on the move, we had about a half dozen different devices running off batteries and most of them ran for only a few hours."

"To win this competition you need to build the best power source at the lowest weight," says Hamre.

The Iowa State group, with funds from the senior design program, the ECpE department, and Iowa State University grants, designed, built, and tested their power system this year.

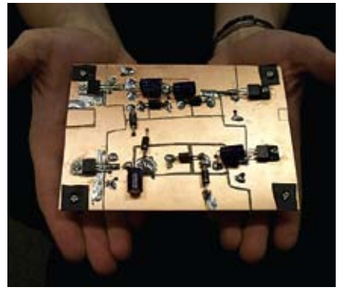
Murray says the main focus of the group's project is using a hydrogenous fuel cell. Consequently, the students say they have learned a lot about fuel cells, maximizing compressed hydrogen, and different types of battery technology, as well as expanded their knowledge of fundamental engineering concepts.

"What we are trying to achieve is revolutionary," says Murray. "For a lack of better words, we are trying to fit a square peg into a round hole. We also had to design around commercially available products to reduce our overall cost."

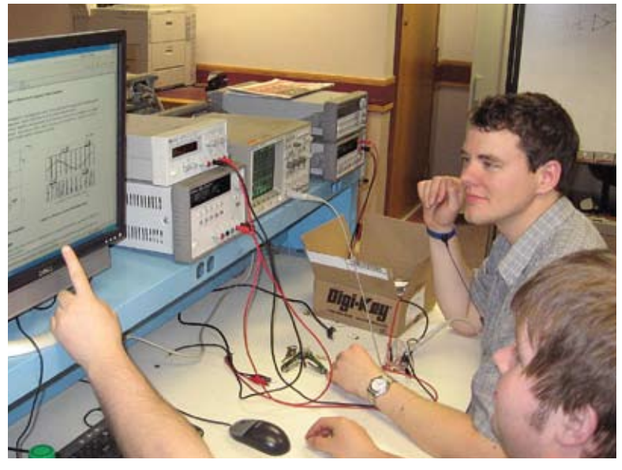
In May, the group, which is advised by Assistant Professor **Dionysios Aliprantis**, presented their final project to the ECpE department's Industry Review Panel, comprised of engineers from companies such as National Instruments, Rockwell Collins, S & S Larsen Associates, and Somark Innovations.

The group hopes to improve their power pack design and compete in the DOD's national competition, a 13-day event held at the Marine Corps Air-Ground Combat Center in Twentynine Palms, California, September 22 to October 4. ■

A senior design team member displays the group's basic idea for a wearable power pack.



Undergraduate students Jason Jirak, *top right,* and Dustin Sult, *bottom right,* conduct research in the lab to develop their final senior design project.



ECpE Research

Centers and Institutes

Faculty and staff in the ECpE department are affiliated with and/or operate the following research centers and institutes at Iowa State University.

Operated by ECpE Faculty

Center for Nondestructive Evaluation

www.cnde.iastate.edu

The Center for Nondestructive Evaluation is a National Science Foundation (NSF) Industry/University Cooperative Research Center and is a member of the Institute for Physical Research and Technology at Iowa State. The center focuses on the research and development of new theories and techniques for use in quantitative nondestructive evaluation.

Electric Power Research Center

ecpe.ece.iastate.edu/powerweb/eprc.htm

The Electric Power Research Center (EPRC) was established in 1988. The center enhances research opportunities related to electric power and the associated technology transfer to classroom activities and to industry; acts as a central contact point with industry, funding agencies, and others in coordinating electric power research activities; and promotes interdisciplinary research. It also attracts students and faculty to the power program, assists faculty members in acquiring research funding and conducting research, and assists new and junior faculty members develop their base research. The center promotes and expands research of interest to faculty and companies who support the center through membership fees. EPRC industry members include Alliant Energy; Central Iowa Power Cooperative; City of Ames, Iowa; City of Cedar Falls, Iowa; Corn Belt Power Cooperative; Dairyland Power Cooperative; MidAmerican Energy; Midwest ISO; Pacific Gas and Electric; PJM Interconnection; and RTE, France.

High-Performance Computing Center

The High-Performance Computing Center (HPCC), currently in the process of being established, will enable interdisciplinary research that addresses the grand research challenges of today. It will seek to advance and promote high-performance computing research in various fields, especially in science and engineering. The center also will acquire and maintain high-performance computing equipment to enable research and act as a formal interface between Iowa State and the Great Lakes Consortium for Petascale Computation. The HPCC will be a member of the CyberInnovation Institute.

Information Infrastructure Institute

www.ece.iastate.edu/icube

The Information Infrastructure Institute (iCUBE) is a multidisciplinary initiative that promotes the development of new IT technologies and their applications to solve real-world problems. The iCUBE initiative addresses both research and educational needs in accordance with the land-grant mission of the university. The institute was developed in 2002 in response to national- and state-level needs to protect critical infrastructure in Iowa and throughout the United States in areas such as information technology; energy distribution; public transportation; communication; and food, water, and agricultural production and distribution systems. iCUBE is a member of the CyberInnovation Institute.

Information Assurance Center

www.iac.iastate.edu

At this NSF Industry/University Cooperative Research Center in information assurance, more than two dozen faculty members from six academic departments work together to explore the problems of securing information in application areas such as software, networks, and electronic democracy. Faculty research interests cover the breadth of information assurance, including intrusion detection, wireless network security, mobile ad-hoc tactical networks, secure e-commerce, public policy for electronic democracy, and the development of a curriculum for information assurance. The center is a U.S. National Security Agency and Department of Homeland Security National Center of Academic Excellence in Information Assurance Education. The Information Assurance Center is a member of the CyberInnovation Institute.

Microelectronics Research Center

www.merc.iastate.edu

The Microelectronics Research Center (MRC) is a multidisciplinary center that focuses on the study of semiconductor materials, devices, and applications. It brings together researchers from engineering and the basic sciences in a collaborative atmosphere to pursue fundamental and applied research in semiconductor electronics and photonics. The MRC is part of the Institute for Physical Research and Technology.

Power Systems Engineering Research Center

ecpe.ece.iastate.edu/powerweb/pserc.htm

The Power Systems Engineering Research Center (PSERC) draws on university capabilities to creatively address the challenges and demands the electric power industry faces. Under the banner of PSERC, multiple U.S. universities, including Iowa State, are working collaboratively to investigate these topics. PSERC is an NSF-sponsored Industry/University Cooperative Research Center.

Analog and Mixed-Signal VLSI Design Center

vlsi.ece.iastate.edu

The Analog and Mixed-Signal VLSI Design Center focuses on research on high-speed data converters and communication circuits, microelectronics, and other related research. Its faculty bring extensive academic experience, broad industrial experience, and continued professional interactions into a center that relies heavily on industrial direction and support. The center aims to provide an outstanding educational experience for graduate students to conduct research that will advance the field, promote industrial interactions and co-development, and provide substantive exposure of analog and mixed-signal design issues to undergraduate students.

Affiliated with ECpE Department

Ames Laboratory

www.ameslab.gov

Ames Laboratory is a government-owned, contractor-operated research facility of the U.S. Department of Energy that is run by Iowa State. For more than 60 years, the Ames Laboratory has sought solutions to energy-related problems through the exploration of

chemical, engineering, materials, mathematical, and physical sciences.

CyberInnovation Institute
www.cyberi.iastate.edu

Motivated by the increasing pace of advances in information sciences and technologies, the CyberInnovation Institute is a new institute that brings together interdisciplinary research teams and industrial partners. By encouraging these partnerships, the institute enhances the competitiveness of research teams and accelerates the transformation of new technologies into the marketplace. These partnerships address real-world problems in areas as diverse as the biological sciences, agriculture, engineering, and business.

Institute for Physical Research and Technology
www.iprt.iastate.edu

The Institute for Physical Research and Technology is a network of scientific research centers at Iowa State that performs world-class scientific research, as well as provides technical assistance to various Iowa companies. For 20 years, the institute has promoted interdisciplinary research in the physical sciences and engineering, specifically to foster development of new technologies. It maintains a close working relationship with the U.S. Department of Energy's Ames Laboratory.

Plant Sciences Institute
www.plantsciences.iastate.edu

The Plant Sciences Institute is a bold venture by the state of Iowa to establish a world-class plant science organization, building on Iowa State's tradition of excellence in agriculture. The institute is a major force in ushering in new technologies to the university and recruiting outstanding faculty to build a premier program in the plant sciences. The institute promotes economic development for agriculture and industry in the state and is key in making Iowa State a world leader in plant biotechnology.

Laurence H. Baker Center for Bioinformatics and Biological Statistics
www.bioinformatics.iastate.edu

This center facilitates and enhances research in bioinformatics and biological statistics by fostering interactions and communication among the faculty, outside laboratories, and funding agencies. The Laurence H. Baker Center engages in research to develop computational, graphical, statistical, mathematical, or algorithmic methods to interpret or mine information from biological data; apply quantitative approaches in biology; and bridge separate experimental biology areas with creative computational approaches. The center is part of the Plant Sciences Institute.

Virtual Reality Applications Center
www.vrac.iastate.edu

The Virtual Reality Applications Center, (VRAC), which operates the world's most realistic virtual reality room, is an interdisciplinary research center focusing on the rapidly expanding interface between humans and computers. The research conducted by faculty in this center involves developing computer interfaces that integrate virtual environments, wireless networking, pervasive computing, and emerging interface devices to amplify the creativity and productivity of people. VRAC is a member of the CyberInnovation Institute. ■

ECpE PhD Alumni Appointed to **Faculty Positions**

The ECpE department's PhD alumni are not only going into industry after graduation, but also are being hired as faculty at many well-reputed universities. Two of those alumni—one who now works at Washington State University and the other who works at the University of Notre Dame—exemplify the high-quality of PhD students the Iowa State University ECpE department produces.

Ananth Kalyanaraman, PhD Class of 2006

For Ananth Kalyanaraman, a 2006 Iowa State PhD recipient, his professional life couldn't be any better. After working alongside Professor **Srinivas Aluru**, Kalyanaraman accepted a position as assistant professor of electrical engineering and computer science at Washington State.

Kalyanaraman, who received his bachelor's degree from the Visvesvaraya National Institute of Technology in Nagpur, India, came to Iowa State to pursue his master's and doctorate degrees. While here, he developed an interest in computational biology and bioinformatics, parallel algorithms and applications, and string algorithms. His research efforts earned him two best paper awards—one at the 2006 Institute of Electrical and Electronics Engineers (IEEE) International Parallel and Distributed Processing Symposium and another at the 2005 IEEE Computational Systems Bioinformatics Conference. He also received the Pioneer Hi-Bred Graduate Research Fellowship and IBM PhD Fellowship, as well as a university Research Excellence Award.

He says his current research is in the area of bioinformatics and computational biology.

"I focus on developing efficient high-performance computing methods and software for complex problems in molecular biology and genetics," he says. "My long-term goal is not just to enable but also to accelerate the tasks of discovering and understanding the fundamental processes that control the biology within and around us."

His current projects are in computational genomics. For one project, he's continuing to work with Iowa State engineers and scientists on sequencing the maize genome. In another project, he's working with wheat geneticists at Washington State to develop methods to advance the state of computing for studies related to wheat genomics.

In November 2007, Kalyanaraman, along with Aluru and Georgia Tech's David Bader, presented a tutorial on high-performance computing methods for computational genomics at the IEEE/Association of Computing Machinery Supercomputing Conference in Tampa, Florida. And since 2002, Kalyanaraman has published four refereed journal articles and five refereed articles for conference publications, as well as contributed to three books related to his research.

—Dana Schmidt

Scott Emrich, PhD Class of 2007

Scott Emrich, a 2007 PhD graduate in bioinformatics and computational biology and another student of Aluru's, grew up surrounded by science. His first job, at age 6, involved caring for lab rats. His mother was a radiation oncology researcher, and so throughout his childhood Emrich was encouraged to experiment with cell cultures at his mother's and her colleagues' labs. His first trip abroad was to a scientific

PHOTOS COURTESY OF ANANTH KALYANARAMAN AND SCOTT EMRICH.

Ananth Kalyanaraman

Scott Emrich

conference in Germany.

So it's fitting that Emrich, who obtained his bachelor's degree in biology and computer science from Loyola College in Baltimore, Maryland, continued his studies at Iowa State and now is a professor and researcher. Last August, he started his current post as an assistant professor in the Department of Computer Science and Engineering at Notre Dame. He researches vector genomics, primarily in mosquitoes that transmit tropical diseases, and builds computational tools to perform large-scale genome analyses. Additionally, he teaches two classes a year—a graduate elective in either parallel algorithms or bioinformatics and a sophomore-level programming class—and says that he looks forward to mentoring talented students.

At Iowa State, his research efforts focused on interdisciplinary maize genomics. Those efforts earned him the 2007 *Science* Editor's Choice Award and 2006 IEEE International Parallel and Distributed Processing Symposium Best Paper Award, as well as university and departmental Research Excellence Awards and the university's Zaffarano Award for superior performance in publishable research by an Iowa State graduate student. He also was a Fall 2006 visiting scholar at the Indian Institute of Technology in Bombay, India, and a National Science Foundation Integrative Graduate Education and Research Traineeship Fellow from 2002 to 2004.

Emrich has published 10 journal articles and coauthored three peer-reviewed conference papers and two book chapters. Two of his papers were published in his field's top journals: *Proceedings of the National Academy of Science* and *Genome Research*, in 2005 and 2007, respectively. Additionally, he has presented at three conferences, including a tutorial on computational plant genomics at the 2007 IEEE Computational Systems Bioinformatics Conference.

"Longer term, I probably will migrate my research into association studies, new sequencing machines, and more systems-level approaches to studying human disease," Emrich says. "As for my plant research, I hope to be a part of the sequencing of at least one wild ancestor, ideally teosinte, which was domesticated into what we know as corn today." ■

—Amy Gorin

PhD Graduate Employment

Our PhD graduates not only obtain faculty positions at major universities, but they also are employed at several well-respected companies and laboratories. Below are just a few of the great organizations where our recent PhD graduates are employed.

- ABB Group
- Akamai Technologies
- Broadcom
- Cadence Design Systems
- California ISO
- Cisco Systems
- Garmin International
- IBM Research
- Intel
- Maxim Integrated Products
- Micron Technology
- Microsoft
- Midwest ISO
- National Semiconductor
- New York ISO
- Oak Ridge National Laboratory
- The Ohio State University Medical Center
- Rockwell Collins
- St. Jude Medical Center
- Siemens
- Silicon Labs
- Texas Instruments
- University of California, San Diego

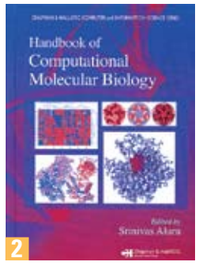
PhD Student Production

Nearly 40 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 research laboratories.

NAME	DISSERTATION TITLE	MAJOR PROFESSOR
Bahuguna, Rashmi	Investigation of Magneto-optical Properties for Optical Fiber Based Devices	R. Weber/M. Mina
Balasubramanian, Srivatsan	Design and Protection Algorithms for Path Level Aggregation of Traffic in WDM Metro Optical Networks	A. Somani
Banerjee, Pubali	Performance and Security Measure of Clustering Protocols for Sensor Networks	D. Jacobson
Bierbaum, Allen	Continuum: An Architecture for User Evolvable Collaborative Virtual Environments	C. Cruz-Neira
Emrich, Scott	Assembly and Analysis of Complex Plant Genomes	S. Aluru
Fei, Haibo	High Linearity Analog and Mixed-Signal Integrated Circuit Design	D. Chen/R. Geiger
Frederick, Michael	Beyond the Arithmetic Constraint: Depth-optimal Mapping of Logic Chairs in Reconfigurable Fabrics	A. Somani
Fu, Fangwei	Transient Eddy Current Response Due to a Subsurface Crack in a Conductive Plate	J. Bowler
Gao, Feng	Optimal GENCO Bidding Strategy	G. Sheble
Gil Sagas, Esteban	Integrated Network Flow Model for a Reliability Assessment of the National Electric Energy System	J. McCalley
He, Chengming	Robust Design of High Gain Amplifiers Using Dynamical Systems and Bifurcation Theory	D. Chen
He, Wengheng	Survivable Design in WDM Mesh Networks	A. Somani
Hill, Lewis	Synesthetic Music Experience Communicator	J. Oliver
Jiang, Yong	Condition-based Hazard Rate Estimation and Optimal Maintenance Scheduling for Electrical Transmission System	J. McCalley
Kalyanaraman, Ananth	Large-scale Methods in Computational Genomics	S. Aluru
Ko, Pang	Suffix Trees and Suffix Arrays in Primary and Secondary Storage	S. Aluru
Lebsack, Carl	Performance Analysis and Optimization of the Java Memory System	M. Chang
Liu, Haifeng	Planning Reactive Power Control for Transmission Enhancement	J. McCalley
Mo, Wei	MIMO Communication Systems: Receiver Design and Diversity-Multiplexing Tradeoff Analysis	Z. Wang
Muthukrishnan, Kamal	Structural and Electronic Properties of Nanocrystalline Silicon Thin-Film Solar Cells Fabricated by Hot Wire and ECR-plasma CVD Techniques	V. Dalal
Pan, Min	An Integrated Placement and Routing Approach	C. Chu
Panda, Durga	Nanocrystalline Silicon Thin-Film Transistors	V. Dalal
Quelhas Alves Freitas, Ana	Economic Efficiencies of the Energy Flows from the Primary Resource Suppliers to the Electric Load Centers	J. McCalley
Sahoo, Deepak	Transient Force Atomic Force Microscopy Systems Approaches to Emerging Applications	M. Salapaka
Seal, Sudip	Parallel Methods for Large-scale Applications in Computational Electromagnetics and Materials Science	S. Aluru
Shen, Zhenhui	Techniques for Building a Scalable and Reliable Distributed Content-based Publish/Subscribe System	S. Tirthapura
Shu, Weiwei	Electromagnetic Waves in Double Negative Metamaterials and Study on Numerical Resonances in the Method of Moments (MoM)	J. Song
Su, Chao	Dynamic Calibration of Current-steering DAC	R. Geiger
Tang, Yongping	Techniques in Placing Network Monitors	T. Daniels
Vanderhorn, Nathan	Fiber Optic Networks: Fairness, Access Controls, and Prototyping	A. Somani
Xiao, Fei	Risk-based Multi-objective Security Control and Congestion Management	J. McCalley
Yadav, Vikas	Distributed Controller Synthesis and Decision Making	M. Salapaka
Yang, Dan	Power System Dynamic Security Analysis via Decoupled Time Domain Simulation and Trajectory Optimization	V. Ajjarapu
Yang, Yuting	Interactive Visualization of Metabolic Networks Using Virtual Reality	J. Dickerson
Zhang, Benhong	Spatial Signal Processing in Wireless Sensor Networks	A. Dogandzic
Zhang, Dongbo	Wireless Multi-user Communication Systems: Diversity Receiver Performance Analysis, GSMuD Design, and Fading Channel Simulator	Y. Ma
Zhang, Lei	Composite Left-handed Materials and Negative Refraction in Photonic Crystals	G. Tuttle
Zhang, Lu	Accurate Electromagnetic Full-wave Modeling for Interconnects in Semiconductor Integrated Circuits	J. Song
Zhou, Changyan	Supervisory Control of Discrete Event Systems for Bisimulation and Simulation Equivalence Specifications	R. Kumar

Faculty Publish
New Books

1



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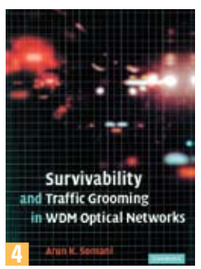

4

Our faculty recently have authored and edited several books. The following is a sampling of these books.

1 *Computational Techniques for Voltage Stability Assessment and Control*

by Venkataramana Ajjarapu

This manual provides basic definitions related to voltage stability based on Institute of Electrical and Electronics Engineers and International Council on Large Electric Systems' voltage stability classification, as well as discusses basic concepts in bifurcations theory and continuation methods. It also offers details related to continuation power flow and an approach to trace voltage stability boundaries for changing system conditions, and it proposes a uniform framework for computation approaches for short- and long-term voltage stability phenomena. The book is published by Springer Science + Business Media.

2 *Handbook of Computational Molecular Biology*

edited by Srinivas Aluru

In the rapidly growing field of computational biology, this tome offers a comprehensive, systematic coverage of techniques and methodologies currently available. The book, published by Chapman & Hall/CRC, presents the first comprehensive distillation of accumulated knowledge of computational biology, links each topic to applications in molecular biology while building on fundamental concepts, offers an algorithmic point of view for immediate implementation and easy reference, and includes illustrations to highlight material discussed.

3 *Introduction to Microwave Circuits: Radio Frequency and Design Applications* (Chinese translation)

by Robert J. Weber

This book, now translated into Chinese and published by the Publishing House of Electronics Industry (*www.phei.com.cn*), is a reference for undergraduate students, microwave engineers, and administrators. It features topics such as incorporation of component parasitics in the design cycle, closed form solution to oscillator design, odd mode stability analysis, scattering parameter analysis methods-mixed mode circuits and load pull techniques, and PIN diode analysis for high-power switching applications.

4 *Survivability and Traffic Grooming in WDM Optical Networks*

by Arun K. Somani

The advent of fiber optic transmission systems and wavelength division multiplexing has led to a dramatic increase in the usable bandwidth of single fiber systems. This book covers in detail survivability (dealing with the risk of losing large volumes of traffic data due to a failure of a node or a single fiber span) and traffic grooming (managing the increased complexity of smaller user requests over high capacity data pipes), both of which are key issues in modern optical networks. The book is published by Cambridge University Press. ■

Faculty Directory
Bioengineering

The faculty in this strategic area also conduct research in one or more of the following traditional research areas:

- Communications and signal processing
- Microelectronics and photonics
- Secure and reliable computing
- Software systems
- VLSI

Srinivas Aluru

Stanley Chair in Interdisciplinary Engineering
Professor
PhD, Computer Science, Iowa State University (1994)

Research interests: Parallel processing, bioinformatics and computational biology, combinatorial scientific computing, applied algorithms

Selected publications:

- Kalyanaraman, A., S. J. Emrich, P. S. Schnable, and S. Aluru. "Assembling Genomes on Large-scale Parallel Computers." Special Issue, *Journal of Parallel and Distributed Computing* 67, (2007): 1240–1255.
- Ott, M., J. Zola, S. Aluru, and A. Stamatakis. "Large-scale Maximum Likelihood-based Phylogenetic Analysis on the IBM Blue Gene/L." In *Proc. ACM/IEEE Supercomputing Conference*, Reno, NV, 2007.
- Kalyanaraman, A. and S. Aluru. "Efficient Algorithms and Software for Detection of Full-length LTR Retrotransposons." *Journal of Bioinformatics and Computational Biology* 4, no. 2, (2006): 197–216.
- Aluru, S., ed. *Handbook of Computational Molecular Biology*, Chapman & Hall/CRC Computer and Information Science Series. Boca Raton, FL: Chapman & Hall/CRC, 2005.
- Ko, P. and S. Aluru. "Space Efficient Linear Time Construction of Suffix Arrays." *Journal of Discrete Algorithms* 3, no. 2–4, (2005): 143–156.

Bioengineering Strategic Research Area

Biology, once largely an empirical science, is rapidly changing as physics, mathematics, and engineering concepts become integral to the field. The ECpE department is making a concerted effort to bring engineering and the life sciences together, thus making ECpE a leader in changing the way we look at combining these two areas of study. The bioengineering strategic research area encompasses areas such as bioinformatics, biomedical engineering, biodynamics/biomechanics, biosensors, biomaterials, biotechnology, bio-signal processing, quantitative microscopy, systems engineering, and tissue engineering. At the heart of this effort are discoveries like gene-regulation mechanisms and the enhanced ability to investigate bioprocesses at molecular and cellular scales. ECpE is set to play a significant role in these areas.

Julie A. Dickerson

Associate Professor
PhD, Electrical Engineering, University of Southern California (1993)

Research interests: Systems biology, bioinformatics, pattern recognition, data visualization, real-time sensor networks

Selected publications:

- Call, A., S. Herrnstadt, E. S. Wurtele, J. Dickerson, and D. Bassham. "Meta!Blast Virtual Cell: A Pedagogical Convergence Between Game Design and Science Education." *Journal of Systematics, Cybernetics, and Informatics* 5, no. 5, (December 2007): 27–31.
- Zhou W., T. Xia, J. Tong, J. Dickerson, B. Su, and X. Gu. "Modeling Protein Interaction Network and Mechanisms in Exocytosis," In *Proc. IEEE 7th International Symposium on Bioinformatics & Bioengineering*, Cambridge, MA, November 2007.

- S. Y. Rhee, J. Dickerson, and D. Xu. "Bioinformatics and its Applications in Plant Biology," *Annual Review of Plant Biology* 57, (2006): 335–359.
- Ding, J., K. Viswanathan, D. Berleant, L. Hughes, E. S. Wurtele, D. Ashlock, J. A. Dickerson, A. Fulmer, and P. S. Schnable. "Using Biological Taxonomy to Access Biological Literature with PathBinderH." *Bioinformatics* 21, no. 10, (2005): 2560–2562.
- Du, P., J. Gong, E. S. Wurtele, and J. Dickerson. "Modeling Gene Expression Networks Using Fuzzy Logic," Special Issue, *IEEE Transactions on Systems, Man, and Cybernetics*, Part B 35, no. 6, (2005): 1351–1359.

Liang Dong

Assistant Professor

PhD, Electronics Science and Technology, Tsinghua University, China (2004)

Research interests: BioMEMS, biosensors, lab on a chip, biomimetics, polymer nanomaterials and structures, cell analysis and manipulation

Selected publications:

- Dong, L. and H. Jiang. "A Tunable and Movable Liquid Microlens In-situ Fabricated Within Microfluidic Channels," *Applied Physics Letter* 91, no. 041109, 2007.
- Agarwal, K., L. Dong, D. J. Beebe, and H. Jiang. "Autonomously-triggered Microfluidic Cooling Using Thermoresponsive Hydrogels." *Lab on a Chip* 7, (2007): 310–315.
- Sridharamurthy, S. S., L. Dong, and H. Jiang. "Microfluidic Chemical/Biological Sensing System Based on Membrane-dissolution and Optical Absorption." *Measurement Science & Technology* 18, (2007): 201–207.
- Dong, L., A. K. Agarwal, D. J. Beebe, and H. Jiang. "Adaptive Liquid Microlenses Activated by Stimuli-responsive Hydrogels." *Nature* 442, (2006): 551–554.
- Dong., L., R. F. Yue, and L. T. Liu. "Fabrication and Characterization of Integrated Uncooled Infrared Sensor Arrays Using a-Si Thin Film Transistors as Active Elements." *Journal of Microelectromechanical Systems* 14, (2005): 1167–1177.

Santosh Pandey

Assistant Professor

PhD, Electrical Engineering, Lehigh University (2006)

Research interests: Bioelectronics, sensors, bioMEMS, devices, VLSI circuits

Selected publications:

- Tao, Chengwu, Baozhen Chen, and Santosh Pandey. "A Novel Floating-Gate Biosensing Device with Controlled Charge-Modulation." In *Proc. IEEE/NIH BISTI Life Science Systems & Applications Workshop*, Bethesda, MD, November 2007.
- Chen, Baozhen, Chengwu Tao, and Santosh Pandey. "Fabrication of a Dual-Gate Charge-Sensing Device Architecture for Single Cell Studies." In *Proc. 3rd Minnesota Nanotechnology Conference*, Minneapolis, MN, November 14, 2007.
- Pandey, Santosh, Akwete Bortei-Doku, and Marvin H. White. "Simulation of Biological Ion Channels as Solid-State Nanodevices." *Computer Methods and Programs in Biomedicine* 85, (2007): 1–7.

Namrata Vaswani

Assistant Professor

PhD, Electrical and Computer Engineering, University of Maryland (2004)

Research interests: Statistical signal processing, computer vision, biomedical image analysis

Selected publications:

- Vaswani, N. "Particle Filtering for Large Dimensional State Spaces with Multimodal Observation Likelihoods." *IEEE Transactions on Signal Processing*, 2008 (forthcoming).
- Rathi, Y., N. Vaswani, A. Tannenbaum, and A. Yezzi. "Tracking Deforming Objects Using Particle Filtering for Geometric Active Contours." *IEEE Transactions on Pattern Analysis and Machine Intelligence*, August 2007, 1470–1475.
- Rathi, Y., N. Vaswani, and A. Tannenbaum. "A Generic Framework for Tracking Using Particle Filter with Dynamic Shape Prior." *IEEE Transactions on Image Processing*, May 2007, 1370–1382.
- Vaswani, N. "Additive Change Detection in Nonlinear Systems with Unknown Change Parameters." *IEEE Transactions on Signal Processing,* March 2007, 859–872.
- Vaswani, N. and R. Chellappa. "Principal Component Null Space Analysis for Image and Video Classification." *IEEE Transactions on Image Processing*, July 2006, 1370–1382. ■

Contact Us

Visit **www.ece.iastate.edu/who-we-are/faculty.html** to find contact information for ECpE faculty.

Faculty Directory
Cyber Infrastructure

The faculty in this strategic area also conduct research in one or more of the following traditional research areas:

- Computing and networking systems
- Software systems
- Secure and reliable computing
- VLSI

Morris Chang

Associate Professor

PhD, Computer Engineering, North Carolina State University (1993)

Research interests: Embedded systems, performance in Java virtual machines, wireless communication protocol

Selected publications:

- Huang, Chin-Tser, M. Matthews, M. Ginley, X. Zheng, C. Chen, and J. M. Chang. "Efficient and Secure Multicast in WirelessMAN: A Cross-layer Design." Special Issue, *Journal of Communications Software and Systems*, 2008 (forthcoming).
- Al-Mefleh, H. and J. M. Chang. "A New ACK Policy to Mitigate the Effects of Coexisting IEEE 802.11/802.11e Devices." In *Proc. IEEE International Conference on Computer Communications*, Phoenix, AZ, April 14-18, 2008.
- Gharaibeh, B., T. Nguyan, and J. M. Chang. "Coping with API Evolution for Running, Mission-Critical Applications Using Virtual Execution Environment." In *Proc. IEEE 7th International Conference on Quality Software*, Portland, OR, October 11-12, 2007: 171–180.
- Abichar, Z., Yanlin Peng, and J. M. Chang, "WiMAX: The Emergence of Wireless Broadband." *IEEE IT Professional* 8, no. 4, (August, 2006): 44–48.
- Hasan, Yusuf and J. M. Chang. "A Tunable Hybrid Memory Allocator." *Journal of Systems and Software* 79, no. 8, (August 2006): 1051–1063.

Tom Daniels

Assistant Professor

PhD, Computer Science, Purdue University (2002)

Research interests: Information assurance and security

Selected publications:

- Gaspar, A., S. Langevin, W. Armitage, R. Sekar, and T. Daniels. "The Role of Virtualization in Computing Education." In *Proc. ACM SIGCSE Technical Symposium on Computer Science Education*, Portland, OR, March 12-15, 2008.
- Anderson, B., T. Gillespie, and T. Daniels. "The Role of Information Warfarew in Information Assurance Education: A Legal and Ethical Perspective." In *Proc. 2007 American Society for Engineering Education Annual Conference & Exposition*, Honolulu, HI, June 2007.
- Tang, Y. and T. Daniels. "On the Economic Placement of Monitors in Router Level Network Topologies." In *Proc. 1st Workshop on the Economics of Securing the Information Infrastructure*, Washington, D.C., October 23-24, 2006.
- Wang, W. and T. Daniels. "Diffusion and Graph-spectral Methods for Network Forensic Analysis." In *Proc. New Security Paradigms Workshop 2006*, Schloss Dagstuhl, Germany, September 19-22, 2006.

Cyber Infrastructure Strategic Research Area

The computing and networking infrastructure, embodied in the Internet, dramatically has altered the technological, scientific, and sociological landscape. When computing-oriented architectures are embedded seamlessly into a diverse set of applications that are seemingly unrelated to computing, the impact of the infrastructure will increase exponentially.

Realizing the importance of real-time adaptive embedded computing architectures, the ECpE department has made this a strategic research area. The department also recognizes that focusing on the newer capabilities of the computing infrastructure must coincide with work on the demands and deficiencies of the existing infrastructure.

James A. Davis

Associate Professor
Vice Provost for Information Technology and Chief Information Officer (2004-present)
PhD, Computer Science, Iowa State University (1984)

Research interests: Enterprise information security strategies, risk management, computer security education

Manimaran Govindarasu

Associate Professor
PhD, Computer Science and Engineering, Indian Institute of Technology, Madras (1998)

Research interests: Real-time systems, computer network security, critical infrastructure systems

Selected publications:

- Muthuprasanna, M. and G. Manimaran. "Distributed Divide-and-Conquer Techniques for Effective DDoS Attack Defenses." In *Proc. IEEE International Conference on Distributed Computing Systems*, Beijing, China, June 17-20, 2008.
- Sudha Anil Kumar, G., G. Manimaran, and Z. Wang. "Energy-aware Scheduling of Real-time Tasks in Wireless Networked Embedded Systems." In *Proc. IEEE Real-Time Systems Symposium*, Tucson, AZ, December 3-6, 2007: 15–24.
- Leon, R. A., V. Vittal, and G. Manimaran. "Application of Sensor Network for Secure Electric Energy Infrastructure." *IEEE Transactions on Power Delivery* 22, no. 2, (April 2007): 1021–1028.
- Basheer, D. and G. Manimaran. "Novel Hybrid Schemes Employing Packet Marking and Logging for IP Traceback." *IEEE Transactions on Parallel and Distributed Systems* 17, no. 5, (May 2006): 403–418.
- Chakrabarti, A. and G. Manimaran. "Routing with Reliability Constraints in QoS Networks." *IEEE/ACM Transactions on Networking* 13, no. 3, (June 2005): 662–675.

Yong Guan

Associate Professor
PhD, Computer Science, Texas A&M (2002)

Research interests: Wireless and sensor network security, computer and network forensics, privacy-enhancing technologies for the Internet

Selected publications:

- Yu, Z., Y. Wei, B. Ramkumar, and Y. Guan. "An Efficient Signature-based Scheme for Securing Network Coding Against Pollution Attacks." In *Proc. 27th IEEE International Conference on Computer Communications*, Phoenix, AZ, April 15-17, 2008: 1409–1417.
- Wei, Y., Z. Yu, and Y. Guan. "Location Verification Algorithms for Wireless Sensor Networks." In *Proc. 27th IEEE International Conference on Distributed Computing Systems*, Toronto, Canada, June 25-29, 2007.
- Zhang, L. and Y. Guan. "Variance Estimation Over Sliding Windows." In *Proc. 26th ACM Symposium on Principles of Database Systems*, Beijing, China, June 11-14, 2007: 228–232.
- Zhang, L. and Y. Guan. "TOPO: A Topology-aware Single Packet Attack Traceback Scheme." In *Proc. IEEE International Conference on Security and Privacy in Communication Networks*, Baltimore, MD, August 28-September 1, 2006.
- Yu, Z. and Y. Guan. "A Dynamic En-route Scheme for Filtering False Data in Wireless Sensor Networks." In *Proc. IEEE International Conference on Computer Communications* 2006, Barcelona, Spain, April 23-27, 2006.

Doug Jacobson

University Professor
PhD, Computer Engineering, Iowa State University (1985)

Research interests: Information assurance, large-scale cyber attack simulation

Selected publications:

- Banerjee, P. and D. Jacobson. "Optimal Configuration of a Secure Clustering Protocol for Sensor Networks." In *Proc. 20th ISCA International Conference on Parallel and Distributed Computing Systems*, Las Vegas, NV, September 24-26, 2007: 145–150.
- Banerjee, P., D. Jacobson, and S. Lahiri. "Security and Performance Analysis of a Secure Clustering Protocol for Senor Networks." In *Proc. 6th IEEE International Symposium on Network Computing and Applications*, Cambridge, MA, July 12-14, 2007: 134–144.
- Jacobson, D. "Computer Security Summer Camp for High School Students." In *Proc. 2006 American Society for Engineering Education Conference*, Chicago, IL, June 18-21, 2006.
- Jacobson, D. and N. Evans. "Cyber Defense Competition." In *Proc. 2006 American Society for Engineering Education Conference*, Chicago, IL, June 18-21, 2006.

Ahmed Kamal

Professor
PhD, Electrical Engineering, University of Toronto, Canada (1986)

Research interests: High-performance networks, optical networks, wireless and sensor networks, performance evaluation

Selected publications:

- Al-Kofahi, O. and A. E. Kamal. "Network Coding-Based Protection of Many-to-One Flow Networks." In *Proc. 4th IEEE International Conference on Mobile Ad-hoc and Sensor Systems*, Pisa, Italy, October 8-11, 2007.
- Kamal, A. E. "1+N Protection in Optical Mesh Networks Using Network Coding on p-Cycles." In *Proc. IEEE Global Telecommunications Conference*, San Francisco, CA, November 27-December 1, 2006.
- Ul-Mustafa, R. and A. E. Kamal. "Design and Provisioning of WDM Networks with Multicast Traffic Grooming." *IEEE Journal on Selected Areas in Communications, Part II: Optical Communications and Networking* 24, no. 4, (April 2006): 37–53.
- Al-Karaki, J. N. and A. E. Kamal. "Routing Techniques in Wireless Sensor Networks: A Survey." *IEEE Wireless Communications* 11, no. 6, (December 2004): 6–28.
- Kamal, A. E. "A Discrete-Time Model of TCP Reno with RED-Based Routers in the Presence of Background Traffic Interference." *Performance Evaluation* 58, no. 2-3, (2004): 109–142.

Suraj C. Kothari

Professor
PhD, Mathematics, Purdue University (1977)

Research interests: Software engineering and its applications to high-performance computing, computational science, and bioinformatics

Selected publications:

- Neginhal, S. and S. C. Kothari. "Event Views and Graph Reductions for Understanding System Level C Code." In *Proc. 22nd IEEE International Conference on Software Maintenance*, Philadelphia, PA, October 2006: 279–288.
- Muthuprasanna, M., K.Wei, and S. C. Kothari. "Eliminating SQL Injection Attacks: A Transparent Defense Mechanism." In *Proc. 8th IEEE International Symposium Web site Evolution*, Philadelphia, PA, September 23-24, 2006: 22–32.
- Kothari S. C. "Addressing Software Bottlenecks: Amplifying Human Capabilities with Tools." Special Issue, *Advances in Computer Science and Engineering*, Berkeley, CA, May 6, 2006: 65–69.
- Kothari S. C., G. Daugherty, L. Bishop, and J. Sauceda. "A Pattern-based Framework for Detecting Software Anomalies." *Software Quality Journal* 12, no. 2, (June 2004): 99–120.
- Kalyanaraman, A., S. Aluru, V. Brendel, and S. C. Kothari. "Space and Time Efficient Parallel Algorithms and Software for EST Clustering." *IEEE Transactions on Parallel and Distributed Systems* 14, no. 12, December 2003, 1209–1221.

Tien Nguyen

Litton Assistant Professor
PhD, Computer Science, University of Wisconsin (2005)

Research interests: Software engineering, architecture, traceability, maintenance, and evolution; version control and configuration management; information retrieval and visualization; Web engineering

Selected publications:

- Nguyen, T., I. Chen, and H. Jaygarl. "Incremental Latent Semantic Indexing for Effective, Automatic Traceability Link Evolution Management." In *Proc. 30th ACM/IEEE International Conference on Software Engineering*, Leipzig, Germany, May 10-18, 2008.
- Dig, D., K. Manzoor, R. Johnson, and T. Nguyen. "Refactoring-aware Configuration Management for Object-Oriented Programs." In *Proc. 29th ACM/IEEE International Conference on Software Engineering,* Minneapolis, MN, May 20-26, 2007: 427–436.
- Nguyen, T. and J. Zhang. "A Novel Visualization Model for Web Search Results." *IEEE Transactions on Visualization and Computer Graphics* 12, no. 5, (September/October 2006): 981–988.
- Nguyen, T. "Model-based Version and Configuration Management for a Web Engineering Lifecycle." In *Proc. 15th International World Wide Web Conference*, Edinburgh, Scotland, May 23-26, 2006: 437–446.
- Nguyen, T., E. Munson, J. Boyland, and C. Thao. "An Infrastructure for Development of Multi-level, Object-Oriented Configuration Management Services." In *Proc. 27th ACM/IEEE International Conference on Software Engineering*, St. Louis, MO, May 15-21, 2005: 215–224.

Diane Rover

Associate Dean, College of Engineering
Professor
PhD, Computer Engineering, Iowa State University (1989)

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:

- Rover, D., R. Mercado, Z. Zhang, M. Shelley, and D. Helvick. "Reflections on Teaching and Learning in an Advanced Undergraduate Course in Embedded Systems." *IEEE Transactions on Education*, 2008, (forthcoming).
- Rover, D. "Integrative Learning." Academic Bookshelf, *ASEE Journal of Engineering Education* 96, no. 3, (July 2007): 275–277.
- Santiago, N., D. Rover, and D. Rodriguez. "A Statistical Approach for the Analysis of the Relation Between Low-Level Performance Information, the Code, and the Environment." *Information* 9, no. 3, (May 2006): 503–517.
- Mina, M., A. Somani, A. Tyagi, D. Rover, M. Feldmann, and M. Shelley. "Learning Streams: A Case Study in Curriculum Integration." In *Proc. 35th ASEE/IEEE Frontiers in Education Conference*, Indianapolis, IN, October 19-22, 2005.
- Lee, K. and D. Rover. "A Web Services and Ontology-based Performance Visualization Framework for Grid Environments." In *Proc. 2005 IEEE International Conference on Cluster Computing*, Boston, MA, September 27-30, 2005.

New Cyber Infrastructure Faculty

One new faculty will join the department in the cyber infrastructure strategic research area during the 2008-09 academic year:

Phillip Jones
Assistant Professor
PhD, Computer Science, Washington University in St. Louis (2008)

Research interests: Adaptable computing systems, reconfigurable hardware, embedded systems, specialized hardware for application acceleration

Arun K. Somani

Anson Marston Distinguished Professor
Jerry R. Junkins Endowed Chair
Department Chair
PhD, Electrical Engineering, McGill University, Montreal, Canada (1985)

- IEEE Fellow
- ACM Distinguished Engineer

Research interests: Optical fiber networking, computer system architecture, dependable computing, reconfigurable system design

Selected publications:

- Ramasubramanian, S. and A. K. Somani. "MICRON: A Framework for Connection Establishment in Optical Networks." *IEEE/ACM Transactions on Networking* 16, no. 2, (April 2008): 473–485.
- Frederick, M. T. and A. K. Somani. "Beyond the Arithmetic Constraint: Depth-Optimal Mapping of Logic Chains in LUT-based FPGAs." In *Proc. ACM/SIGDA International Symposium on Field-Programmable Gate Arrays*, Monterey, CA, February 24-26, 2008, 37–46.
- Subramanian, V., M. Bezdek, N. D. Avirneni, and A. K. Somani. "Superscalar Processor Performance Enhancement Through Reliable Dynamic Clock Frequency Tuning." In *Proc. IEEE/IFIP International Conference on Dependable Systems and Networks*, Edinburgh, Scotland, June 25-28, 2007, 196–205.
- Somani, A. K. "Network Design: Algorithms and Examples." In *Wiley Encyclopedia of Electrical and Electronics Engineering*, ed. John Webster (Hoboken, NJ: John Wiley & Sons, 2007).
- Gupta, R., V. Sekhri, and A. K. Somani. "CompuP2P: An Architecture for Internet Computing Using Peer-to-Peer Networks." *IEEE Transactions on Parallel and Distributed Systems* 17, no. 11, (November 2006): 1306–1320.

Akhilesh Tyagi

Associate Professor
PhD, Computer Science, University of Washington (1988)

Research interests: Computer architecture, compiler backends, VLSI design and CAD (secure and trusted computing platforms)

Selected publications:

- Keung, K., V. Manne, and A. Tyagi. "A Novel Charge Recycling Design Scheme Based on Adiabatic Charge Pump." *IEEE Transactions on VLSI Systems* 15, (July 2007): 733–745.
- Mahadevan, G. and A. Tyagi. "Architecture Support for 3-D Obfuscation." *IEEE Transactions on Computers* 55, no. 5, (May 2006): 497–507.
- Keung, K. and A. Tyagi. "State Space Reconfigurability: An Implementation Architecture for Self Modifying Finite Automata." In *Proc. 2006 ACM International Conference on Compilers, Architecture, and Synthesis for Embedded Systems*, Seoul, Korea, October 22-25, 2006, 83–92.

ARUN K. SOMANI PHOTO COURTESY OF CRAIG CARROLL PHOTOGRAPHY

Joseph Zambreno

Assistant Professor
PhD, Computer Engineering, Northwestern University (2006)

Research interests: Reconfigurable computing, computer security, compilers, computer architecture

Select publications:

- Narayanan, R., D. Honbo, G. Memik, A. Choudhary, and J. Zambreno. "An FPGA Implementation of Decision Tree Classification." In *Proc. Design, Automation, and Test in Europe*, April 2007, 189–194.
- Ozisikyilmaz, B., R. Narayanan, J. Zambreno, G. Memik, and A. Choudhary. "An Architectural Characterization Study of Data Mining and Bioinformatics Workloads." In *Proc. IEEE International Symposium on Workload Characterization*, San Jose, CA, October 25-27, 2006.
- Zambreno, J., D. Honbo, A. Choudhary, R. Simha, and B. Narahari. "High-Performance Software Protection Using Reconfigurable Architectures." In *Proc. IEEE* 94, no. 2, (February 2006): 1–13.
- Zambreno, J., A. Choudhary, R. Simha, B. Narahari, and N. Memon. "SAFE-OPS: An Approach to Embedded Software Security." *ACM Transactions on Embedded Computing Systems* 4, no. 1, (February 2005): 189–210.
- Zambreno, J., D. Nguyen, and A. Choudhary. "Exploring Area/Delay Tradeoffs in an AES FPGA Implementation." In *Proc. International Conference on Field-Programmable Logic and its Applications*, Antwerpen, Belgium, August 30-Sepetember 1, 2004, 575–585.

Zhao Zhang

Assistant Professor
PhD, Computer Science, College of William and Mary (2002)

Research interests: Computer architecture, parallel and distributed computing, hardware support for security

Selected publications:

- Lin, J., H. Zheng, Z. Zhu, E. Gorbatov, H. David, and Z. Zhang. "Software Thermal Management of DRAM Memory for Multicore Systems." In *Proc. International Conference on Measurement and Modeling of Computer Systems*, Annapolis, MD, June 2-6, 2008.
- Lin, J., Q. Lu, X. Ding, Z. Zhang, X. Zhang, and P. Sadayappan. "Gaining Insights into Multicore Cache Partitioning: Bridging the Gap Between Simulation and Real Systems." In *Proc. 14th International Symposium on High-Performance Computer Architecture*, Salt Lake City, UT, February 16-20, 2008.
- Lin, J., H. Zheng, Z. Zhu, H. David, and Z. Zhang. "Thermal Modeling and Management of DRAM Memory Systems." In *Proc. 34th International Symposium on Computer Architecture*, San Diego, CA, June 9-13, 2007.
- Zhu, Z. and Z. Zhang. "A Performance Comparison of DRAM Memory System Optimizations for SMT Processors." In *Proc. 11th International Symposium on High-Performance Computer Architecture*, San Francisco, CA, February 2005.
- Zhang, Z., Z. Zhu, and X. Zhang. "Design and Optimization of Large Size and Low Overhead Off-Chip Caches." *IEEE Transactions on Computers* 53, no.7, (July 2004): 843–855. ■

Iowa State Named Information Assurance Center of Excellence

The U.S. National Security Agency (NSA) and the Department of Homeland Security (DHS) have just awarded Iowa State University its fourth designation as a National Center of Academic Excellence in Information Assurance Education.

Iowa State was among the first six universities to be designated national centers for information assurance in 1999. The NSA and DHS renewed Iowa State's designation in 2002, 2005, and now 2008. The most recent designation is for five years.

The centers are "intended to reduce vulnerabilities in the national information infrastructure by promoting higher education in information assurance and producing a growing number of professionals with information assurance expertise in various disciplines," according to a joint statement from the federal agencies.

The agencies sponsor the national centers as part of President George W. Bush's National Strategy to Secure Cyberspace. That strategy refers to cyberspace as the nervous system of the country's critical infrastructure.

Iowa State's Information Assurance Center includes 28 faculty members who study a range of computer security issues.

Faculty Directory
Distributed Sensing and Decision Making

The faculty in this strategic area also conduct research in one or more of the following traditional research areas:

- Communications and signal processing
- Computing and networking systems
- Software systems
- Systems and controls

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:

- Dogandzic, A. and B. Zhang. "Bayesian Complex Amplitude Estimation and Adaptive Signal Detection in Low-Rank Interference." *IEEE Transactions on Signal Processing* 55, (March 2007): 1176–1182.
- Dogandzic, A. and B. Zhang. "Bayesian NDE Defect Signal Analysis." *IEEE Transactions on Signal Processing* 55, (January 2007): 372–378.
- Dogandzic, A. and B. Zhang. "Distributed Estimation and Detection for Sensor Networks Using Hidden Markov Random Field Models." *IEEE Transactions on Signal Processing* 54, (August 2006): 3200–3215.
- Dogandzic, A. and A. Nehorai. "Generalized Multivariate Analysis of Variance: A Unified Framework for Signal Processing in Correlated Noise." *IEEE Signal Processing Magazine* 20, (September 2003): 39–54.
- Dogandzic, A. "Chernoff Bounds on Pairwise Error Probabilities of Space-Time Codes." *IEEE Transactionson Information Theory* 49, (May 2003): 1327–1336.

Nicola Elia

Associate Professor

PhD, Electrical Engineering, Massachusetts Institute of Technology (1996)

Research interests: Networked control systems, feedback communication systems, control with limited information

Selected publications:

- Liu, Q., V. Vittal, and N. Elia. "Expansion of System Operating Range by an Iterpolated LPV FACTS Controller Using Multiple Lyapunov Functions." *IEEE Transactions on Power Systems* 21, no. 3, (2006): 1311–1320.
- Liu, J. and N. Elia. "Writing on Dirty Paper with Feedback." *Communication on Information and Systems* 5, no. 4, (2005): 401–422.
- Elia, N. "Remote Stabilization Over Fading Channels." *Systems and Control Letters* 54, no. 3, (2005): 238–249.
- Elia, N. "When Bode Meets Shannon: Control Oriented Feedback Communication Schemes." Special Issue, *IEEE Transactions on Automatic Control* 49, no. 9, (September 2004): 1477–1488.

Sang W. Kim

Associate Professor

PhD, Electrical Engineering, University of Michigan (1987)

Research interests: Wireless communications, cooperative communications, code division multiple access, space-time coding, multiuser detection, cross-layer design

Selected publications:

- Kim, S. W. "Substream-based Soft Handoff in CDMA Cellular Networks." *IEEE Transactions on Communications*, 2008, (forthcoming).
- Lee, Y. H. and S. W. Kim. "Generalized Joint Power and Rate Adaptation in DS/CDMA Communications Over Fading Channels." *IEEE Transactions on Vehicular Technology* 57, January 2008): 603–608.
- Kim, S. W., S. G. Kim, and B. K. Yi. "Decentralized Random Parity Forwarding in Large-Scale Wireless Relay Networks." In *Proc. IEEE Global Communications Conference*, Washington, DC, November 26-30, 2007.
- Kim, S. W. "Concatenated Random Parity Forwarding in Wireless Multi-Source Multi-Hop Networks." In *Proc. IEEE Information Theory Workshop*, Lake Tahoe, CA, September 2-6, 2007.

Ratnesh Kumar

Professor

PhD, Electrical and Computer Engineering, University of Texas at Austin (1991)

- IEEE Fellow

Research interests: Control, diagnosis, and verification of event-driven, real-time, and hybrid systems, and their applications in software, embedded, and power systems

Selected publications:

- Kumar, R. and S. Takai. "Inference-based Ambiguity Management in Decentralized Decision-Making: Decentralized Control of Discrete Event Systems." *IEEE Transactions on Automatic Control* 52, no. 10, (2007): 1783–1794.
- Zhou, C. and R. Kumar. "Bisimilarity Control of Partially Observed Deterministic Discrete Event Systems." *IEEE Transactions on Automatic Control* 52, no. 9, (September 2007): 1642–1653.
- Huang, J. and R. Kumar. "Directed Control of Discrete Event Systems: Optimization-based Approach." *IEEE Transactions on Systems, Man, and Cybernatics: Part A* 37, no. 5, (September 2007): 780–791.
- Kumar, R., S. Jiang, C. Zhou, and W. Qiu. "Polynomial Synthesis of Supervisor for Partially Observed Discrete Event Systems by Allowing Nondeterminism in Control." *IEEE Transactions on Automatic Control* 50, no. 4, (2005): 463–475.
- Jiang, S. and R. Kumar. "Failure Diagnosis of Discrete Event Systems with Linear-time Temporal Logic Fault Specifications." *IEEE Transactions on Automatic Control* 49, no. 6, (2004): 934–945.

Yao Ma

Assistant Professor

PhD, Electrical and Computer Engineering, National University of Singapore (2000)

Research interests: Wireless networks, radio resource allocation, MIMO UWB communication, cognitive radio

Selected publications:

- Ma, Y., D. Zhang, and R. Schober. "Rate-Maximizing Multiuser Scheduling for Parallel Channel Access." *IEEE Signal Processing Letters* 14, no. 7, (July 2007): 441–444.
- Ma, Y. and J. Jin. "Effect of Channel Estimation Errors on M-QAM with MRC and EGC in Nakagami Fading Channels." *IEEE Transactions on Vehicular Technology*, June 2007, 1239–1250.
- Ma, Y. and L. Zhao. "Achievable Performance of Orthogonal STBC Over Spatially-Correlated Rician Channels." *IEEE Transactions on Vehicular Technology*, June 2007, 1251–1261.
- Zhao, L., W. Mo, Y. Ma, and Z. Wang. "Diversity and Multiplexing Tradeoff in General Fading Channels." *IEEE Transactions on Information Theory* 53, no. 4, (April 2007): 1549–1557.
- Ma, Y., R. Schober, and D. Zhang. "Exact BER of M-QAM with MRC and Imperfect Channel Estimation in Rician Fading Channels." *IEEE Transactions on Wireless Communications*, March 2007, 926–936.

Distributed Sensing and Decision Making Strategic Research Area

The ECpE department has determined the area of distributed sensing and decision making as a pivotal strategic area of interest due to the emergence and convergence of new technologies. First, information technology platforms that have emerged in the last decade have enhanced the cost-effectiveness and speed associated with the processing, manipulating, storing, and transferring of large data sets. The expanding wireless technology significantly has increased functionality by making communication of data and information mobile. Additionally, improved sensor technology has provided efficient, inexpensive sensors for diverse purposes.

The convergence of these technologies has given rise to complex system interactions and the large number of autonomous, heterogeneous entities working together toward a desired global behavior have made it imperative for researchers to coordinate and manage those complex interactions. Related technologies that lead to and are governed by the advantages of distributed architectures will play a fundamental role in future engineering systems.

Research efforts of faculty in this strategic area encompass many of the areas above, including sensor networks, wireless technology, complex systems, and distributed computing.

Daji Qiao

Assistant Professor
PhD, Electrical Engineering,
University of Michigan (2004)

Research interests: Modeling, analysis, and protocols/algorithms design for wireless local area networks, wireless sensor networks, and wireless mesh networks

Selected publications:

- Qiao, D., S. Choi, and K. G. Shin. "Interference Analysis and Transmit Power Control in IEEE 802.11a/h Wireless LANs." *IEEE/ACM Transactions on Networking* 15, no. 5, (October 2007): 1007–1020.
- Shukla, V. and D. Qiao. "Distinguishing Data Transience from False Injection in Sensor Networks." In *Proc. IEEE Communications Society Conference on Sensor Mesh and Ad Hoc Communications and Networks*, San Diego, CA, June 18-21, 2007.
- Mo, W., D. Qiao, and Z. Wang. "Lifetime Maximization of Sensor Networks Under Connectivity and k-Coverage Constraints." In *Proc. IEEE International Conference on Distributed Computing in Sensor Systems*, San Francisco, CA, June 18-20, 2006.
- Kim, J., S. Kim, S. Choi, and D. Qiao. "CARA: Collision-Aware Rate Adaptation for IEEE 802.11 WLANs." In *Proc. IEEE Conference on Computer Communications*, Barcelona, Spain, April 23-27, 2006.
- Qiao, D., and K. G. Shin. "Smart Power-Saving Mode for IEEE 802.11 Wireless LANs." In *Proc. IEEE Conference on Computer Communications*, Miami, FL, March 13-17, 2005.

Aditya Ramamoorthy

Assistant Professor
PhD, Electrical Engineering,
University of California, Los Angeles (2005)

Research interests: Network information theory, sensor networks, error control coding with applications in data storage and wireless communications

Selected publications:

- Kim, J., A. Ramamoorthy, and S. W. McLaughlin. "Design of Efficiently-Encodable Rate-Compatible Irregular LDPC Codes." *IEEE Transactions on Communications*, 2008 (forthcoming).
- Somasundara, A. A., A. Ramamoorthy, and M. B. Srivastava. "Mobile Element Scheduling with Dynamic Deadlines." *IEEE Transactions on Mobile Computing* 6, no. 4, (April 2007): 395–410.
- Ramamoorthy, A., K. Jain, P. A. Chou, and M. Effros. "Separating Distributed Source Coding from Network Coding." *IEEE Transactions on Information Theory* 52, no. 6, (June 2006): 2785–2795.
- Ramamoorthy, A., J. Shi, and R. D. Wesel. "On the Capacity of Network Coding for Random Networks." *IEEE Transactions on Information Theory* 51, no. 8, (August 2005): 2878–2885.

Alexander Stoytchev

Assistant Professor
PhD, Computer Science,
Georgia Institute of Technology (2007)

Research interests: Developmental robotics, autonomous robotics, machine learning, computational perception

Selected publications:

- Stoytchev, A. "Behavior-Grounded Representation of Tool Affordances." In *Proc. IEEE International Conference on Robotics and Automation*, Barcelona, Spain, April 18-22, 2005: 3071–3076.
- Stoytchev, A. "Five Basic Principles of Developmental Robotics." *Neural Information Processing Systems Conference 2006 Workshop on Grounding Perception, Knowledge, and Cognition in Sensori-Motor Experience*, Whistler, Canada, December 8, 2006.
- Sinapov, J. and A. Stoytchev. "Learning and Generalization of Behavior-Grounded Tool Affordances." In *Proc. 6th IEEE International Conference on Development and Learning*, London, England, July 11-13, 2007.
- Stoytchev, A. "Toward Video-Guided Robot Behaviors." In *Proc. 7th International Conference on Epigenetic Robotics*, Camden, NJ, November 5-7, 2007: 165–172.
- Stoytchev, A. "Learning the Affordances of Tools Using a Behavior-Grounded Approach." In *Affordance-Based Robot Control*, *Springer Lecture Notes in Artificial Intelligence* 4760, (2008): 140–158.

Srikanta Tirthapura

Associate Professor
PhD, Computer Science, Brown University (2002)

Research interests: Distributed data processing, distributed coordination in wired and wireless networks, data stream computation

Selected publications:

- Xu, B., S. Tirthapura, and C. Busch. "Sketching Asynchronous Streams Over Sliding Windows." *Distributed Computing,* 2008 (forthcoming).
- Pavan, A. and S. Tirthapura. "Range Efficient Counting of Distinct Elements in a Massive Data Stream." *SIAM Journal on Computing* 37, no. 2, (2007): 359–379.
- Shen, Z. and S. Tirthapura. "Approximate Covering Detection Among Content-based Subscriptions Using Space Filling Curves." In *Proc. IEEE International Conference on Distributed Computing Systems,* Santa Fe, NM, June 18-20, 2007.
- Busch, C., R. LaFortune, and S. Tirthapura. "Improved Sparse Covers for Graphs Excluding a Fixed Minor." In *Proc. ACM Symposium on Principles of Distributed Computing*, Portland, OR, August 12-15, 2007, 61–70.
- Cormode, G., S. Tirthapura, and B. Xu. "Time-Decaying Sketches for Sensor Data Aggregation." In *Proc. ACM Symposium on Principles of Distributed Computing*, Portland, OR, August 12-15, 2007, 215–224.

Umesh Vaidya

Assistant Professor
PhD, Mechanical Engineering,
University of California, Santa Barbara (2004)

Research interests: Ergodic theory approach to the control of complex systems with applications in power systems, complex dynamics in atomic force microscopy, and control of mixing in fluid flows

Selected publications:

- Mehta, P.G., U. Vaidya, and A. Banaszuk. "Markov Chains, Entropy, and Fundamental Limitations in Nonlinear Stabilization." *IEEE Transactions on Automatic Control* 53, no. 3, (April 2008), 784–791.
- Vaidya, U. and P. G. Mehta. "Lyapunov Measure for Almost Everywhere Stability." *IEEE Transactions on Automatic Control* 53, no. 1, (March 2008): 307–323.
- Mathew, G., I. Mezic, S. Grivopoulos, U. Vaidya, and L. Petzold. "Optimal Control of Mixing in Stokes Fluid Flows." *Journal of Fluid Mechanics* 580, (2007): 261–281.
- Vaidya, U. and I. Mezic. "Controllability for a Class of Area-Preserving Twist Maps." *Physica D* 189, (2004): 234–246.

Zhengdao Wang

Associate Professor
PhD, Electrical Engineering,
University of Minnesota (2002)

Research interests: Signal processing, wireless communications, information theory

Selected publications:

- Zhao, L., W. Mo, Y. Ma, and Z. Wang. "Diversity and Multiplexing Tradeoff in General Fading Channels." *IEEE Transactions on Information Theory*, April 2007, 1549–1558.
- Mo, W., Z. Wang, and A. Dogandzic. "EM-based Iterative Receiver for Coded MIMO Systems in Unknown Spatially Correlated Noise." *Wiley's Wireless Communications and Mobile Computing* 7, (January 2007): 81–89.
- Ma, Y., Z. Wang, and S. Pasupathy. "Asymptotic Performance of Hybrid-Selection/Maximal-Ratio Combining Over Fading Channels." *IEEE Transactions on Communication* 54, no. 5, (May 2006): 770–777.
- Wang, Z. and X. Yang. "Blind Channel Estimation for Ultra Wide-Band Communications Employing Pulse Position Modulation." *IEEE Signal Processing Letters* 12, no. 7, (July 2005): 520–523.
- Wang, Z. and G. B. Giannakis. "Outage Mutual Information Rate of Space-Time MIMO Channels." *IEEE Transactions on Information Theory* 50, no. 4, (April 2004): 657–662.

Lei Ying

Assistant Professor
PhD, Electrical Engineering,
University of Illinois at Urbana-Champaign (2007)

Research interests: Wireless sensor networks, resource allocations in wireless networks, mobile networks

Selected publications:

- Ying, L., R. Srikant, and G. Dullerud. "Distributed Symmetric Function Computation in Noisy Wireless Sensor Networks." *IEEE Transactions on Information Theory* 53, no. 12, (December 2007): 4826–4833.
- Ying, L., R. Srikant, A. Eryilmaz, and G. Dullerud. "A Large Deviations Analysis of Scheduling in Wireless Networks." *IEEE Transactions on Information Theory* 52, no. 11, (November 2006): 5088–5098.
- Ying, L., R. Srikant, A. Eryilmaz, and G. Dullerud. "Distributed Fair Resource Allocation in Cellular Networks in the Presence of Heterogeneous Delays." *IEEE Transactions on Automatic Control* 52, no. 1, (January 2007): 129–134.
- Ying, L., R. Srikant, and D. Towsley. "Cluster-based Back-pressure Routing Algorithm." In *Proc. IEEE Conference on Computer Communications*, Phoenix, AZ, April 13-19, 2008.
- Ying, L., S. Yang, and R. Srikant. "Coding Achieves the Optimal Delay-Throughput Tradeoff in Mobile Ad-Hoc Networks: Two-Dimensional I.I.D. Mobility Model with Fast Mobiles." In *Proc. 5th International Symposium on Modeling and Optimization in Mobile, Ad-hoc, and Wireless Networks*, Limassol, Cyprus, April 16-20, 2007. ■

Faculty Directory
Energy Infrastructure

The faculty in this strategic area also conduct research in one or more of the following traditional research areas:

- Computing and networking systems
- Electric power and energy systems
- Microelectronics and photonics
- Systems and controls

Venkataramana Ajjarapu

Professor

PhD, Electrical Engineering, University of Waterloo (1986)

- IEEE Fellow

Research interests: Power system security, real-time control of power and power electronics systems

Selected publications:

- Luo, C. and V. Ajjarapu. "Identification of Interacting Power System Dynamic Phenomena via Continuation of Invariant Subspaces." In *Proc. 16th Power Systems Computation Conference*, Glasgow, Scotland, July 14-18, 2008.
- Yang, D. and V. Ajjarapu. "Critical Eigenvalues Tracing for Power System Analysis via Continuation of Invariant Subspaces and Projected Arnoldi Method." *IEEE Transactions on Power Systems* 22, no. 1, (February 2007): 324–332.
- Wen, X. and V. Ajjarapu. "Application of a Novel Eigenvalue Trajectory Tracing Method to Identify Both Oscillatory Stability Margin and Damping Margin." *IEEE Transactions on Power Systems* 21, no. 2, (May 2006): 817–824.
- Yang, D. and V. Ajjarapu. "A Decoupled Time Domain Simulation Method via Invariant Subspace Partition for Power System Analysis." *IEEE Transactions on Power Systems* 21, no. 1, (February 2006): 11–18.
- Qin, W., H. Song, and V. Ajjarapu. "Continuation Based Quasi-Steady State Analysis." *IEEE Transactions on Power Systems* 21, no. 1, (February 2006): 171–179.

Energy Infrastructure Strategic Research Area

The accelerating energy crisis continues to drive discovery in the ECpE department. Our professors are leading projects that will help answer the challenges we face as a result of growing energy demands worldwide. They are conducting research in solar energy, wind energy, power system dynamics and control, operational decision-making, distribution systems, reliability, voltage security, economic systems and markets, asset management, power electronic systems, and power systems security.

Dionysios Aliprantis

Assistant Professor

PhD, Electrical Engineering, Purdue University (2003)

Research interests: Electric machines and power systems, power electronics and controls, evolutionary optimization methods

Selected publications:

- Aliprantis, D. C., O. Wasynczuk, and C. D. Rodríguez Valdez. "A Voltage-Behind-Reactance Synchronous Machine Model with Saturation and Arbitrary Rotor Network Representation." *IEEE Transactions on Energy Conversion*, 2008 (forthcoming).
- Aliprantis, D. C., S. D. Sudhoff, and B. T. Kuhn. "A Brushless Exciter Model Incorporating Multiple Rectifier Modes and Preisach's Hysteresis Theory." *IEEE Transactions on Energy Conversion* 21, no. 1, (March 2006): 136–147.
- Aliprantis, D.C., S. D. Sudhoff, and B. T. Kuhn. "Genetic Algorithm-based Parameter Identification of a Hysteretic Brushless Exciter Model." *IEEE Transactions on Energy Conversion* 21, no. 1, (March 2006): 148–154.
- Aliprantis, D. C., S. D. Sudhoff, and B. T. Kuhn. "A Synchronous Machine Model with Saturation and Arbitrary Rotor Network Representation." *IEEE Transactions on Energy Conversion* 20, no. 3, (September 2005): 584–594.
- Aliprantis, D. C., S. D. Sudhoff, and B. T. Kuhn. "Experimental Characterization Procedure for a Synchronous Machine Model with Saturation and Arbitrary Rotor Network Representation." *IEEE Transactions on Energy Conversion* 20, no. 3, (September 2005): 595–603.

Sumit Chaudhary

Assistant Professor

PhD, Electrical Engineering, University of California, Riverside (2006)

Research interests: Organic semiconductors, solar cells, nano-optoelectronics

Selected publications:

- Chaudhary, S., H. Lu, A. M. Muller, C. J. Bardeen, and M. Ozkan. "Hierarchical Placement and Associated Optoelectronic Impact of Carbon Nanotubes in Polymer: Fullerene Solar Cells." *Nano Letters* 7, no. 7, (2007): 1973–1979.
- Chaudhary, S. and M. Ozkan. "Self-Organization Dependent Optical Emission of Luminescent Polymers in Porous Alumina Templates." *Journal of Nanoelectronics and Optoelectronics* 2, (2007): 278–281.
- Yilmaz, O. F., S. Chaudhary, and M. Ozkan. "Hybrid Organic-Inorganic Electrode for Efficient Charge Injection or Collection in Organic Optoelectronic Devices." *Nanotechnology* 17, (2006): 3662–3667.
- Chaudhary S., J. H. Kim, K. V. Singh, and M. Ozkan. "Fluorescent Microscopy Visualization of Single-Walled Carbon Nanotubes Using Semiconductor Nanocrystals." *Nano Letters* 4, no. 12, (2004): 2415–2419.
- Chaudhary S., W. C. W. Chan, and M. Ozkan. "Trilayer Hybrid Polymer-Quantum Dot Light-Emitting Diodes." *Applied Physics Letters* 84, no. 15, (2004): 2925–2927.

Vikram Dalal

Thomas M. Whitney Professor in Electrical and Computer Engineering

Associate Department Chair

PhD, Electrical Engineering, Princeton University (1969)

Research interests: Microelectronics and photonics, photovoltaic solar energy conversion devices, plasma processing, semiconducting materials and devices, sensor devices

Selected publications:

- Saripalli, S., P. Reusswig, P. Sharma, and V. L. Dalal. "Transport properties of Nanocrystalline Si and (Si,Ge)." *Journal of Non-Crystalline Solids* 354, (2008): 2426–2429.
- Madhavan, A. and V. Dalal. "Alternative Designs for Nanocrystalline Si Solar Cells." *Journal of Non-Crystalline Solids* 354, (2008): 2403–2406.
- Jaju, V. and V. L. Dalal. "Growth and Properties of Fluorinated Plasma Oxide for MOSFET Devices." *Journal of Non-Crystalline Solids* 354, (2008): 2839–2842.
- Ghosh, D., R. Shinar, V. L. Dalal, Z. Zhou, and J. Shinar. "Novel Integrated Organic Sensors." *Journal of Non-Crystalline Solids* 354, (2008): 2606–2609.
- Stieler, Dan, Vikram Dalal, Max Noack, and Eric Schares. "Electron Mobility in Nanocrystalline Si." *Journal of Applied Physics* 100, no. 036106, (2006).

Chen-Ching Liu

Palmer Chair in Electrical Engineering

Professor

PhD, Electrical Engineering and Computer Sciences, University of California, Berkeley (1983)

- IEEE Fellow

Research interests: Electric power infrastructure, alternate energy sources

Selected publications:

- Salazar, H., C. C. Liu, and R. F. Chu. "Decision Analysis of Merchant Transmission Investment by Perpetual Options Theory." *IEEE Transactions on Power Systems*, August 2007, 1194–1201.
- Li, G., C. C. Liu, C. Mattson, and J. Lawarree. "Day-Ahead Electricity Price Forecasating in a Grid Environment." *IEEE Transactions on Power Systems*, February 2007, 266–274.
- Schneider, K., C. C. Liu, and Jean-Philippe Paul. "Assessment of Interactions Between Power and Telecommunications Infrastructures." *IEEE Transactions on Power Systems*, August 2006, 1123–1130.
- Li, H., J. Rosenwald, and C. C. Liu. "Strategic Power Infrastructure Defense." In *Proc. IEEE*, May 2005, 918–933.

Iowa State Team Selected to Compete in 2009 U.S. Solar Decathlon Competition

The U.S. Department of Energy (DOE) has selected Iowa State University as one of 20 teams from 25 international colleges and universities to compete in the fourth Solar Decathlon in the fall of 2009 in Washington, D.C.

Solar Decathlon teams design, build, and operate attractive and energy-efficient solar-powered homes. Each team is awarded $100,000 over two years to support the Solar Decathlon's research goal of reducing the cost of solar-powered homes and advancing solar technology.

Since its inception in 2002, the Solar Decathlon has developed into one of the premier venues in the United States for research and development into green building technologies. In the fall of 2009, the National Mall will be transformed into a showcase for cutting-edge solar and building technologies as Solar Decathlon homes from 16 U.S. states and territories and three countries are displayed in a solar village. More than 100,000 people visited the houses during the 2007 competition.

Iowa State faculty and students from 11 departments in five colleges, including the College of Engineering's ECpE department, have met weekly for more than a year to establish the first Solar Decathlon team from the state of Iowa. Ulrike Passe, assistant professor of architecture, is heading the effort.

"Iowa State will bring a new and distinctive perspective to the competition with our strengths in design, engineering and agricultural technologies," Passe says. "Our house is a laboratory for ongoing research into design for extreme climates. In our case, we need to accommodate Iowa's cold winters and hot, humid summers."

More than 100 Iowa State students are expected to participate—either as extracurricular activity through the Solar Decathlon Club (an official student organization open to all students), in specific for-credit courses in design and liberal arts and sciences, or through assignments and projects in various courses in business, design, engineering, and liberal arts and sciences.

After 2009, Iowa State's Solar Decathlon house will be reconstructed on campus to serve as an educational facility and laboratory for green building technology and systems performance testing.

Jim McCalley

Harpole Professor in Electrical Engineering

PhD, Electrical Engineering,
Georgia Institute of Technology (1992)

- IEEE Fellow

Research interests: Operational decision making, security assessment, power system dynamics, asset management, bulk energy production and transportation, energy control centers

Selected publications:

- Xiao, F. and J. McCalley. "Risk-based Security and Economy Tradeoff Analysis for Real-Time Operation." *IEEE Transactions on Power Systems* 22, no. 4, (November 2007): 2287–2288.
- Quelhas, A., E. Gil, J. McCalley, and S. Ryan. "A Multiperiod Generalized Network Flow Model of the U.S. Integrated Energy System: Part I Model Description." *IEEE Transactions on Power Systems* 22, no. 2, (May 2007): 829–836.
- Jiang, Y., J. McCalley, and T. Van Voorhis. "Risk-based Maintenance Optimization for Transmission Equipment." *IEEE Transactions on Power Systems* 21, no. 3, (August 2006): 1191–1200.
- Chen, Q. and J. McCalley. "A Cluster Distribution as a Model for Estimating High-Order Event Probabilities in Power Systems." *Probability in the Engineering and Informational Sciences* 19, no. 4, (October 2005): 489–505.
- Chen, Q. and J. McCalley. "Identifying High-Risk N-k Contingencies for Online Security Assessment." *IEEE Transactions on Power Systems* 20, no. 2, (May 2005): 823–834. ■

Small-Scale Technology

The faculty in this strategic area also conduct research in one or more of the following traditional research areas:

- Communications and signal processing
- Computing and networking systems
- Electromagnetic, microwave, and nondestructive evaluation
- Microelectronics and photonics
- Systems and controls
- VLSI

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:

- Theodoulidis, T. and J. R. Bowler. "Impedance of an Induction Coil at the Opening of a Borehole in a Conductor." *Journal of Applied Physics*, no. 024905, (2008).
- Bowler, N. and J. R. Bowler. "Theory of Four-Point Alternating Current Potential Drop Measurements on Conductive Plates." In *Proc. Royal Society Series* A 463, no. 2079, (2007): 817–836.
- Bowler, J. R. and F. Fu. "Time Domain Dyadic Green's Function for an Electric Source in a Conductive Plate." *IEEE Transactions Magazine* 42, no. 11, (2006): 3661–3668.
- Theodoulidis, T. P. and J. R. Bowler. "Eddy Current Interaction with a Right-Angled Conductive Wedge." In *Proc. Royal Society Series A* 461, no. 2062, (2005): 3123–3139.
- Sun, H., J. R. Bowler, and T. P. Theodoulidis. "Eddy Currents Induced in a Finite Length Layered Rod by a Coaxial Coil." *IEEE Transactions Magazine* 41, no. 9, (2005): 2455–2461.

Nicola Bowler

Associate Professor

PhD, Physics, University of Surrey, UK (1994)

Research interests: Electromagnetic properties of composite materials, electromagnetic nondestructive evaluation of dielectrics and metals

Selected publications:

- Bowler, J. R. and N. Bowler. "Theory of Four-Point Alternating Current Potential Drop Measurements on Conductive Plates." In *Proc. Royal Society Series A* 463, no. 2079, (2007): 817–836.
- Bowler, N. "Theory of Four-Point Alternating Current Potential Drop Measurements on a Metal Half-Space." *Journal of Physics D: Applied Physics* 39, (2006): 584–589.
- Bowler, N. "Designing Dielectric Loss at Microwave Frequencies Using Multi-Layered Filler Particles in a Composite." *IEEE Transactions on Dielectric Electric Insulation* 13, (2006): 703–711.

Degang Chen

Associate Professor

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

Research interests: Analog and mixed signal VLSI design and testing

Small-Scale Technologies Strategic Research Area

Small-scale technologies significantly have altered the way we lead our lives and have made computers and modern electronics, including cell phones, TVs, and digital music players, widely available and affordable. Although the impact already has been impressive, the story is far from over: small-scale technologies have found new impetus from the MEMS and nanotechnology initiatives. The ECpE department recognizes the need to more fully understand and exploit the full potential of small-scale technologies. The ECpE's Microelectronics Research Center, along with the Iowa State University Department of Chemical and Biological Engineering's W. M. Keck Laboratory for High Throughput Atom-Scale Analysis, are being utilized to meet this objective.

Selected publications:

- Jiang, H., B. Olleta, D. Chen, and R. L. Geiger. "Testing High-Resolution ADCs with Low-Resolution/Accuracy Deterministic Dynamic Element Matched DACs." *IEEE Transactions on Instrumentation and Measurement* 56, no. 5, (October 2007): 1753–1762.
- He, C., L. Jin, D. Chen, and R. L. Geiger. "Robust High-Gain Amplifier Design Using Dynamic Systems and Bifurcation Theory with Digital Post-Processing Techniques." *IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications* 54, no. 5, (May 2007): 964–973.
- He, C., X. Dai, H. Xing, and D. Chen. "New Layout Strategies with Improved Matching Performance." *Analog Integrated Circuits and Signal Processing* 49, no. 3, (December 2006): 281–289.
- Lin, Y., D. Chen, R. L. Geiger. "Yield Enhancement with Optimal Area Allocation for Ratio-Critical Analog Circuits." *IEEE Transactions on Circuits and Systems I: Regular Papers* 53, no. 3, (March 2006): 534–553.
- Wang, X. Z. and D. Chen. "Output Tracking Control of a One-Link Flexible Manipulator via Causal Inversion." *IEEE Transactions on Control Systems Technology* 14, no. 1, (January 2006): 141–148.

Chris Chong-Nuen Chu

Associate Professor

PhD, Computer Science,
University of Texas at Austin (1999)

Research interests: Interconnect optimization; placement and routing of VLSI circuits

Selected publications:

- Yan, J. Z., and C. Chu, "Deferred Decision Making Enabled Fixed-Outline Floor planner." In *Proc. IEEE/ACM Design Automation Conference*, Anaheim, CA, June 8-13, 2008.
- Chu, C. and Y. C.Wong. "FLUTE: Fast Lookup Table-based Rectilinear Steiner Minimal Tree Algorithm for VLSI Design." *IEEE Transactions on Computer-Aided Design* 27, no. 1, (January 2008): 70–83.
- Viswanathan, N., G. J. Nam, C. Alpert, P. Villarrubia, H. Ren and C. Chu. "RQL: Global Placement via Relaxed Quadratic Spreading and Linearization." *IEEE/ACM Design Automation Conference*, San Diego, CA, June 4-8, 2007, 453–458.
- Pan, M. and C. Chu. "IPR: An Integrated Placement and Routing Algorithm." In *Proc. IEEE/ACM Design Automation Conference*, San Diego, CA, June 4-8, 2007: 59–62.
- Viswanathan, N. and C. Chu. "FastPlace: Efficient Analytical Placement Using Cell Spreading, Iterative Local Refinement and a Hybrid Net Model." In *Proc. of the International Symposium on Physical Design*, Phoenix, AZ, April 18-21, 2004, 26–33.

Randall L. Geiger

Willard and Leitha Richardson Professor in Electrical and Computer Engineering

PhD, Electrical Engineering,
Colorado State University (1977)

- IEEE Fellow

Research interests: Analog VLSI design, VLSI testing, high-speed data converters

Selected publications:

- Jin, L., D. Chen, and R. L. Geiger. "SEIR Linearity Testing of Precision A/D Converters in Non-stationary Environments with Center-Symmetric Interleaving." *IEEE Transactions on Instruction and Measurement*, October 2007, 1776–1785.
- Jiang, H., B. Olleta, D. J. Chen, and R. L. Geiger. "Testing High-Resolution ADCs with Low-Resolution/Accuracy Deterministic Dynamic Element Matched DACs." *IEEE Transactions on Circuits and Systems I*, May 2007, 964–973.
- Oletta, B., H. Jiang, D. J. Chen, and R. L. Geiger. "A Deterministic Dyanmic Element Mating Approach for Testing High-Resolution ADCs with Low Accuracy Excitations." *IEEE Transactions on Instruction and Measurement* 55, no. 3, (June 2006): 902–915.
- Lin, Y., D. Chen, and R. L. Geiger. "Yield Enhancement with Optimal Area Allocation for Radio-Critical Analog Circuits." *IEEE Transactions on Circuits and Systems* 53, (March 2006): 534–553.
- Cong and R. L. Geiger. "A 1.5v 14-bit 100-MS/s Self-Calibrated DAC." *IEEE Journal of Solid State Circuits* 38, no. 12, (December 2003): 2051–2060.

Jaeyoun Kim

Assistant Professor

PhD, Electrical Engineering,
University of Michigan at Ann Arbor (2003)

Research interests: Photonics, plasmonics, application of optical nanostructures for bioengineering, optical BioMEMS, bio-mimetic optics

Selected publications:

- Kim, J. "Surface Plasmon-Polaariton Waveguiding Characteristics of Metal/Dielectric Quasi-Coplanar Structures." *Optic Letters* 31, (2007): 3405–3407.
- Liu, G. L., J. Kim, Y. Lu, and L. P. Lee. "Fluorescence Enhancement of Quantum Dots Enclosed in Au Nanopockets with Sub Wavelength Aperture." *Applied Physics Letters*, no. 241118, (2006).
- Jeong, K. H., J. Kim, and L. P. Lee. "Biomimetic Artificial Compound Eyes." *Science* 312, (2006): 557–561.
- Liu, G. L., J. Kim, Y. Lu, and L. P. Lee. "Optofluidic Control via Photothermal Nanoparticles." *Nature Materials* 5, (2006): 27–32.
- Kim, J., K. H. Jeong, and L. P. Lee. "Artificial Ommatidia by Self-Aligned Microlenses and Waveguides." *Optic Letters* 30, (2005): 5–7.

Mark J. Kushner

College of Engineering Dean
James Melsa Professor

PhD, Applied Physics, California Institute of Technology (1979)

- IEEE Fellow
- American Physical Society Fellow
- American Vacuum Society Fellow
- Institute of Physics Fellow
- International Union of Pure and Applied Chemistry Fellow
- Japanese Society for Advancement of Science Fellow
- Optical Society of America Fellow

Research interests: Partially ionized gases (or plasmas)

Selected publications:

- Babaeva, N. Y. and M. J. Kushner. "Ion Energy and Angular Distributions into the Wafer Focus Ring Gap in Capacitively Coupled Discharges." *Journal of Physics D* 41, no. 062004, (2008).
- Arakoni, R., J. J. Ewing, and M. J. Kushner. "Microdischarges for Use as Microthrusters: Modelling and Scaling." *Journal of Physics D* 41, no. 105208, (2008).
- Agarwal and M. J. Kushner. "Characteristics of Pulsed Plasma Doping Sources for Ultra-shallow Junction Formation," *Journal of Applied Physics* 101, no. 063305, (2007).
- Yang, Y. and M. J. Kushner. "Modeling of Magnetically Enhanced Capacitively Coupled Plasma Sources: Two Frequency Discharges." *Journal of Vacuum Science Technology A* 25, (2007): 1420–1432.
- Bhoj, N. and M. J. Kushner. "Continuous Processing of Polymers in Repetitively Pulsed Atmospheric Pressure Discharges with Moving Surfaces and Gas Flow." *Journal of Physics D* 40, (2007): 6953–6968.

Mani Mina

Senior Lecturer

PhD, Electrical Engineering, Iowa State University (1989)

Research interests: High-speed systems, magneto optics, applied electromagnetics, education

Selected publications:

- Tioh, J. W., M. Mina, and R. J. Weber. "Magnetically Controlled Switches for Optoelectronics Networking: The Problem, Available Technology, New Implementations." *IEEE Transactions on Magnetics* 43, no. 6, (June 2007): 2698–2700.
- Bahuguna, R., M. Mina, and R. J. Weber. "Mach-Zehnder Interferometric Switch Utilizing Faraday Rotation." *IEEE Transactions on Magnetics* 43, no. 10, (June 2007): 2680–2682.
- Bahuguna, R., M. Mina, J. W. Tioh, and R. J. Weber. "Magneto-Optic-Based Fiber Switch for Optical Communications." *IEEE Transactions on Magnetics* 42, no. 6, (October 2006): 3099–3101.
- Anderson, N. E., M. Mina, and A.A.B. Brojeny. "On the Utilization of Magnetic Vector Potential for a Description of a Superconducting Transmission Line." *IEEE Transactions on Applied Superconductivity* 16, no. 3, (September 2006): 1913–1917.
- Mina, M., T. Daniels, S. Russell, and R. Gerdes. "Intrusion Detection, Performance Assurance, and System Maintenance: A New Paradigm in Computer Security." *Material Evaluation* 63, no.12, (December 2005): 1203–1211.

New Small-Scale Technologies Faculty

Two new faculty will join the department in the small-scale technologies strategic research area during the 2008-09 academic year:

Ayman Fayed
Assistant Professor
PhD, The Ohio State University (2004)

Research interests: Mixed-signal CMOS circuit design for high-speed wire-line and wireless applications, integrated power management/delivery circuits, adaptive circuits, ADCs

Nathan Neihart
Assistant Professor
PhD, University of Washington (2008)

Research interests: VLSI, multiple-antenna transmitters in deep sub-micron CMOS, multiple-input/multiple-output architectures and algorithms for spectral sensing cognitive radio applications

Jiming Song

Associate Professor
PhD, Electrical Engineering,
Michigan State University (1993)

Research interests: Fast and efficient algorithms in computational electromagnetics, modeling of VLSI interconnects on silicon and signal integrity, inverse scattering and nondestructive evaluation, antenna analysis and design, antenna applications of metamaterials

Selected publications:

- Zhang, L. and J. M. Song. "Effects of the Thin-Film Metal Ground Embedded in On-Chip Microstrip Lines." *IEEE Microwave and Wireless Components Letters* 17, no. 6, (June 2007): 439–441.
- Shu, W. W. and J. M. Song. "Complete Mode Spectrum of a Grounded Dielectric Slab with Double Negative Metamaterials." *Progress in Electromagnetics Research*, PIER 65, (2006): 103–123.
- Lloyd, T. W., J. M. Song, and M. Yang. "Numerical Study of Surface Integral Formulations for Low-Contrast Objects." *IEEE Antennas Wireless Propagation Letters* 4, (2005): 482–485.
- Chew, W. C., J. M. Song, T. J. Cui, S. Velamparambil, L. Hastriter, and B. Hu. "Review of Large-Scale Computing in Electromagnetics with Fast Integral Equation Solvers." *Computer Modeling in Engineering & Sciences* 5, no. 4, (April 2004): 361–372.
- Song, J. M., F. Ling, W. Blood, E. Demircan, K. Sriram, G. Flynn, K. H. To, R. Tsai, Q. Li, T. Myers, M. Petras, and A. Dengi. "De-embedding Techniques for Embedded Microstrips." *Microwave and Optical Technology Letters* 42, no.1, (2004): 50–54.

Gary L. Tuttle

Associate Professor
PhD, Electrical Engineering,
University of California, Santa Barbara (1991)

Research interests: Semiconductor materials, nanoelectronics, photonic crystals, negative-index materials

Selected publications:

- Moussa, R., B. Wang, G. Tuttle, T. Koschny, and C. M. Soukoulis. "Effect of Beaming and Enhanced Transmission in Photonic Crystals." *Physical Review* B 76, no. 235417, (2007).
- Kohli, P., C. Christensen, J. Muehlmeier, R. Biswas, G. Tuttle, and K. M. Ho. "Add-Drop Filters in Three-Dimensional Layer-by-Layer Photonic Crystals Using Waveguides and Resonant Cavities." *Applied Physics Letters*, no. 231103, (2006).
- Zhou, J. F., L. Zhang, G. Tuttle, T. Koschny, and C. M. Soukoulis. "Negative Index Materials Using Simple Short Wire Pairs." *Physical Review* B 73, no. 041101, (2006).
- Wang, B., W. Dai, A. Fang, L. Zhang, G. Tuttle, T. Koschny, and C. M. Soukoulis. "Surface Waves in Photonic Crystal Slabs." *Physical Review B* 74, no. 195104, (2006).
- Sell, C., C. Christensen, J. Muehlmeier, G. Tuttle, Z. Y. Li, and K. M. Ho. "Waveguide Networks in Three-Dimensional Layer-by-Layer Photonic Crystals." *Applied Physics Letters* 85, (2004): 707–709.

Robert J. Weber

David C. Nicholas Professor in Electrical and Computer Engineering
PhD, Electrical Engineering,
Iowa State University (1967)

- IEEE Fellow

Research interests: Electromagnetics, microwave circuits and systems, MEMS/bio-MEMS, electro optics, fiber-optics

Selected publications:

- Tioh, J. W., M. Mina, and R. J. Weber. "Magnetically Controlled Switches for Optoelectronics Networking: The Problem, Available Technology, New Implementations." *IEEE Transactions on Magnetics* 43, no. 6, (June 2007): 2698–2700.
- Bahuguna, R., M. Mina, and R. J. Weber. "Mach–Zehnder Interferometric Switch Utilizing Faraday Rotation." *IEEE Transactions on Magnetics* 43, no. 6, (June 2007): 2680–2682.
- Wanner, S., R. Weber, and J. Song. "Mutual Coupling in Phase Array." *IEEE AP-S International Symposium 2007*, Honolulu, HI, June 10-15, 2007.
- Bahuguna, R., M. Mina, J. W. Tioh, and R. J. Weber. "Magneto-Optic-Based Fiber Switch for Optical Communications." *IEEE Transactions on Magnetics* 42, no. 10, (October 2006): 3099–3101.
- Weber, R. "RF/microwave Sensed Cantilevers, Diaphragms, and Tactile Sensors for Passive and Active Sensor Systems." In *Proc. IEEE/ National Library of Medicine Life Science Systems and Application Workshop 2006*, Bethesda, MD, July 14-16, 2006, 1–2. ■

Staff and Other Appointments

Additional Faculty Appointments

- Maneesha Aluru, Associate Scientist (ECpE)
- Viren Amin, Adjunct Assistant Professor (Center for Nondestructive Evaluation)
- Rana Biswas, Adjunct Associate Professor (Ames Lab/Physics)
- Brett Bode, Adjunct Assistant Professor (Ames Lab)
- Soon-Jo Chung, Courtesy Assistant Professor (Aerospace Engineering)
- Jennifer Davidson, Courtesy Associate Professor (Mathematics)
- Brian Hornbuckle, Courtesy Assistant Professor (Agronomy)
- Glenn R. Luecke, Courtesy Professor (Mathematics)
- James Oliver, Courtesy Professor (Mechanical Engineering)
- Joseph Shinar, Courtesy Professor (Physics)
- Masha Sosonkina, Adjunt Associate Professor (Ames Lab)
- Costas Soukoulis, Courtesy Distinguished Professor (Physics)
- Lizhi Wang, Courtesy Assistant Professor (Industrial and Manufacturing Systems Engineering)
- Janice Wiersema, Lecturer (Information Assurance Center)

Postdoctoral Appointments

- Salah A. Aly
- Natalia Babaeva
- Ethalinda Cannon
- Renchang Dai
- Sudhansu Dash
- Yunke Hou
- Shubalaxmi Kher
- Linyong Mao
- Viet Hoang Nguyen
- Jaroslaw Zola

Support Staff

Administrative Support

- Ginny Anderson, Information Assurance Center Secretary
- Tom C. Baird, EPES Program Manager
- Susana Bucklin, Administrative Specialist
- Stephanie Drake-Zierke, EPES Account Clerk
- Sara K. Harris, Assistant to the Department Chair
- Karen Knight, Secretary
- Dana Schmidt, Communications Specialist
- Laurie Shinn, Fiscal Secretary
- Greg Smith, Senior Design Program Coordinator

Computing Support Group

- Jason Boyd, Lab Coordinator
- Gary Bridges, Electronic Technician
- Cory Farver, System Support Specialist
- Leland Harker, Electronic Technician
- Steven Kovarik, System Support Manager
- Steve Nystrom, System Support Specialist
- Mark Shamblin, System Support Specialist

Student Services

- Roger Bentley, Academic Adviser
- Deb Martin, Academic Adviser
- Tony Moore, Academic Adviser
- Pam Myers, Records Analyst
- Megan Sawyer, Secretary
- Vicky Thorland-Oster, Program Manager

ECpE Celebrates 100 Years

Iowa State University's ECpE department is celebrating its centennial this year. Throughout its history, the department has prided itself in conducting innovative research and providing an exceptional education to young engineers. The following timeline shows a snapshot of the department's research and education excellence in the past 100 years.

1909
- The Department of Electrical Engineering is established
- The first home of department, the Engineering Annex, opens

1915
- The telephone lab is created and first courses in telephony and telephone engineering are offered

1916
- First courses in radio and telegraphy begin

1921
- The department constructs its own radio tower and station; the station begins broadcasting in 1922

1925
- Edd R. McKee is awarded the department's first master's degree

1927
- Alumnus Ronald J. Rockwell joins Crosley Corporation where he pioneered radio, high-fidelity, and television technologies, as well as designed the first high-resolution TV transmitter in the Midwest

1932
- Oral A. Brown is awarded department's first PhD

1936
- The department receives ABET accreditation

1939
- Graduate student Clifford Berry co-creates world's first electronic digital computer

Clifford Berry co-invented the Atanasoff-Berry Computer

AC Network Analyzer

1949
- Professors Warren B. Boast and John D. "Jack" Ryder begin constructing the AC Network Analyzer to be used by power utilities to simulate the entire transmission process

1950
- Electrical Engineering Hall (later renamed Coover Hall) opens

1957
- Biomedical Electronics program is initiated

1959
- The first courses in analog and digital computers are offered
- The high-speed, digital Cyclone Computer is completed

Cyclone Computer

1962
- Professor Alvin A. Read begins courses on lasers

1964
- Professor David L. Carlson creates an infant respiratory augmenter

1967
- Anson Marston Distinguished Professor and Alumnus R. Grover Brown begins early GPS research

1971
- Graduate student David C. Nicholas invents the encoding process for fax machines, which is Iowa State's highest earning patent, bringing in $36 million to date

1972
- Alumnus Thomas M. Whitney develops first hand-held scientific calculator, the HP-35

1973
- Alumnus Donald Linder lead's the Motorola team that develops the world's first portable phone

1975
- Alumnus Robert O. Evans receives the National Medal of Technology for conceiving the first compatible family of commercial computers at IBM in the 1960s

1976
- Undergraduate computer engineering degree program is created

1979
- Computer engineering program receives ABET accreditation

1983
- Professor and Alumnus James W. Nilsson writes *Electric Circuits*, one of the world's bestselling electric circuits textbooks

1984
- Department changes its name to Department of Electrical and Computer Engineering

1984
- Alumnus Edward R. McCracken begins working for Silicon Graphics and helps company develop 3-D graphics machines that launched the "world of virtual reality"
- Anson Marston Distinguished Professor and Alumnus Arthur V. Pohm co-invents Magnetoresistive Random Access Memory (MRAM), a revolutionary computer memory technology

1996
- Students build Cybot, a self-propelled, self-directed, voice-interactive robot

1998
- Alumnus Kenneth M. Peterson is one of three engineers to create Motorola's IRIDIUM, a worldwide communication system using satellite phones

1999
- Information assurance program launches—one of only six in the nation at the time

2002
- A voice-interactive, self-propelled, self-directed, semi-artificially intelligent robot, Octagonal Speech-Controlled, Autonomous Robot (aka OSCAR), debuts

2003
- University Professor and Alumnus Doug Jacobson creates the world's first Internet-Scale Event and Attack Generation Environment

2006
- Alumnus Sehat Sutardja is named Inventor of the Year
- CyBlue, an IBM Blue Gene/L supercomputer, is acquired for bioinformatics research

2007
- Software engineering undergraduate degree program launches

2009
- Department celebrates 100 Years

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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; and
- 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

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