Advancing TECHNOLOGY

2015 Annual Magazine

Department of Electrical and Computer Engineering

THE UNIVERSITY OF ARIZONA
College of Engineering
The dedication of all who have come together to grow ECE in the last year has paid off immensely. Thank you. Our faculty members are growing in number and heading to market with their inventions. Enrollment is rising. And students — supported by scholarships, internships, and industry mentors — are excelling. They are graduating ready for industry, government and academia.

The department is adding five new faculty members this academic year, bringing the total to 34 and strengthening the foundation of our program. Faculty members have brought in more than $11 million in research funding in the last year alone. A third of our faculty are founders or co-founders of startups, and in the last two years 21 patents have been issued for ECE inventions.

The work of our faculty and students is advancing technology to solve some of the world’s biggest challenges and helping boost the economy. In this issue of the ECE annual magazine, read about Salim Hariri’s cyber-DNA software to stop hackers and Bane Vasic’s company that is advancing technology to clean up computer memory.

Our professors are also leading the way in revamping classrooms so all students at all levels in classes of all sizes are involved in hands-on learning and real-life projects. A story on Page 25 covers how ECE is creating engaging learning environments, from the earliest engineering courses.

Talented, job-ready students are graduating with the skills and knowledge to advance computing, wireless technology, cybersecurity, telemedicine, solar power and disease diagnostics.

ECE’s 327 undergraduate students and 241 graduate students are making their ideas happen — like graduate student Farah Fargo, who won an international award for her cloud computing research.

We are grateful to the seasoned engineers passing the torch to our students and for the support of our industry partners, who not only help fund critical research but who also provide our students with mentoring and real-world experiences through internships and other work opportunities.

“Talented, job-ready students are graduating with the skills and knowledge to advance computing, wireless technology, cybersecurity, telemedicine, solar power and disease diagnostics.” — TAMAL BOSE

Read on Page 29 about how Mark Pierpoint — vice president and general manager of software and modular solutions at Keysight, a spinoff of Agilent’s electronic measurement business — has arranged donations of lab equipment and software, and helped implement a certification program to give students an edge in the job market.

A special thank you also to Paul and Linda Prazak and to Gene and Marylyn Tobey, who recently set up scholarships that will help students for many years to come.

It is an honor every day to be a part of such a dedicated team and to see our students thriving. I look forward to another year of everyone working in tandem to improve the lives of people in Arizona and across the globe.

Best regards,

Tamal Bose

Professor and Department Head
University of Arizona researchers are developing technology that converts smartphones into powerful eye-examining instruments that could prevent millions of people from going blind.

Wolfgang Fink, associate professor of electrical and computer engineering and biomedical engineering, is principal investigator on a project funded by the National Science Foundation to create "smart ophthalmoscopes," specialized instruments for examining various parts of the eye’s interior. The devices, which can be attached to any smartphone, and accompanying software will enable health care providers, particularly in remote areas, to quickly and easily determine if patients are at risk of losing their vision.

“Our hand-held ophthalmoscopes will permit eye exams in places they would otherwise be impossible. These are not passive recording instruments, but investigational tools with sophisticated data-processing and analytical capabilities.”

— WOLFGANG FINK

Fink said they would be comparable to typical eye exam equipment used in an eye doctor’s office, yet they would be affordable, highly portable and mobile, and easy to use.

“All that’s needed is a person on a bicycle with a smart ophthalmoscope. They can visit and examine clients of any age, in any language — anywhere, anytime. No trucks, heavy equipment or extensive training required. I believe this portable vision-screening capability will revolutionize the availability and economy of rural health care, and the field of ophthalmology at large.” Here’s how it works: The user — who might be a health care provider, aid worker, nurse, paramedic or caregiver — attaches the ophthalmoscope to a smartphone, points it at the eye and takes a picture. Taking advantage of the smartphone’s ability to take high-resolution pictures, the ophthalmoscope captures detailed images of the interior segments and surfaces.
Biomedical engineering student Jerri-Lynn Kincade and Wolfgang Fink select images of the eye’s interior on a smartphone to be sent to a remote “expert system” for subsequent analysis.

of the patient’s eye, with no need for dilating eye drops, chin rests or other gear typically used for an eye exam.

Next, the user runs a custom app on the smartphone that relays these images to a remote “expert system” — which uses intelligent software to suggest diagnoses much like a human medical expert — for processing and analysis. In seconds, the results are relayed back to the user and displayed on the smartphone’s screen. A single health care provider could conduct as many as 100 initial assessments in one day and immediately put patients on the fast track to accurate diagnosis and treatment for potentially vision-robbing ailments.

Fink stressed that smart ophthalmoscopes are no substitute for examinations and diagnoses by a trained eye specialist. However, in the absence of a trained specialist, he said, people in the field can make initial assessments, such as suspicion of cataracts or glaucoma, and refer patients for follow-up.

Engineering Vision

The National Science Foundation has awarded $800,000 for this three-year research project, through its Partnership for Innovation: Building Innovation Capacity program. The trans-disciplinary research study has three main parts to be tackled in parallel:

• In collaboration with an optical engineering design firm, Fink is designing and building prototype smartphone attachments that will soon be tested on patients in the UA College of Medicine, under the direction of Dr. Joseph Miller, the project’s co-investigator and head of the department of ophthalmology and vision science.

• Senior research scientist Mark Tarbell and Fink will create a framework for a central expert system that can extract, process and analyze the data from smartphones and relay information back to the smartphones.

• Fink and Tarbell will implement image-analysis algorithms to provide medical reports that will help ophthalmologists and other eye-care specialists make diagnoses and recommendations for patients.

In 2012 Fink was inducted into the College of Fellows of the American Institute for Medical and Biological Engineering. He holds more than a dozen issued patents and several pending patent applications — many for vision-related products — some of which constitute the background intellectual property for this project.

Fink has brought several partners on board for the new NSF project. They include Breault Research Organization, an optical engineering design firm; the Center for Military Medicine Research at the University of Pittsburgh; Tech Launch Arizona; and Caltech, where he holds an appointment as visiting associate in physics.
Overcoming limitations in digital electronic computing will likely involve creative solutions, especially when it comes to big-data tasks in science, health care, business and defense.

With a recent $7.5 million U.S. Department of Defense award, electrical and computer engineering professor Mark Neifeld, who has a joint appointment in Optical Sciences, is leading a Multidisciplinary University Research Initiative, or MURI, project to help find those solutions. The team is examining how optical technology can be used to advance computing speed and power.

“Current digital electronic computing technology is reaching its limits in cost and capacity,” said Neifeld, “and alternatives are needed to solve these problems.”

Optics in computing allows for higher bandwidth and massive parallelism, or many processors working in conjunction to perform a set of computations, Neifeld explained, making it a better option for handling some of the more complex computing tasks, such as weather prediction and biological process modeling.

Joining Neifeld, the principal investigator on the project, are researchers from the University of California, at Berkeley, San Diego and Los Angeles, as well as UA Optical Sciences professor Nasser Peyghambarian. Over the next five years, the team will identify pressing computing problems that could benefit from optical computing and develop new hybrid computer architectures that use both optical and electronic technologies.

“Nationally, these are competitive awards,” said Tamal Bose, ECE department head. “The fact that we have a leadership position on such a prestigious team speaks of the quality of our faculty in ECE.”
The world depends on faster computers to deal with increasingly complex information. ECE professor Ahmed Louri, who served for two years in Washington, D.C., as the National Science Foundation’s director of Software and Hardware Foundations, is finding ways to meet the need for speed.

“Virtually every sector of our society — security, manufacturing, health care, education, science, entertainment, military — has become dependent on exponential growth in computing performance,” said Louri, a 26-year veteran of the department.

With the support of a $308,000 NSF grant and other research and industry funding totaling more than $2.5 million, Louri is developing the systems needed to support high-performance computers. His research is expected to result in improved performance in all types of computing — from cellphones, laptops and servers to supercomputers and data centers.

The solution for more computing power has been to add more processing cores on a single microchip, with all the cores sharing the same memory, and a trend toward parallelism.

Parallel computing or processing allows program tasks to be split among the cores and executed simultaneously, if the software has the capability. These methods have managed to speed up computers, but even they may be reaching their limits, Louri explained.

Louri’s solution is a cross-layer cooperatively designed system with computer architecture structures that communicate with one another more effectively.

“We are completely rethinking the design of network-on-chips to take advantage of advances in interconnect technologies, such as photonics and 3-D stacking to develop scalable, energy efficient, bandwidth-reconfigurable and reliable network-on-chips for multicores,” Louri said.

Louri, who received the NSF Career Award in 1989, has published more than 125 journal articles and conference papers in various areas of computer engineering and holds several U.S. patents. He has been awarded the Advanced Telecommunications Organization of Japan Fellowship; the Centre Nationale de Recherche Scientifique, France, Fellowship; the Japan Society for the Promotion of Science Fellowship; and several teaching awards. He is also a fellow of the Institute of Electrical and Electronics Engineers.

Louri joined ECE in 1988 after receiving his master’s and doctoral degrees in computer engineering from the University of Southern California, Los Angeles, in 1984 and 1988, respectively.
Cybersecurity researchers in the UA College of Engineering are developing ways to make the airwaves more secure and protect wireless customers from eavesdropping.

Each day brings new revelations of risks to security and privacy on the Internet. News reports describe hackers stealing information from corporate networks, government agencies gathering metadata from personal cellphones, and smartphone manufacturers installing encryption software that law enforcement cannot crack. You’d think everyone using a wireless device would be on high alert.

Yet many people still feel secure using their laptops or cellphones for, say, banking, sending email, playing video games or accessing medical records. After all, they’ve taken precautions to keep these activities private.

ECE professor Marwan Krunz is the principal investigator on a research project aimed at developing software and other techniques to protect everyday users of wireless technology from the under-recognized but very real threat of eavesdropping.

In the four-year, $660,000 project funded by the National Science Foundation Secure & Trustworthy Cyberspace program, Krunz and co-PI Loukas Lazos, ECE associate professor, are expanding their earlier studies of eavesdropping on military and industrial wireless networks.

Wireless transmissions are highly vulnerable to eavesdropping because they typically broadcast in all directions. Anyone within range of a transmitting device, with the right equipment and know-how, can tune in and gather information about the person using it. That’s because every Wi-Fi user has a unique signature, or fingerprint, which is essentially a pattern of the person’s activity and behavior online.

Transmission signatures provide telling contextual information about Wi-Fi users, such as which websites they’re visiting, and
ECE doctoral students are working with Marwan Krunz, third from left, on an NSF-funded project to develop software that will protect everyday users of wireless technology from eavesdroppers.

can even disclose a user’s physical location.

“...In five seconds of eavesdropping on encrypted Wi-Fi traffic, eavesdroppers can achieve 80 percent accuracy in guessing what websites users are visiting and which applications they are running,” Krunz said.

Working with sophisticated cognitive radios, directional antennas and an array of wireless gadgets, Krunz, Lazos and several graduate students are devising ingenious ways to create signature-free wireless transmissions.

These include new forms of transmitter/receiver “friendly jamming” — artificial noise injected into a wireless transmission that authorized parties can understand and ignore but which thwarts would-be eavesdroppers; and beamforming, which enables a device to pinpoint where its signal can be received, preventing it from being captured elsewhere.

This research will ultimately yield software that can be installed during the production of laptop and tablet computers, cellphones and other wireless devices. Consumers may also be able to download the software to their current devices from wireless cards.
Electrical and computer engineering associate professor Ivan Djordjevic was recently named an 1885 Distinguished Scholar.

The 1885 Society recognized Djordjevic, who has a joint appointment in the College of Optical Sciences, for transformative advancements in how large data sets are transmitted via the Internet and wireless optical networks and for his contributions to undergraduate and graduate instruction.

“I am honored to be selected by the 1885 awards committee,” said Djordjevic, who, along with two other University of Arizona faculty members, was notified of the award in May 2014. “This will increase my visibility at the university level as well as nationally and internationally.”

The 1885 Society Distinguished Scholars Award, created in 2012, acknowledges outstanding mid-career faculty whose leadership, research, scholarship and creative contributions promise to advance their respective disciplines.

“Ivan Djordjevic’s commitment to student engagement and research make him an ideal candidate for this award. He joins the ranks of great professors at this university who have established internationally recognized, prolific interdisciplinary research.” — TAMAL BOSE

The honorees each received $10,000 to further their work.

The University of Arizona Foundation’s 1885 Society is a leadership group dedicated to furthering excellence by providing an annual, consistent source of unrestricted funding to the Office of the UA President. A committee of Distinguished and Regents’ Professors from across campus selects 1885 Distinguished Scholars.
Electrical and computer engineering professor Kelly Simmons-Potter has been named fellow of the American Ceramic Society (ACerS), one of the highest levels of membership in the organization. She was recognized at the society’s 116th Annual Meeting in October 2014 for her research in photosensitive materials and radiation-hardened optics and for her extensive service to the society.

“I am both honored and delighted to receive this distinguished recognition,” said Simmons-Potter.

Simmons-Potter, who joined the UA in 2003, has joint appointments in the College of Optical Sciences and in the department of materials science and engineering. She also serves as director of the Arizona Research Institute for Solar Energy, or AzRISE, which focuses on research, curriculum and outreach in solar and renewable energy. Her research explores the linear and nonlinear responses of optical materials and devices to both ionizing and nonionizing radiation, as well as how defect physics affects the optical behavior of materials.

Simmons-Potter is the co-author of three textbooks in the field of optics and has written more than 80 peer-reviewed journal and conference publications. She has delivered more than 100 scholarly presentations and holds several U.S. patents. Simmons-Potter received her BS in physics in 1986 from Florida State University and her MS and PhD in 1990 and 1994, respectively, in optical sciences from the UA. She spent 10 years at Sandia National Laboratories, from 1994 to 2003, where she received five awards for excellence. She received the 1995 Norbert J. Kreidl Award from the ACerS Glass and Optical Materials Division, or GOMD, for her work in photosensitive optical materials, and in 2005 and 2012 was honored by the Hardened Electronics and Radiation Technology Society for her work in radiation-hardened optical materials.

Simmons-Potter’s service with ACerS spans from 1997 to the present and includes four years on the executive committee of GOMD, for which she was named chair in 2012.
Richard Ziolkowski, UA professor of electrical and computer engineering, is no stranger to traveling the world as a representative for the College of Engineering. Starting in January 2015, he will once again represent the College as he flies across the globe to work in Australia as a Fulbright Distinguished Chair.

Ziolkowski’s five-month term as the Fulbright Distinguished Chair in Advanced Science and Technology involves working with the country’s Defence Science and Technology Organisation to help connect government work and educational research. Based in Melbourne, he is working on DSTO priority research projects as well as giving guest lectures and attending seminars at universities throughout Australia.

A key benefit of the program is the opportunity to explore longer-term collaboration and create new links with institutions in Australia. Thus, his time in Australia, Ziolkowski said, will align well with the College of Engineering’s global initiatives and help strengthen already developing international ties there.

“Not only will I be focusing on bringing my expertise to DSTO and universities in Australia, but I’ll be keeping in mind opportunities to foster international ties that are important for UA’s College of Engineering,” he said.

Ziolkowski has traveled internationally many times throughout his career, most notably as past president of the Antennas and Propagation Society for the Institute of Electrical and Electronics Engineers. He has visited Switzerland, Singapore, China and India to help promote international research in metamaterial exploration. Ziolkowski, an expert in transformative engineering of electromagnetic phenomena, devices and systems, gave a plenary talk in the Netherlands at the April 2014 European Conference on Antennas and Propagation.

The highly competitive Fulbright Scholar Program, a U.S. State Department initiative, supports relations between students, researchers and scholars of the United States and other countries.

“Not only will I be focusing on bringing my expertise to DSTO and universities in Australia, but I’ll be keeping in mind opportunities to foster international ties that are important for UA’s College of Engineering.”

— RICHARD ZIOLKOWSKI
As computers and telecommunications devices become more and more powerful, scientists and engineers around the world are constantly working to improve coding techniques that ensure reliable data transmission. University of Arizona electrical and computer engineering professor Bane Vasic, who recently received a Fulbright U.S. Scholar grant, is one of those researchers.

Vasic will join experts in Serbia at the University of Nis Faculty of Electronic Engineering, or ELEF, and in France at École Nationale Supérieure de l'Électronique et de ses Applications, or ENSEA, in spring 2015 to advance error-correcting code techniques.

It is one thing to be able to transmit a multitude of different types of data over many kinds of devices. It is quite another matter to ensure that all the data arrives at its destination intact. Error-correction techniques guarantee the flawless transmission of digital data over the airwaves or through cables, even in the presence of corrupting influences, called noise.

“The error-correction codes that we as engineers build in communications or memory chips are a kind of grammar that computers use to understand data and keep it meaningful.” — BANE VASIC

Over the last 10 years, Vasic has been instrumental in the development of an error-correction technique called low-density parity check codes, or LDPC codes. LDPC coding is the most reliable way to transmit data intact over communications channels such as wireless networks, satellites and power lines.

Computer chips built to consume less power and work at faster speeds can also compromise data reliability. Vasic’s research with ELEF and ENSEA will build on LDPC code techniques to develop error-correction methods to match evolving computer hardware.

(Vasic continued on page 14)
With the big data industry booming and technology companies incorporating flash memory into all kinds of devices, the demand for reliable, solid-state memory is growing at an exponential rate. Codelucida, a new startup company based on a technology developed in the department of electrical and computer engineering at the University of Arizona and the University of Cergy-Pontoise in France, aims to bring new levels of accuracy and efficiency to these solid-state drives (SSDs).

To bring their invention to market, the creators of the new technology, including Bane Vasic, worked with Tech Launch Arizona, the UA unit that advances academic discoveries, developing them into intellectual property, inventions and marketable technologies.

“The technology we’re developing is relating to decoders and how you retrieve information on SSDs,” Vasic explained. “As errors happen, you not only need an algorithm to correct them, but you need that software to be energy- and space-efficient, so it will fit on chips for mobile devices.”

_Space Lidar Earns Pioneers International Award_

Twenty years ago a team of engineers and scientists, including one of ECE’s own, Professor Emeritus John Reagan, launched the Lidar In-Space Technology Experiment instrument, or LITE, to help scientists better understand global climate change.

Built at the NASA Langley Research Center in Virginia, the laser-based sensor was tested in 1994 during a nine-day Space Shuttle Discovery mission. It was the first time Lidar, or light detection and ranging, had been used for atmospheric studies in space.

In September 2014, the international space community honored the LITE mission team for their groundbreaking work. Patrick McCormick, LITE mission team member and professor at Hampton University in Virginia, accepted the Group Achievement Award in Paris during the IEEE 1st International Workshop on Space-Based Lidar Remote Sensing Techniques and Emerging Technologies.

“LITE ushered in a new era of remote sensing where active probing could challenge passive techniques for earth science measurements,” McCormick said.

Reagan, who joined ECE in 1967 and served as department head from 1997 until 2003, has contributed to other Lidar missions, including NASA’s CALIPSO satellite, and been instrumental in designing Lidar retrieval algorithms and Lidar calibration techniques.
Books, Monographs, Patents and Editorships

July 1, 2013 – December 31, 2015

BOOKS, MONOGRAPHS

Bose, Tamal

Lysecky, Roman

Potter, Kelly

EDITORSHIPS OR ASSOCIATE EDITORSHIPS

Bilgin, Ali
Associate Editor, *IEEE Transactions on Image Processing*
Associate Editor, *IEEE Transactions on Computational Imaging*

Djordjevic, Ivan
Editor, *IEEE Communications Letters*
Associate Editor, *Frequenz*
Associate Editor, *International Journal of Optics*
Lead Guest Editor, *IEEE Signal Processing Magazine,* Special Issue on Advanced DSP and Coding for Multi-Tb/s Optical Transport

Hariri, Salim

Krunz, Marwan
Associate Editor, *IEEE Transactions on Network and Service Management*
Editor, *International Journal of Distributed Sensor Networks*

Louri, Ahmed
Associate Editor, *IEEE Transactions on Computers*

Marcellin, Michael
Guest Editor, *Eurasip Journal on Advances in Signal Processing,* special issue on Real-Time Multimedia Coding and Transmission
Melde, Kathleen
Guest Co-Editor, *IEEE Transactions on Antennas and Propagation*, Special Section on Antenna Systems and Propagation for Cognitive Radio

Potter, Kelly
Member, Editorial Advisory Board, *Journal of Non-Crystalline Solids*

Rozenblit, Jerzy
Associate Editor, *Transactions of the Society for Computer Simulation*

Szilagyi, Miklos
Editorial Board, *International Journal of BioSciences and Technology*
Editorial Board, *International Journal of Cybernetics and Systemics*

Vasic, Bane
Guest Editor, *IEEE Journal on Selected Areas in Communications*, Special Issue on Communication Methodologies for the Next-Generation Storage Systems
Editorial Board Member, *IEEE Transactions in Magnetics*

Wang Roveda, Janet
Associate Editor, *IEEE Circuits and Systems*
Guest Editor in Chief, *VLSI Design Journal*

Xin, Hao
Associate Editor, *IEEE Antennas and Wireless Propagation Letters and IEEE Wireless Propagation Letters*

Faculty Startup Companies

Acomni LLC
Avirtek
Bioevidence Detection Systems (BDS)
Canyon View Diagnostics LLC
Codelucida
Episys Science Inc.
MIAO IC Design LLC
MicroBioMonitoring Systems LLC
MicroBioSystems of Arizona LLC
Ocotillo ElectroMagnetics Inc.
Signal Dynamics LLC
Sonoran Analytical Instruments and Diagnostics
Core Faculty Research Interests

Ali Akoglu
Associate Professor, PhD, Arizona State University
Adaptive hardware systems, reconfigurable architectures, computer-aided design tools for field-programmable gate arrays, scientific computing

Ali Bilgin
Assistant Professor, PhD, University of Arizona
Signal and image processing, data compression, magnetic resonance imaging

Tamal Bose
Professor and Department Head, PhD, Southern Illinois University
Adaptive filtering, spectrum sensing, cognitive radio, channel equalization

Ivan B. Djordjevic
Associate Professor, PhD, University of Nis, Serbia
Coding for optical channels, quantum error correction, coded modulation, turbo equalization, OFDM, optical wireless communications, advanced optical networks

Steven L. Dvorak
Professor, PhD, University of Colorado, Boulder
Geophysical applications of electromagnetics, theoretical and computational electromagnetics, optics, applied mathematics, microwave measurements

Wolfgang Fink
Associate Professor, PhD, University of Tübingen, Germany
Artificial vision (vision prostheses), autonomous robotic space exploration, biomedical sensor/system development, cognitive/reasoning systems, computer-optimized design

Salim Hariri
Professor, PhD, University of Southern California, Los Angeles
Resilient systems and applications, big-data analytics for cybersecurity, autonomic computing, self-protection of clouds, networks and applications, anomaly-based behavior analysis of applications and networks, high-performance parallel and distributed computing and applications
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
<th>Research Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raymond Kostuk</td>
<td>Professor, PhD</td>
<td>Stanford University</td>
<td>Holographic techniques, medical imaging systems, photovoltaic devices and systems</td>
</tr>
<tr>
<td>Onur Ozan Koyluoglu</td>
<td>Assistant Professor, PhD</td>
<td>Ohio State University</td>
<td>Information and coding theory, communications, statistics and neuroscience, with special emphasis on networks, security, and neural coding problems</td>
</tr>
<tr>
<td>Marwan Krunz</td>
<td>Professor, PhD</td>
<td>Michigan State University</td>
<td>Wireless networks, cognitive and software-defined radio, protocol design, MIMO communications, secure network protocols, wireless sensor networks, optical networks</td>
</tr>
<tr>
<td>Loukas Lazos</td>
<td>Associate Professor, PhD</td>
<td>University of Washington</td>
<td>Security and privacy of wireless systems, network security, algorithms, network optimization, wireless communications</td>
</tr>
<tr>
<td>Ahmed Louri</td>
<td>Professor, PhD</td>
<td>The University of Southern California, Los Angeles</td>
<td>Computer architecture, parallel computing, fault-tolerant and reliable computing, energy-efficient computing, interconnection networks, network-on-chips, photonic interconnects</td>
</tr>
<tr>
<td>Roman Lysecky</td>
<td>Associate Professor, PhD</td>
<td>University of California, Riverside</td>
<td>Embedded systems design, dynamic adaptability, hardware/software co-design, field-programmable gate arrays, low-power methodologies</td>
</tr>
<tr>
<td>Michael W. Marcellin</td>
<td>Regents’ Professor, PhD</td>
<td>Texas A&amp;M University</td>
<td>Digital communication and data storage systems, data compression, signal processing</td>
</tr>
</tbody>
</table>
Michael M. Marefat
Associate Professor, PhD, Purdue University
Intelligent systems, computer vision and robotics, machine learning, software engineering, biomedical applications

Kathleen Melde
Professor, PhD, University of California, Los Angeles
High-density circuit packaging and interconnects, antennas, integration of antennas and high-density packaging technology

Mark A. Neifeld
Professor, PhD, Caltech
Computational imaging and spectroscopy, compressive sensing, optical devices and systems, optical communications, applications of information theory

Kelly Simmons-Potter
Professor, PhD, University of Arizona
Linear and nonlinear response of optical materials and devices to ionizing and nonionizing radiation

Linda S. Powers
Professor, PhD, Harvard University
High-speed data acquisition systems, spectroscopy instrumentation, medical diagnostics, environment monitoring

Jeffrey J. Rodriguez
Associate Professor, PhD, University of Texas, Austin
Digital signal and image processing and analysis, with applications in biomedicine and telecommunications

Janet Meiling Roveda
Associate Professor, PhD, University of California, Berkeley
Smart grid and smart home, VLSI system for biomedical applications, multicore design, data-centric systems, reliable systems and circuits, DNA computing, synthetic biology
Jerzy W. Rozenblit

University Distinguished Professor, PhD, Wayne State University

Design and analysis of complex systems, modeling and computer simulation, computer-aided minimally invasive surgery, applications of computer-based technologies to clinical and academic medicine

Jonathan Sprinkle

Associate Professor, PhD, Vanderbilt University

Autonomous vehicle technology, modeling, embedded systems and controls, systems engineering

Miklos N. Szilagyi

Professor, PhD, Leningrad Electrotechnical University

Complexity, agent-based simulation, n-person games, charged particle beams, optics

Ratchaneekorn “Kay” Thamvichai

Professor of Practice, PhD, University of Colorado, Boulder

Digital signal processing, communications, digital design, embedded system design

Hal S. Tharp

Associate Professor, Associate Department Head, PhD, University of Illinois, Urbana-Champaign

Control theory

Bane Vasic

Professor, PhD, University of Nis, Serbia

Coding theory, information theory, digital communications, memory and storage systems

Hao Xin

Professor, PhD, MIT

Microwave/millimeter wave/THz devices, circuits, antennas and their applications in wireless communication and sensing systems

Richard W. Ziolkowski

Professor, PhD, University of Illinois, Urbana-Champaign

Metamaterials, antennas, multi-physics, nanophotonics, scattering
As more and more organizations realize the benefits of cloud computing — reduced hardware costs, increased bandwidth, and anywhere, anytime access to data, for example — engineers are tasked with developing technology to more effectively manage resources in the cloud.

One hurdle in cloud computing involves balancing power consumption and performance. As such, UA electrical and computer engineering graduate student Farah Fargo, in collaboration with ECE professor Salim Hariri and other graduate students, has introduced a real-time monitoring system that enables server hosts to dramatically reduce power consumption while maintaining quality of service.

The “Autonomic Cloud Management System” research earned Fargo a Best Research Poster award at the 2014 IEEE International Cloud and Autonomic Computing Conference in London. Hariri also received an award for his leadership role in cloud computing research.

In the simplest terms, cloud computing means sharing a network of remote servers hosted on the Internet, rather than relying on local servers or personal devices, to store and access computing resources that range from applications to data centers. For everyday computer users, Google Drive, with its online applications and storage, is one example of a cloud service.

It takes energy — lots of it — to power the mega-data centers that serve up cloud resources. By some accounts cloud data centers consumed an estimated 91 billion kilowatt-hours of electricity in 2013, enough to power all the households in New York City twice over.

At peak usage times, more servers are needed to effectively meet demand. But when cloud usage is low, the extra servers still consume energy while sitting idly waiting for the next peak period.

The system provides real-time feedback about the cloud workload — number of users performing what tasks — at any given time and assigns available cloud resources on an as-needed basis. Rather than power extra servers in anticipation of increased workload, the system provides just enough server space to host what is needed in any given second.

“Over-provisioning techniques are typically used for meeting the peak workloads,” Fargo explained. “In comparison, our technique dynamically matches the application requirements with just enough system resources to meet the quality of service requirements for the cloud applications, which leads to a reduction in power consumption.”

(Above) ECE graduate student Farah Fargo (center), shown with a fellow researcher and professor Salim Hariri (right), received the Best Research Poster award at the 2014 IEEE International Cloud and Autonomic Computing Conference in London for her research in cloud computing and load-balancing systems.
UA undergraduate and graduate students interacted with more than 500 participants, including two Nobel Laureates, at the 39th annual International Conference on Infrared, Millimeter, and Terahertz Waves, held at the University of Arizona in September 2014.

Among the experts in science, technology, engineering and astronomy from 35 different countries were Nobel Laureates in physics John Mather and Serge Haroche, who received the prize in 2006 and 2012, respectively.

“We have been so lucky to hear from these Nobel Laureates, along with several others, who are truly advancing the work of infrared, millimeter and terahertz research,” said Hao Xin, UA electrical and computer engineering professor and conference general secretary. “We were honored to serve as a gathering spot for scientists around the world who are moving this technology forward.”

Areas that incorporate infrared, millimeter and terahertz wave technology range from medical imaging to personal computing to satellite communications.

Not only did UA College of Engineering students participate in the conference, but they also played a critical role in hosting it. More than 40 undergraduate and graduate student volunteers, the bulk of whom were UA students, helped run the conference — from planning activities and events to setting up presentations.

“These volunteers worked closely with giants in engineering and science, and that will inspire the students to contribute to the engineering community in even greater ways,” said Xin.

UA ECE graduate student Xiaoju (Daisy) Yu said volunteering allowed her the opportunity to attend the conference.

“It’s great for students to volunteer because they can attend the conference for free and become more familiar with current research while exchanging ideas with top researchers,” she said.
Engineering students from all three Arizona public universities gathered in October 2014 to put their antenna knowledge to the test. Twenty-two students from the University of Arizona, Northern Arizona University and Arizona State University attended the 2014 Antenna Measurement Techniques Association, or AMTA, Meeting and Symposium, held in October 2014 in Tucson.

The annual conference highlights the latest technology and research in antennas and electromagnetic measurement technologies. AMTA Student Day gives college students a chance to interact with industry experts and learn more about careers in the field.

“The reality is, there are quite a few jobs in this field,” said Lydell Frasch, past president of AMTA. “Many companies have a hard time finding young, qualified students to connect with, and Student Day allows students a chance to speak with these companies who are looking for bright minds.”

Students toured vendor exhibits, sat in on paper presentations, did hands-on antenna design activities and participated in social events.

Ian Armstrong, a UA electrical and computer engineering graduate student, considered himself lucky to be one of the students at the conference.

“Student Day is a wonderful opportunity to meet other students with the same interests and identify companies that need engineers with a passion for antenna design,” said Armstrong.

For ECE graduate student Arghya Sain, the conference was an opportunity to apply theories learned in class to real-world scenarios.

“We learn about antenna theory in class, but we rarely get to see the instruments used to perform antenna measurements in the industry,” Sain said. “The complex machines that we saw in action at the conference were the product of different engineering disciplines and principles working in tandem, and this realization can inspire students to look beyond their field and take a holistic approach to engineering.”

Antenna engineering can be overwhelming for young engineers, said AMTA president Chi-Chih Chen, adding that Student Day helps demystify the field.

“Once students have seen how engineers solve problems in industry, they can see their field from a different perspective,” he said. “These students are our future. We need to pass on this knowledge to them.”

(Above) UA, ASU, and NAU students tour vendors at the J.W. Marriott Starr Pass Resort in Tucson and mingle with engineering professionals as they learn about the possibilities in antenna design.
In a dazzling turnout of talent and technology, more than 350 students showcased an enormous range of innovations at the 2014 UA College of Engineering Design Day. In an event that brought together multidisciplinary teams of student innovators, ECE student projects stood out as winning contributions.

Out of 64 projects displayed, nine teams with ECE student team members took home awards, totaling $6,400 in prize money. Awards included the Ventana Innovation in Engineering Award, the Universal Avionics Best Integration and Test Philosophy Award and the PADT Award for the Best Use of Prototyping.

Among the nine winning teams, projects ranged from designing a smartphone app that works as a hearing aid to developing an airplane cabin pressure rate sensor.

Top Performers
Take Home $6,400 in Design Day Prizes

Students from across the College of Engineering worked in multidisciplinary teams to solve design problems identified by industry partners, faculty and student clubs. ECE students were on nine of the winning teams. Projects ranged from designing a smartphone app that works as a hearing aid to developing an airplane cabin pressure rate sensor.

Role Reversal:
Graduating Students Applaud Faculty

ECE's pre-commencement ceremony is not just a chance to recognize graduating students. It is also a time to celebrate the professors who helped get them there.

ECE students awarded associate department head Hal Tharp and professor of practice Ratchaneekorn "Kay" Thamvichai the 2013-2014 ECE Teaching Award, which recognizes faculty who make a difference in students’ lives through mentoring, encouragement and support.

Tharp, who teaches courses at all levels, earned a PhD in electrical engineering from the University of Illinois in 1986 and joined ECE the following year. His research focuses on systems control theory.

Thamvichai earned a PhD in electrical engineering from the University of Colorado at Boulder in 2002 and joined ECE in Fall 2013. Her research interests include digital signal processing, communications and embedded systems design.
A electrical and computer engineering professors are switching things up to better engage students in large classes. And their efforts, part of a national program to improve STEM education, are paying off.

While lecture halls can accommodate the hundreds of students who take introductory classes, traditionally they do not encourage active student participation, which is key to improving science, technology, engineering and math, or STEM, education.

As part of a UA initiative supported by the Association of American Universities, College of Engineering faculty have revamped ECE175, a prerequisite for all ECE majors as well as a number of other Engineering majors. The new class structure incorporates more discussion, one-on-one help, hands-on activities and team projects.

“It is becoming more and more evident that students in all types of classes at all levels need interactive, hands-on learning for success.”
— LOUKAS LAZOS

Like in a “flipped classroom,” the restructured ECE175 emphasizes active student participation. Typically in a flipped classroom, lecture and homework elements are reversed. For example, students might watch a lecture online before the class, then use class time for exercises, projects and discussions. ECE175 still includes a lecture for teaching concepts, but instructors are incorporating more discussion, and a new required lab gives students opportunities to go over homework, get their questions answered, and practice coding.

“It’s not always easy to have an environment of interactivity during a lecture, but we are absolutely making it better,” Lazos said, adding, “The lab component is what translates into student understanding.”

The three-hour lab taught in a small class setting by graduate students and veteran ECE 175 undergraduates brings an added benefit — classmates can help one another.
EC professor Salim Hariri’s cyber-DNA technology — software that learns a user’s typical behaviors, detects abnormal usage and locks out intruders — is headed to market.

Just as hackers gain access to personal information by exploiting a user’s digital trail — programs used, sites visited and keystrokes, for example — Hariri’s software follows a user’s digital trail to protect personal information.

“We can’t protect something if we don’t know how it functions or operates,” said Hariri, who founded Avirtek, a cybersecurity company. “So we decided, why not look at the users, how they type and use the mouse, how many browsers they have open and how much memory they use?”

When the software spots unusual behavior, it asks the user a series of predetermined security questions. Incorrect answers result in the user’s system shutting down.

In addition to preventing individual accounts from being hacked, Hariri said, the new technology can keep large hacker groups from crashing servers. The software is being marketed for use in the medical and military fields, but could become available to consumers as Avirtek expands, he said.
Longtime Supporters
Endow Student Scholarships

Students in the University of Arizona department of electrical and computer engineering are learning the skills to solve problems in computing performance, cybersecurity, telemedicine, fiber optics and cloud computing. Many of them depend on the support of scholarships made possible by generous alumni and friends.

The department would like to extend a special thank you to Gene and Marylyn Tobey and to Paul and Linda Prazak, who recently established student scholarship funds.

Paul and Linda Prazak have established the Paul R. and Eva L. Prazak ECE Endowed Scholarship.

“Linda and I felt it was time to give back to the University and the community, and establishing an endowed ECE scholarship is one way to do this.” — PAUL PRAZAK

Marylyn graduated in the first four-year chemical engineering class at the UA. She had a varied career in the aerospace industry and was recently honored at a ChEE dinner as a pioneer woman in that field. Gene was a vice president of Burr-Brown Corp. and president and founder of Intelligent Instrumentation Inc.

The Tobeyes have said that they were the beneficiaries of private scholarships, during an era in which Arizona was far more supportive of its state universities. Recognizing the great value of their educations, they now want to help provide financial support for today’s College of Engineering students.

“People like the Tobeyes and Prazaks make a big difference in the lives of our students,” said Tamal Bose, ECE department head. “I really value their dedication to serving the University community.”

Gene (BSEE ’59 and MSEE ’61) and Marylyn Tobey (BSChE ’61) have set up the Gene E. and Marylyn Schumann Tobey Endowed Scholarship to benefit both ECE and ChEE students.

(Top Left) Paul and Linda Prazak at a ’60s party.
(Top Right) Gene and Marylyn Tobey.
$20M Agilent Software Donation Gives Students an Edge in Job Market

As part of Agilent’s Industry-Ready Student Certification Program, students are required to pass a radio frequency and microwave design course and lab, complete a required number of hours using Agilent software, and demonstrate aptitude in a final hands-on test.

Thanks to a $20 million design software donation from Agilent Technologies in fall 2013, UA Engineering students have a new tool to help get them certifiably ready for the work world.

As part of its radio frequency and Microwave Industry-Ready Student Certification Program, Agilent donated EEsof Electronic Design Automation, or EDA, software for UA students to download onto their personal computers.

“Experience with the software gives students an edge in the job market,” said Kathleen Melde, professor in the department of electrical and computer engineering, who regularly uses Agilent products in her labs and classes.

“Our goal is to prepare our students to be industry-ready, and this certification program helps students gain the recognition they need to stand out to employers,” she said. “This program makes our students more competitive, and eventually helps them get the jobs they want.”

The program identifies, acknowledges and rewards top students for meeting certain requirements that qualify them as industry-ready in RF, or radio frequency, and microwave fields. To participate in the program, universities must demonstrate the use of Agilent software and tools in the curriculum.

In November 2014, Agilent’s division that develops and sells electronic measurement products spun off as a new company, Keysight Technologies Inc.

Melde said she has been using Agilent products since she began teaching for the UA in 1996. She is a believer in hands-on learning and knows the importance of students mastering the use of industry-standard tools to stand out in a competitive job market.

“When you have a chance to implement what you learn in the classroom, it solidifies your knowledge,” Melde said. “If a student can leave here with a wide variety of skills, it ultimately gets them where they want to go. Agilent tools help us get the students where they want to be.”

Agilent is a longtime supporter of the College of Engineering and the electrical and computer engineering department.

“The University of Arizona represents the best of innovation, teaching and research,” said John Kikuchi, program manager with Keysight’s World Wide University.
Mark Pierpoint’s Student-Centered Support Keeps on Giving

Mark Pierpoint, vice president and general manager of software and modular solutions at Keysight Technologies, the recent spinoff of Agilent’s electronic measurement business, is making sure ECE students have the tools they need to succeed in the classroom and the work world.

The longtime ECE supporter oversaw a donation of $20 million in design software for UA students from Agilent Technologies in fall 2013 and recently arranged a $14,000 donation of electronic instrumentation.

“Mark Pierpoint is a great supporter of our department, and we recognize him as a fundamental part of this department’s growth,” said Tamal Bose, ECE department head. “Much of our students’ success is directly related to Mark’s continual support.”

Pierpoint also helped ECE implement the RF and Microwave Industry-Ready Student Certification Program, which identifies, acknowledges and rewards top students for meeting certain requirements that qualify them as industry-ready in RF, or radio frequency, and microwave fields.

“If we are to continue to improve our world, we need to develop the next generation of engineers and Keysight is helping in this through support of science, technology and math in K through 12 institutions as well as university education,” Pierpoint said. “We create our own future, and I believe that ECE will be central in helping address the challenges we face.”

Pierpoint, who earned his doctorate in microwave engineering and bachelor’s degree in electrical and electronic engineering from the University of Leeds in the U.K., serves on the ECE Industrial Advisory Board and the advisory board for the UA Broadband Wireless Access & Applications Center, a National Science Foundation center that collaborates with industry to create flexible, efficient and secure wireless networks.
Thank You for Your Gift

We gratefully acknowledge the support of the following sponsors.
July 1, 2013 – January 1, 2015

**Individuals**
- Ben L. Allinder
- Irfan Aziz
- Michael R. Barclay
- Tamal Bose
- William T. Corbin
- Kirk A. Damron
- Joann Demassa
- Hemant N. Dhulla
- Daniel A. Donegan
- Sun Edison
- Ren Egawa
- Jerry G. Fossum
- Emma J. Goodman
- Nancy Griffin-Jonovich
- Michael G. Herrick
- Wen Huang
- Hunt Family Trust
- Judith S. Johnson
- Howard L. Kennedy
- Lawrence K. Kentera
- Tao Liang
- Victor H. Ling
- Edwin & Cheryl Long
- Robert T. McBride
- Arve Michelsen
- Saul R. Mora
- Jimmy R. Naylor
- John A. Reagan
- Dilli P. Sharma
- Barbara Tizard
- Richard J. Vitales
- Electra M. Weyker

**Foundations**
- International Foundation for Telemetering
- Texas Instruments Foundation

**Corporations**
- Agilent Technologies
- Cisco Systems Inc.
- COHO Data Inc.
- EMC
- Indiana University
- Keysight Technologies
- Texas Instruments Inc.
- Tucson Electric Power Co.
- Xilinx Inc.
# ECE by the Numbers

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. News and World Report</td>
<td></td>
</tr>
<tr>
<td><strong>Electrical Engineering Graduate Program</strong></td>
<td></td>
</tr>
<tr>
<td>#34</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Graduate Students</strong></td>
<td>241</td>
</tr>
<tr>
<td><strong>Number of Undergraduate Students</strong></td>
<td>327</td>
</tr>
<tr>
<td><strong>Number of Core Faculty</strong></td>
<td>34</td>
</tr>
<tr>
<td><strong>IEEE Fellows</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Regents’ Professors</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>AIMBE Fellows</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Computer Engineering Graduate Program</strong></td>
<td></td>
</tr>
<tr>
<td>#39</td>
<td></td>
</tr>
<tr>
<td><strong>U.S. News and World Report</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Annual Research Expenditures</strong></td>
<td>$7 million</td>
</tr>
<tr>
<td><strong>OSA Fellows</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>University Distinguished Professors</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Percent of Faculty with Startup Companies</strong></td>
<td>25%</td>
</tr>
</tbody>
</table>