2017
Annual Magazine

Department of Electrical and Computer Engineering

THE UNIVERSITY OF ARIZONA
College of Engineering

2017
Annual Magazine

The University of Arizona
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The annual ECE magazine is published for alumni and friends of the University of Arizona Department of Electrical and Computer Engineering in the College of Engineering.

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Produced by Tiana Velez and the College of Engineering marketing team.

Designed by Dennis Rhodes.

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Taking the Department to the Next Level

The UA Department of Electrical and Computer Engineering continues to push the boundaries in education and research. Enrollment and faculty numbers are growing, new technology and startups are emerging, and students are more engaged than ever.

We are proud to introduce six new faculty members, which brings the number of ECE faculty to 33 and adds even more depth to our expertise in areas such as computer architecture, cybersecurity, wireless networks and artificial intelligence. We also say goodbye to two longtime faculty members: Ahmed Louri, who left to serve as ECE department chair at George Washington University, and Mark Neifeld, who is working as a consultant. We are fortunate to have benefited from their accomplishments over the last 20 years.

More than a quarter of our faculty are operating startups and moving their inventions to market. Students are also in the entrepreneurial spirit. In fact, ECE was the first UA Engineering department with a select group of students who exchanged their senior design projects for an entrepreneurial stint in the Eller College of Management. In this competitive yearlong program, undergraduates work with students from other majors to build businesses and commercialize their research.

At 412 declared undergraduate majors and 286 graduate students, enrollment continues to rise as students participate in relevant research and active learning. Many courses have embraced interactive learning. Under the leadership of Roman Lysecky, ECE is one of the few engineering programs in the country to integrate interactive textbooks featuring a less-text-more-action classroom approach. In addition, ECE is offering a 100-percent online master's program.

Research in uncharted territories is changing lives for the better. For example, Janet Roveda's STEM learning study on sleep habits is the largest-ever national project of its kind involving elementary school students, and Jerzy Rozenblit's $1.9 million grant for a surgery training device is providing a better grasp of noninvasive surgical techniques to reduce errors. We are advancing technology while educating a new generation of students to continue the ECE legacy.

Thank you for your continued support!

Tamal Bose, Department Head

ECE by the Numbers

NUMBER OF GRADUATE STUDENTS
286

NUMBER OF CORE FACULTY
33

NUMBER OF UNDERGRADUATE STUDENTS
412
DECLARED MAJORS

ANNUAL RESEARCH EXPENDITURES
$7
MILLION

IEEE FELLOWS
5

RESEARCH CENTERS
3

PATENTS ISSUED (2015 – 2016)
9

OPERATIONAL STARTUP COMPANIES
12

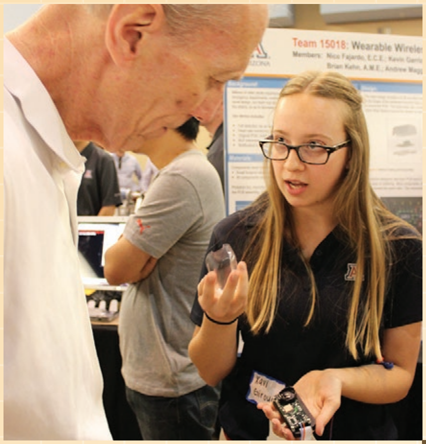
INTERNATIONAL STUDENTS
32%

COUNTRIES REPRESENTED
29

MINORITY STUDENTS*
30%

*Students who identify as belonging to one or more of the following ethnic groups: Black/African American, Hispanic/Latino, Asian/Pacific Islander, American Indian/Alaska Native

Design Day and **Student Interface Awards**



ECE SENIORS BOOST DESIGN TEAMS

At Design Day 2016, ECE students on 13 teams took home some big awards, including those for first- and second-place overall design.

Left: Xaviere Giroud explains her team's project to an attendee. The ECE-sponsored team won the Prototron Circuits Best Printed Circuit Design Award.

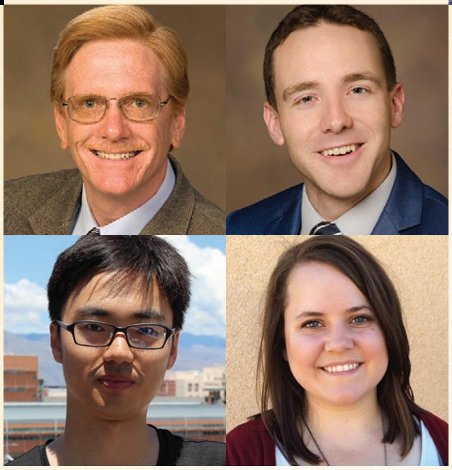
FACULTY AND STAFF HELP STUDENTS BUILD COMMUNITY

The annual Student Interface Awards for Excellence recognize ECE faculty, staff and teaching assistants who support our students by making them feel they are an essential and valued part of the University community.

2015-2016 AWARD WINNERS

(Right, clockwise, from top left)

Senior Faculty: Michael Marcellin
Junior Faculty: Garrett Vanhoy
Staff Award: Sydney Donaldson
TA Award: Shengxiang (Troy) Zhu



IEEE HONORS IOTA XI

IEEE-Eta Kappa Nu's UA Chapter, Iota Xi, was named one of 22 IEEE-HKN Outstanding Chapters by the organization's board of governors. Chapters are honored for their community service and student outreach, including organizing tech talks, peer mentoring, participating in educational fairs and helping younger students and robotics clubs. Additional consideration is given to how well each chapter raises instructional and institutional standards, and encourages scholarship and creativity. ECE associate professor and associate department head Hal Tharp is Iota Xi's faculty adviser.

Above: A few members of IEEE-Eta Kappa Nu, Iota Xi, pose with their chapter award. Courtesy of Hal Tharp.

Each semester, the College of Engineering honors outstanding undergraduate and graduate students nominated by professors and department heads. In spring 2016 a separate category for teaching assistants was added.

In order, from left to right:

Nicolas Fajardo (Spring 2016)
Outstanding Senior
Nicolas was an undergraduate lab assistant and active in a number of organizations, including IEEE-Eta Kappa Nu, Aerial Robotics Club and the Badminton Sports Club, for which he also served as president. Nicolas began his career at IBM as a characterization engineer after graduation.

Min Liang (Spring 2016)
Outstanding Graduate Student
Min's academic interest is in electromagnetics, with a focus on high-frequency electronic areas. In 2012 Min won the IEEE Antennas and Propagation Society PhD Research Award. As of this printing, he has published one book chapter, nine journal papers and more than 30 conference papers.

Nengyun Zhang (Spring 2016)
Outstanding Teaching Assistant
Nengyun is the TA for two courses – Numeric Modeling of Physics and Biological Systems and Computational Techniques. His research focuses on machine learning applications, including image feature extraction and recognition, and he is co-authoring a paper for a peer-reviewed journal.

Arghya Sain (Fall 2015)
Outstanding Graduate Student
Arghya was a research assistant in the High Frequency Packaging and Antenna Design Lab, and co-author of "Broadband Characterization of Coplanar Waveguide Interconnects with Rough Conductor Surfaces" with professor Kathleen Melde, which was published in IEEE Transactions on Components, Packaging and Manufacturing Technology.

Jerrie Fairbanks (Spring 2015)
Outstanding Graduate Student
Jerrie's research includes the development of a real-time, time-resolved detection system for light measurements on biological problems and compressive sensing for medical imaging. In fall 2011 he served as a teaching assistant for ECE 207: Electrical Engineering Elements.

Rachel Powers (Spring 2015)
Outstanding Senior
Rachel was an active member of IEEE-Eta Kappa Nu, also serving as its chapter president. While at the UA, she worked as a supplemental lab coordinator and sound monitoring system project lead, and later worked with Hal Tharp and Jonathan Sprinkle on control systems and the Cognitive and Autonomous Test (CAT) vehicle.

Matthew Watson (Fall 2015)
Outstanding Senior
Matthew is a master's student in ECE. As an undergraduate he worked as a research assistant in the College of Optical Sciences, and co-authored the publication "A High-NA Solid Immersion Objective for Imaging a Blu-Ray Disc and Investigating Subsurface Damage." He has interned at Intel, Raytheon and Rincon Research Corp.

Research Discovery Brings Invisibility Closer to Reality

Hao Xin has overcome a major research hurdle in the race to build invisibility cloaks and other fantastical devices.

Since the beginning of recorded time, humans have used materials found in nature to improve their lot. Since the turn of this century, scientists have studied metamaterials, artificial materials engineered to bend electromagnetic, acoustic and other types of waves in ways not possible in nature.

Now, Hao Xin, a professor of electrical and computer engineering at the University of Arizona, has made a discovery with these synthetic materials that may bring engineers one step closer to building microscopes with superlenses that see molecular-level details, or shields that conceal military airplanes and even people.

Xin and his co-authors reported their findings in the online journal Nature Communications in an article titled "Microwave Gain Medium with Negative Refractive Index."

SOLVING A VEXING DESIGN PROBLEM

In the UA's Millimeter Wave Circuits and Antennas Laboratory, Xin uses a 3-D printer to make metamaterials from metals, plastics and other substances. Resembling porous plastic bowling balls and tiny copper wire circuit boards, these objects are configured in precise geometrical patterns to bend waves of energy in unnatural ways. In particular, they exhibit a property called negative refraction, meaning they can bend a wave backwards.

Hao Xin
Professor

Through a prism with negative refraction, a straw leaning in a glass of water would appear inverted: the piece above the water's surface would appear below the water and leaning in the opposition direction.

In a more futuristic scenario, someone looking at a person wearing a cloak with artificially designed refraction properties would see part or none of the person, depending on the cloak's refractive index distribution and whether the light bouncing off of it reached the viewer's eye.

Xin studies how metamaterials affect microwaves. But whether studying microwaves, light waves, sound waves or seismic waves, metamaterials with negative refraction have presented a vexing physics problem for engineers: They reduce the strength of the wave.

"One of the biggest problems with metamaterials is that they produce energy loss," Xin said. "The waves decay as they pass through the artificial material. We have designed a metamaterial that retains negative refraction but does not diminish energy."

In fact, the synthetic material not only prevented energy loss – it actually caused energy gain, with the microwave intensifying in strength as it passed through the material. Xin achieved this by embedding simple battery-powered tunnel diodes (a type of semiconductor device) and micronanofabrication technologies into the new material.

"Many people did not think it was possible to achieve energy gain along with negative refraction," Xin said.

He first showed it was possible, with one-dimensional metamaterials, in a paper published in Physical Review Letters in 2011. His new findings have broader implications because they involve 3-D metamaterials. The research is funded by the Air Force Office of Scientific Research, or AFOSR. Xin presented his findings in November 2014 at Duke University to scientists with the Tri-Service Metamaterials Program, which promotes collaboration between government, industry and academia to advance metamaterials research and development for the Department of Defense. Xin, whose research projects also include using breast cancer imaging techniques to detect explosives, conducts his AFOSR-funded metamaterials research with doctoral students in the Millimeter Wave Circuits and Antennas Lab.

BROAD APPLICATIONS

While Xin works with microwave frequencies, his findings have implications for optical, acoustic and many other types of radiation. Metamaterials with both negative refraction and energy gain properties will help engineers tackle problems of lens diffraction that prevent even the most sophisticated microscopes from probing some extremely tiny materials, including many individual proteins and viruses.

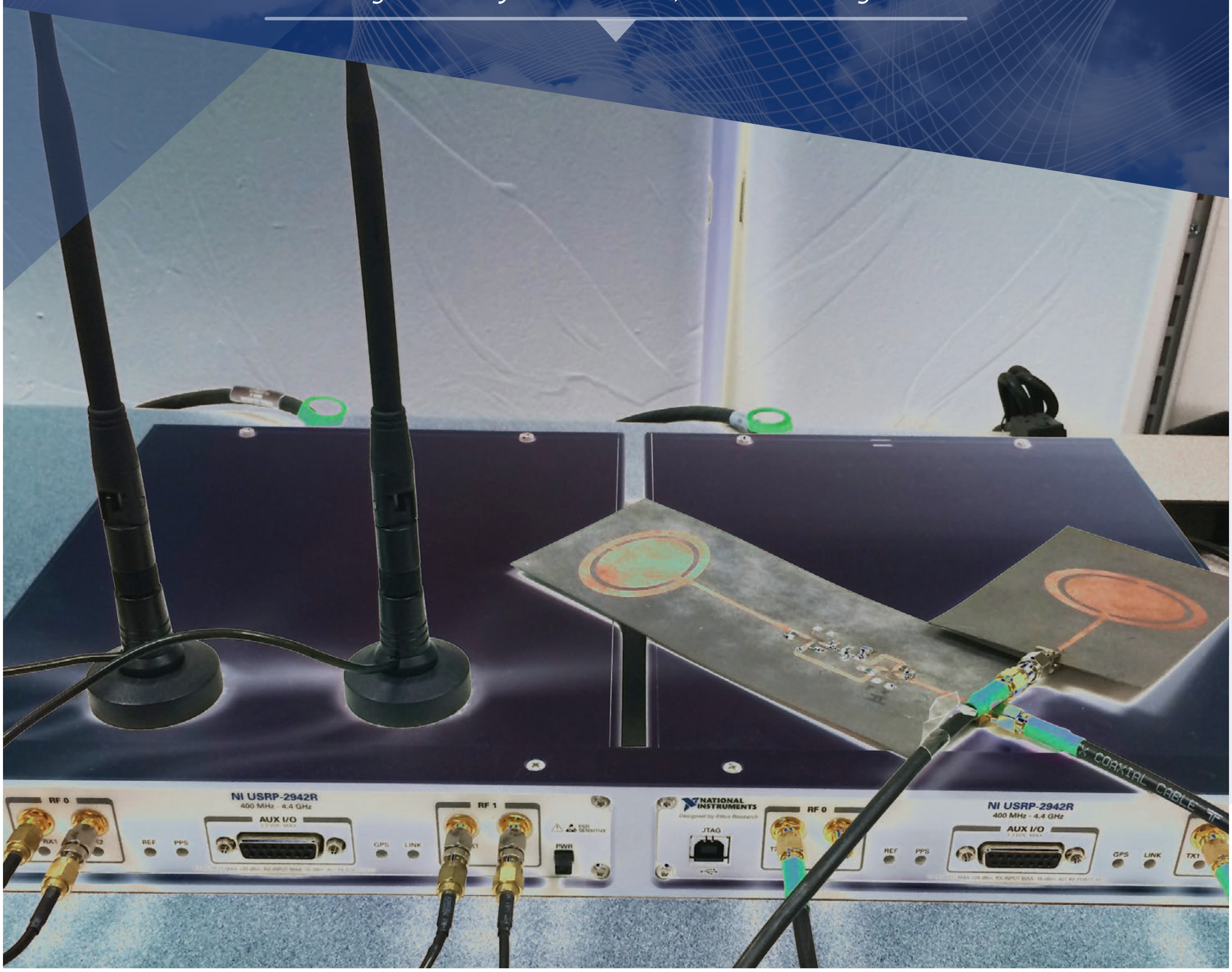
Beyond such superlenses for biomedical and other uses, metamaterials are being studied to produce higher-performance microwave circuits, more energy-efficient and earthquake-resistant buildings, more powerful solar power converters, improved sensor technologies, and ever-smaller antennas that will make wireless devices used for everything from health monitoring to military surveillance more flexible, efficient and practical.

Metamaterials remain in the testing phase. Xin said it will be years before potential fantastical applications like invisibility cloaks actually appear on the market.

But his research is inherently practical, he said, predicting: "Invisibility cloaks will be a reality in my lifetime."

Tackling Wireless Scarcity and **Security**

Building new ways to connect, then securing them.



Marwan Krunz

Professor

Envision a world without lost signals or time-consuming searches for Wi-Fi connections. Marwan Krunz, a professor in the UA departments of electrical and computer engineering and computer science, is working to shift how we structure wireless systems and make anytime-anywhere connectivity a reality.

The surge in Wi-Fi-enabled devices has been a boon for society but a strain on the limited wireless spectrum that provides the frequencies they use. Many of the frequencies are fixed, having been allocated exclusively for radio, television, military, mobile and other operators.

Krunz's solution to the lack of available frequencies is dynamic spectrum access, or DSA.

DSA classifies users of a frequency as either primary or secondary – those specifically assigned to the frequency, and those hoping to use it, respectively – and encourages sharing between the two. Primary users get priority. When they're not using the frequency, secondary users get the opportunity to temporarily access it.

"There are a lot of users, but it's not well utilized," explained Krunz. "Wireless usage fluctuates depending on the time of day and location – for example, at night or in rural areas."

Successful DSA adoption goes beyond access and requires creating and securing a single device that can operate seamlessly on multiple frequencies, often simultaneously.

"Conventional antennas only work within a set frequency. If you try to adapt one to work with multiple frequencies, the end result is a device that is either very large, which doesn't work for mobile use, or which doesn't work at all," said professor Hao Xin.

With funding from the National Science Foundation, Xin and Krunz are co-creating a handheld cognitive radio with two antennas capable of working across frequencies from 470 MHz to 4.4 GHz.

Explained Krunz: "The device would locate and hop on an available frequency without the users ever seeing or noticing it. It would sense an open channel and use it for a short period of time while keeping an eye out for other open channels. When the primary user wanted their channel back, it would hop to one of those open channels."

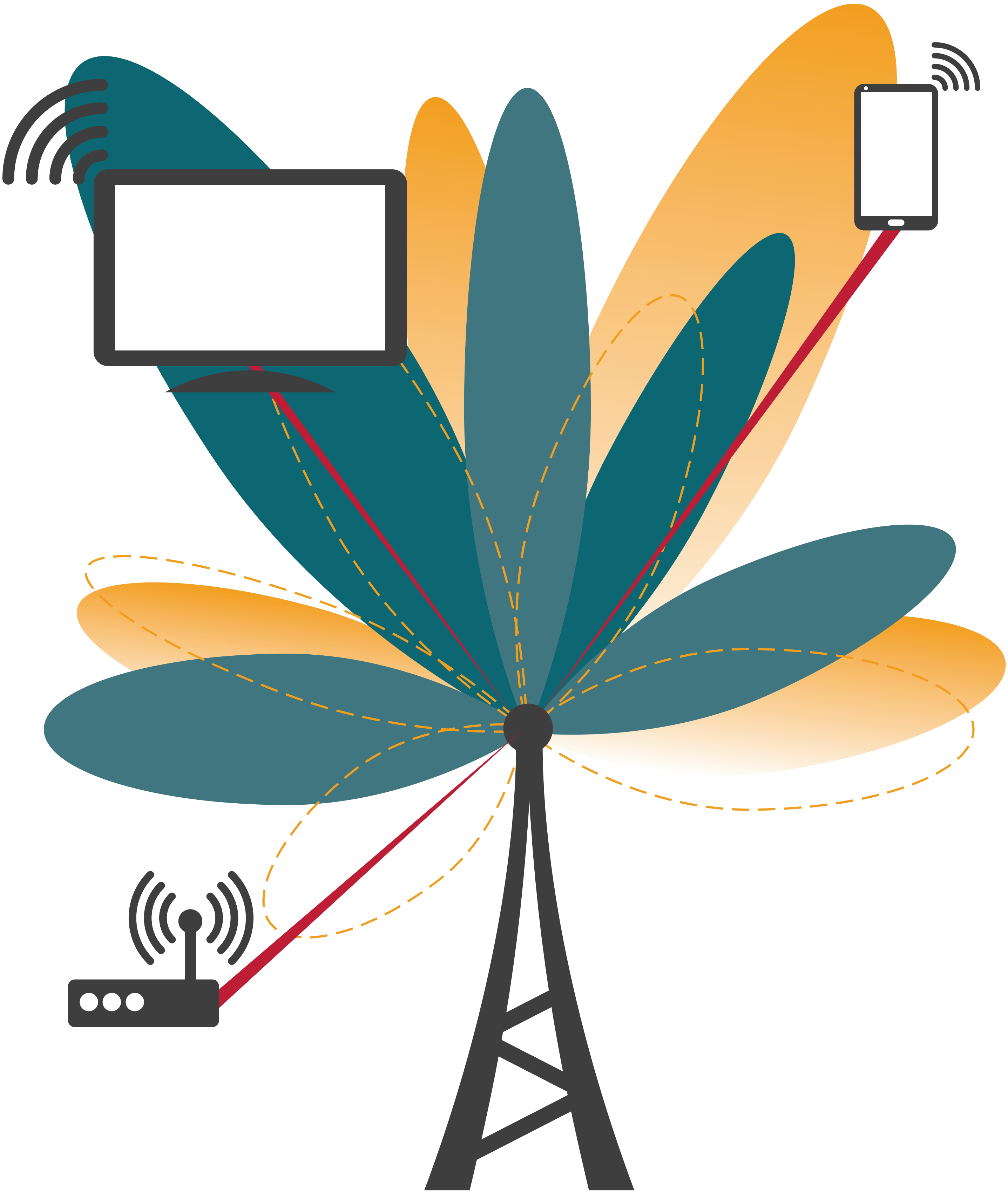
SECURING THE AIRWAVES

Krunz's eagerness to improve Wi-Fi access is tempered by the knowledge that a broadened network will require even more security.

Wireless transmissions broadcast in all directions, making them especially vulnerable to eavesdropping, a means of intercepting Wi-Fi signals to capture online fingerprints or signatures. Armed with transmission signatures, which includes contextual data such as websites users are visiting and even their physical locations, eavesdroppers can disguise their own identities and go on to steal personal information.

Using software and new methods to create signature-free wireless transmissions, Krunz is collaborating with associate professor Loukas Lazos, who specializes in cybersecurity, and several graduate students to thwart eavesdroppers. The researchers are developing transmitter-receiver-friendly jamming, whereby artificial noise that only authorized parties can recognize, and ignore, is injected into wireless transmissions; and beamforming, which enables a device to define where its signal can be received, preventing it from being captured elsewhere.

It's a whole new Wi-Fi world out there.



Using Smart Antennas to **Smooth out** and **Speed up Connectivity**

Associate Professor Ming Li is among the newest to the department (see page 26), and his research is fast gaining acclaim. In early 2016 Li became the first UA faculty member since 2010 to be selected for the highly competitive Office of Naval Research Young Investigator Program, or YIP.

As a Young Investigator, Li received a three-year research grant of up to $510,000 to develop an algorithm that adapts reconfigurable antennas to work with multihop wireless networks, resulting in improved overall transmission capacity and speed, reduced chances of lost data, and limited reliance on costly infrastructure.

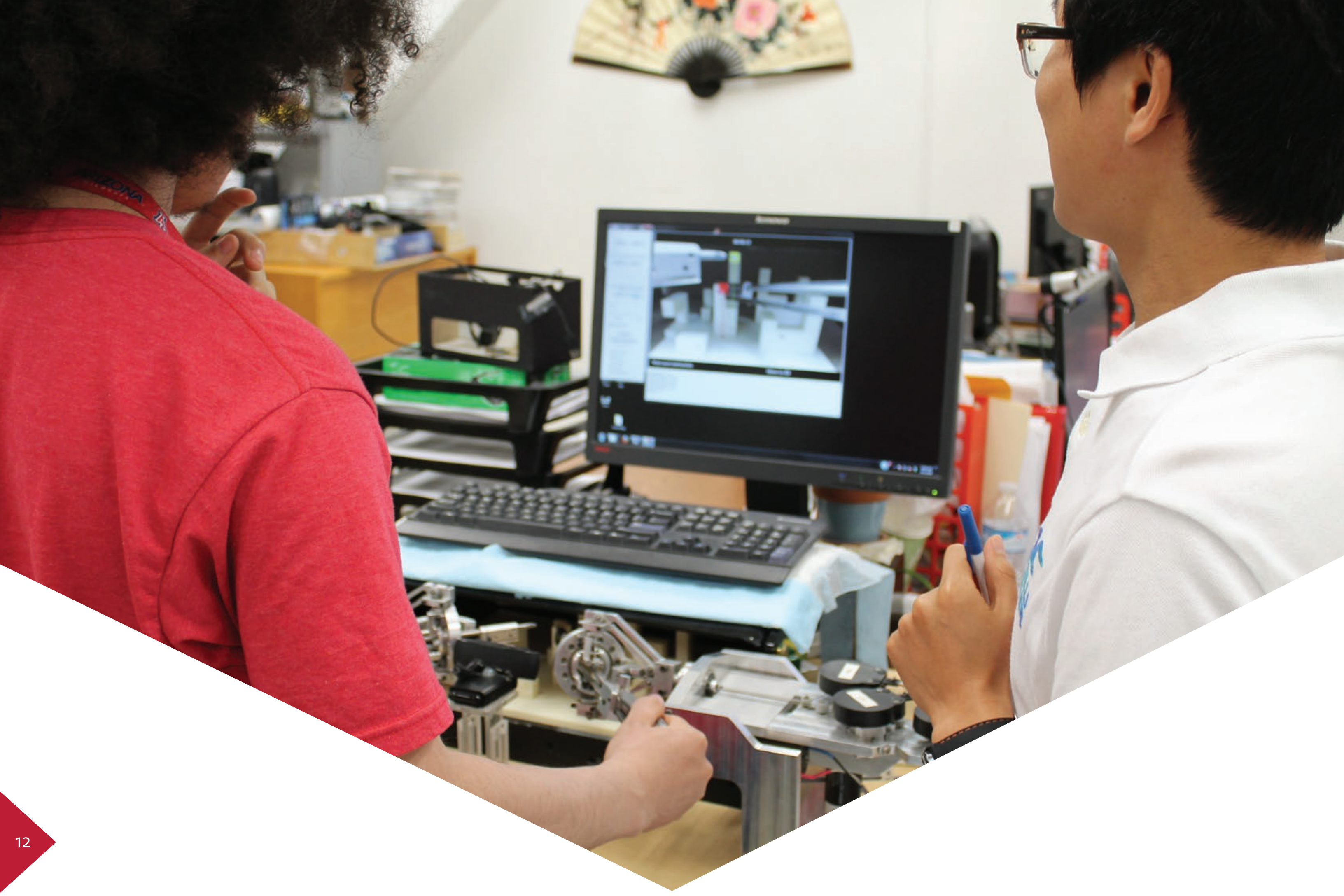
Reconfigurable antennas aren't new, but past research mostly focused on their use with single-hop networks involving one-to-one direct connections. In a multihop wireless network, or MWN, data travels through a series of connection points – modems, routers, servers or satellites – hopping from one link to another until it reaches its destination.

MWNs are frequently used in military operations because of their security and range, but their locations in sometimes remote areas of the world often strain network capabilities. Like traditional wireless networks, MWNs are susceptible to interference, and with more links for the data to hop through, there's more potential for transmission delays and signal loss along the way.

Li's algorithm is expected to boost an MWN's ability to send data quickly and reliably without congested signals. Further, the small size of the reconfigurable antenna lends itself to portability, making network setup more efficient and cost-effective than with larger antennas.

"With a multihop network and a reconfigurable antenna, we could set up a network quickly with little money and without the need to build fixed infrastructure like a radio tower," explained Li. Using this system, "we could, for example, monitor the health of multiple soldiers in the field using sensors on their uniforms to transmit biomedical data back to a home base in real time."

Ming Li
Associate Professor



Giving Surgeons a **Guiding Hand**

Simulation device will train surgeons to perform minimally invasive surgery with advanced depth perception.

Guidance systems, similar to those used by rearview cameras, could make learning to perform robotic surgery as simple as backing up a car, and it's the basic idea behind University Distinguished Professor Jerzy Rozenblit's research.

The Raymond J. Oglethorpe Endowed Chair will travel to Poland for six months in 2017 as a Fulbright Senior Scholar to collaborate with researchers at Wroclaw University of Technology, where they will develop models and devices to train physicians in minimally invasive laparoscopic surgery.

"The researchers in Poland are strong in control systems, automation and robotics. They'll help with the image processing, and I'll get to shadow surgeons to gain additional insights into the clinical aspects of my research," said Rozenblit, who has a joint appointment in the UA department of surgery.

Used extensively for gynecological and urological procedures, robotic systems are becoming the norm for trickier surgeries involving the brain, neck and spine. Using the system, a surgeon controls the robotic arms and its surgical tools to create a small incision, insert a camera and view its images on operating room monitors.

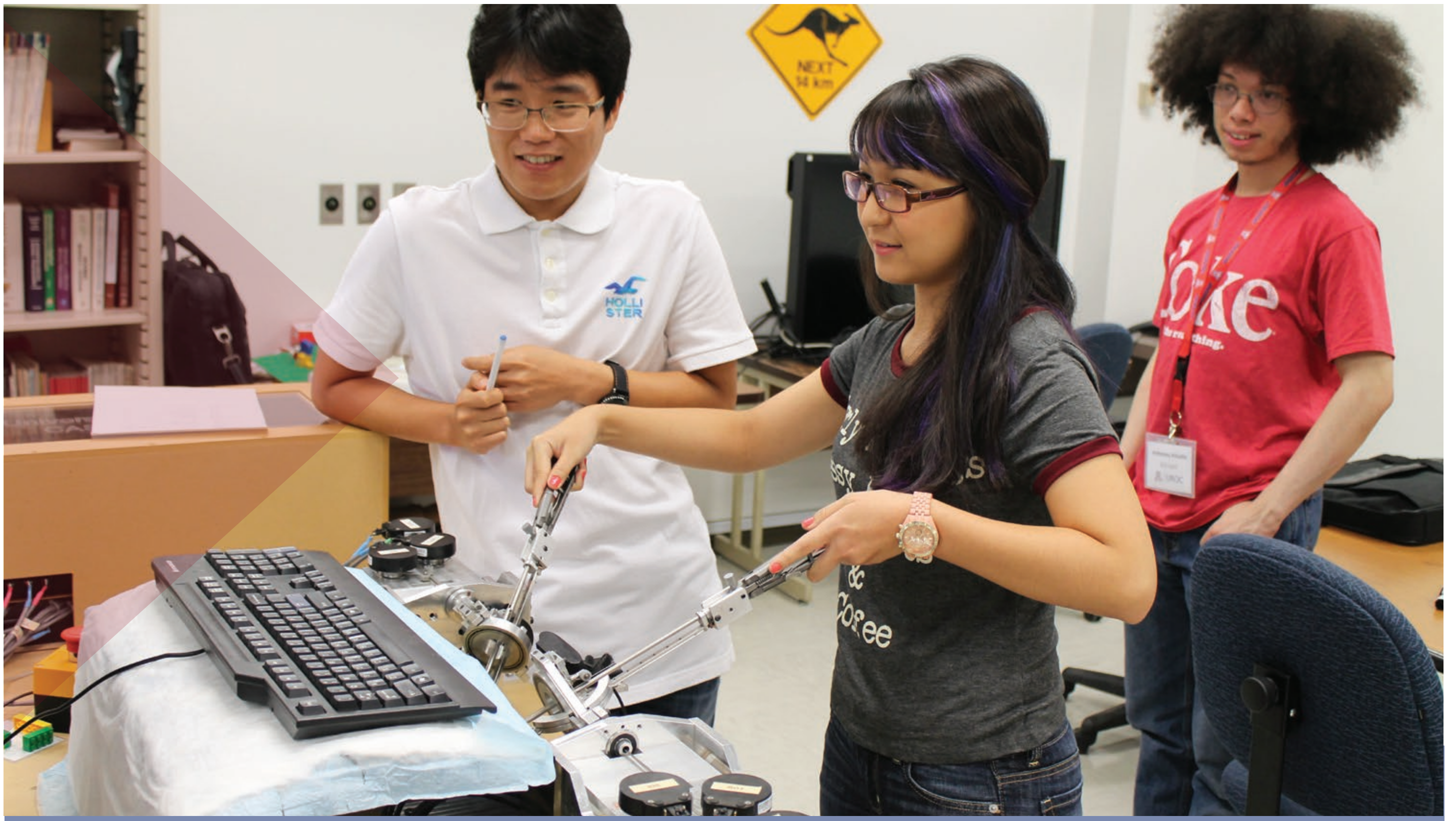
For all its advantages, robotic laparoscopic surgery has a serious limitation: loss of three-dimensional depth perception. The surgeon is guided only by the camera's onscreen images, and by extension, the robotic arms moving the tools inside the patient's body. Go too deep, or not deep enough, and serious damage could occur to a nerve, artery or other organ.

Jerzy W. Rozenblit
Distinguished Professor
Oglethorpe Endowed Chair

These are "life-critical computing systems," a term coined by Rozenblit. "If you mess up a payroll, it's annoying and inconvenient. If you mess up a surgery, we're talking about mistakes that are irreversible."

The use of robotic and laparoscopic surgical systems requires extensive training. Adding a guided simulation model to teach surgeons how to correct depth perception gradually can reduce errors in the operating room, Rozenblit explained.

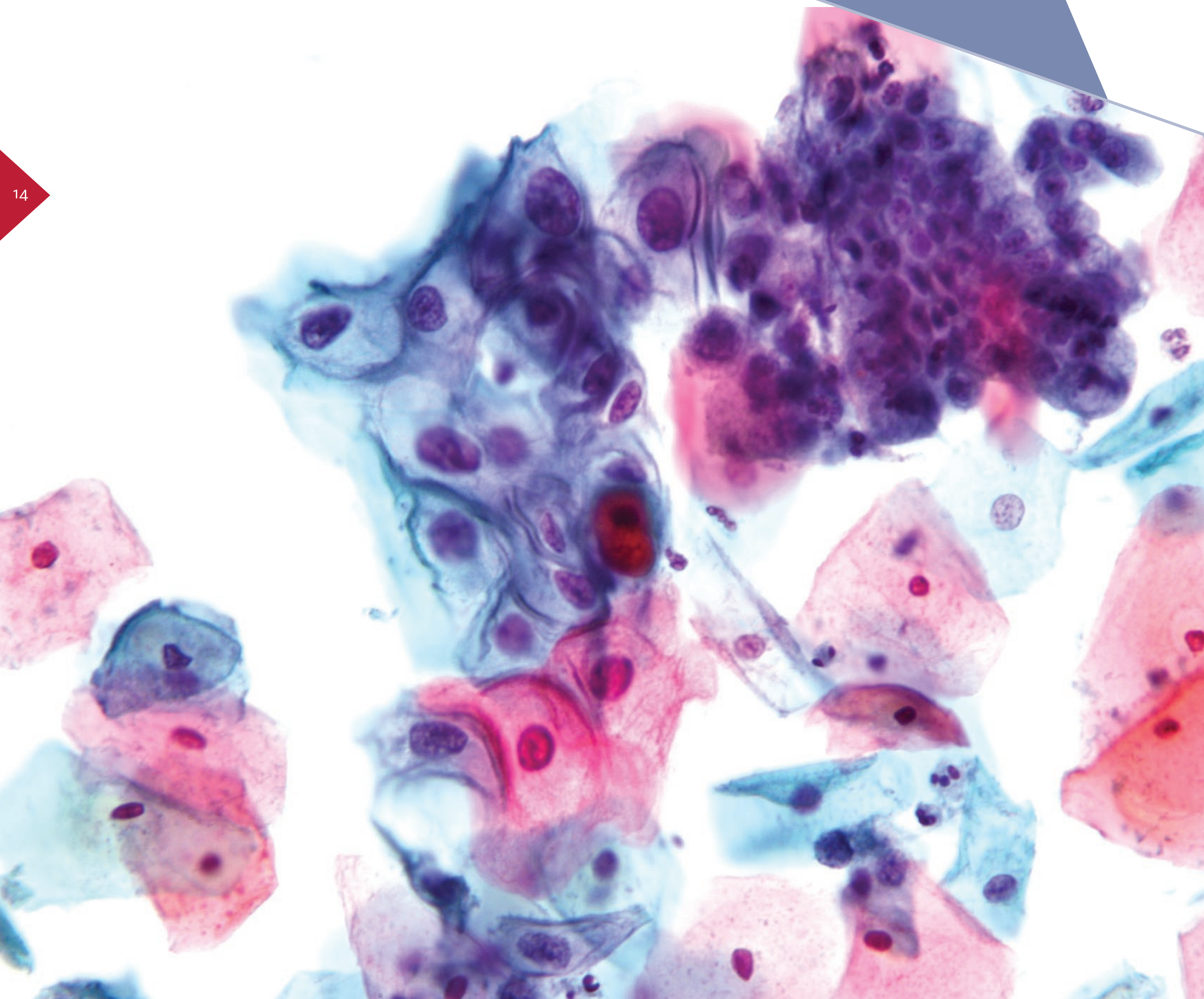
"We have a responsibility as scientists and engineers to ensure the technologies we create are reliable and safe. Such a system would offer unlimited training opportunities without sacrificing patient safety."



TOP LEFT: Western State Colorado University student Anthony Arkadie, in red, tests out the computer-assisted surgery training system developed by ECE Distinguished Professor Jerzy Rozenblit while graduate research assistant Minsik Hong observes. Arkadie attended the UA through a Research Experiences for Undergraduates program hosted by ECE Associate Professor Jonathan Sprinkle.

ABOVE *(from left to right)*: Graduate research assistant Minsik Hong, Clarisa Grijalva, and Anthony Arkadie from Western State Colorado University, experiment with the computer-assisted surgery training system developed by ECE Distinguished Professor Jerzy Rozenblit. Grijalva and Arkadie were summer participants in the Latin American Partnership Initiative and Research Experiences for Undergraduates (REU) programs, respectively.

Shrinking Digital Data for **Speedier Diagnoses**



Ali Bilgin
Associate Professor

Technology has made it easier to create high-quality digital images, but at a cost – huge file sizes. Big data becomes a big challenge when applied to health records or imaging results needed by health care workers in remote areas or with limited technological resources.

"We're in a global transition to digitize biomedical data, but there's a lot of it out there, and it's in files too large to be transmitted, stored or retrieved. Compressing this data is essential to speed diagnoses and save more lives," said Ali Bilgin, a University of Arizona associate professor in the departments of electrical and computer engineering and biomedical engineering.

Bilgin is the principal investigator on a $1.3 million project with the National Institutes of Health to develop open-source software that compresses medical slide images up to 100 times without losing detail or resolution. The resulting size will enable doctors, pathologists and other health care workers across the globe to access and analyze patients' digital files more easily, leading to quicker second opinions and diagnoses.

"Let's say a pathologist sees a large cluster of a certain cell type in their digital image. The software can display all digital pathology samples with a similar cellular feature," Bilgin said. "This has tremendous potential to improve our ability to quickly identify disease."

Perhaps most revolutionary, the software can customize the compressed images for specific tasks.

"A pathologist and a research scientist would have different goals in examining an image: one to check for signs of cancer, the other to identify the types of cancer cells," Bilgin explained. "Our technology will tailor the size and format of the digital image so neither receives extra data they don't need."

Michael Marcellin, a UA Regents' Professor in electrical and computer engineering and optical sciences, is co-investigator of the NIH-funded study. Marcellin was a major contributor to JPEG2000, the standard image-compression coding system used today and the one that is being used in Bilgin's biomedical image-compression research.

Other participating UA researchers include Elizabeth A. Krupinski, professor and vice chair of medical imaging and associate director of the Arizona Telemedicine Program, and Amit Ashok, assistant professor of optical sciences and electrical and computer engineering.

PHOTO: A magnified digital image shows the presence of a mild lesion commonly caused by human papillomavirus, or HPV, which is associated with cervical cancer. Credit: Nephron via Wikimedia Commons

Reimagining Textbooks for Interactive Learners

Roman Lysecky
Associate Professor

ECE associate professor Roman Lysecky is using a modern spin on an old classic – the textbook – to create a more interactive learning environment for undergraduates and improve student performance.

With the help of digital books developed by zyBooks, Lysecky is taking a less-text-more-action approach to lower-division STEM courses in electrical and computer engineering.

"Textbooks are less and less a student's go-to source of information, and maybe text isn't the ideal way to describe these topics," Lysecky said. "When you're teaching, you want to interact with students. You want to ask questions that lead them to think and come to correct answers. An interactive textbook with animations helps to describe technical concepts better."

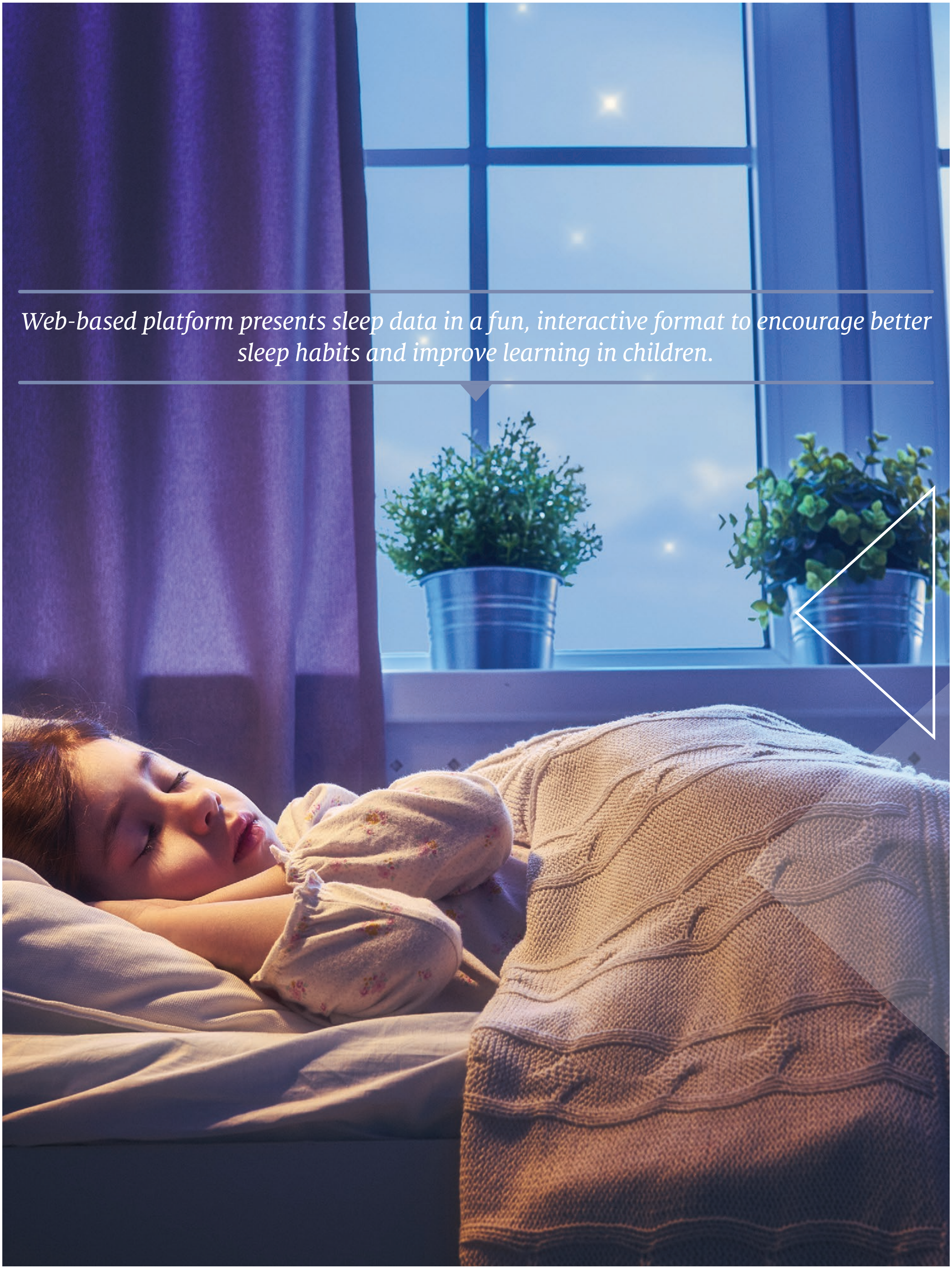
The University of Arizona is one of about 250 universities using zyBooks' interactive textbooks, and it's one of seven spearheading the Association of American Universities' five-year initiative to improve undergraduate STEM learning.

Lysecky, a project leader on the UA campus for the AAU STEM Initiative, says zyBooks textbooks, which cost a fraction of their old-school counterparts, represent the kind of learning experience students need and deserve.

"It's about helping students succeed in critical courses for their long-term success."

Research presented at the 2015 annual conference of the American Society for Engineering Education found zyBooks' learning material increased student performance by more than a quarter of a letter grade compared to traditional textbooks. It increased performance by more than a third of a letter grade for students in the lower quartile.

Since first using the books, Lysecky has become co-lead of zyBooks' authoring efforts and a zyBooks author himself, producing content for "Programming in C," "Programming in Java" and, most recently, "Data Structures Essentials."



Web-based platform presents sleep data in a fun, interactive format to encourage better sleep habits and improve learning in children.

Sleeping Toward STEM Success

Janet Meiling Roveda, professor of electrical and computer engineering, is a co-investigator in Z-Factor, a three-year, UA-led study that uses data gathered from elementary school students to develop an interactive curriculum around the topic of sleep. With more than 500 fourth- and fifth-graders expected to participate, it is the largest-ever national study linking sleep habits and STEM learning in elementary school students.

"We're trying to get kids engaged in STEM topics and rested enough to pursue them," Roveda explained, referring to the science, technology, engineering and mathematics fields. "In the process, we expect to educate children and parents about sleep's role in academic performance."

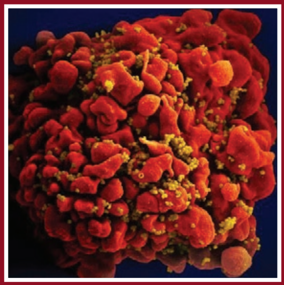
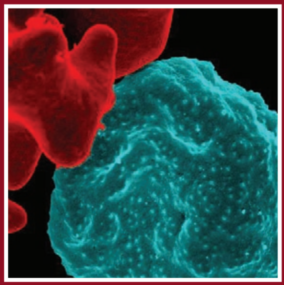
Data such as hours and quality of sleep, restlessness and other factors are monitored over a period of several nights by watch-like devices worn by the children, then entered into Roveda's web-based software program, MySleep. Finally, the data is converted into easy-to-understand charts and graphs, which students can use to create research projects. Teachers can incorporate MySleep results into lessons on math, statistics, averages, probabilities and other subjects.

"By studying their own sleep data and using mobile technologies for personal data management, these elementary school students are on a real-world research frontier," said Michelle Perfect, associate professor in the UA College of Education's department of disability and psychoeducational studies, and lead investigator on Z-Factor.

ECE professor Linda Powers and associate professor Wolfgang Fink, experts in large-scale biomedical research studies, assisted in the creation of MySleep.

Janet Meiling Roveda
Professor

Professor Linda Powers *(left)* and researchers measure the soil in Chile's Atacama Desert, searching for microbial life in the driest place on earth.

Disposable blood tests in development by professor Linda Powers' company, MicroBioSystems of Arizona, would detect a number of blood-borne diseases like HIV *(pictured left and center, infecting an H9 T-cell)*, hepatitis, and malaria *(pictured in blue at right, infecting a red blood cell).*

From Lab to **Market**

Professor Linda Powers' research takes her from the vast Arctic to the remote Atacama Desert, but the technology she develops is on a much smaller scale – micro, even.

The Thomas R. Brown Distinguished Chair in Bioengineering has created disposable blood tests for HIV, malaria and other diseases, as well as hand-held sensors that can detect, identify and quantify trace amounts of potentially dangerous microorganisms, even bioterrorism agents, on a variety of surfaces and in fluids.

Powers' instruments – distributed through her Tucson-based company, MicroBioSystems – alert authorities to the presence of contaminants in a number of environments, from hospitals rooms to water systems.

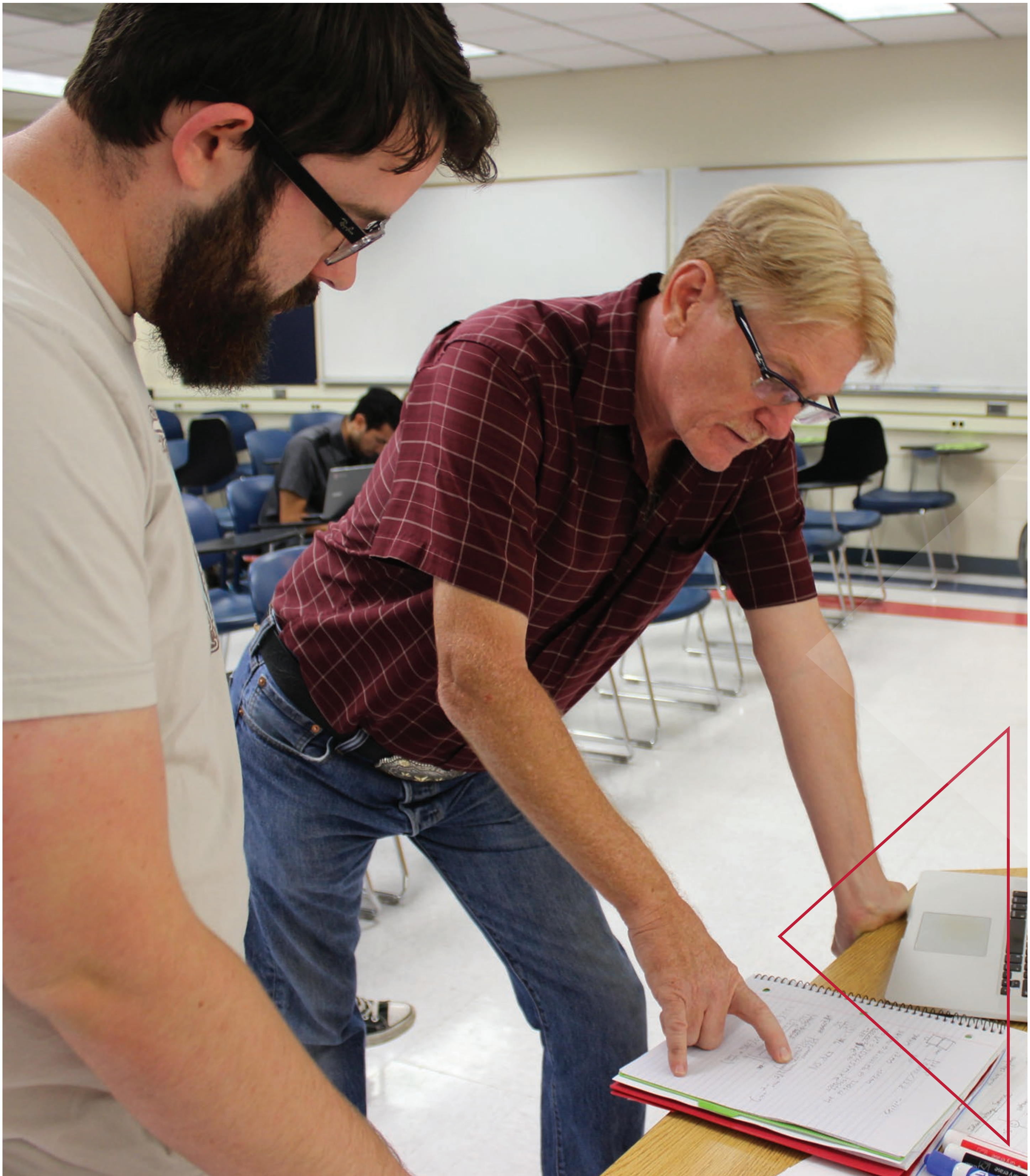
Tech Launch Arizona named Powers one of its 2015 honorees for entrepreneurship at the second annual I-Squared Awards for Innovation and Impact. The award also acknowledged her work with organizations supporting diversity among engineering students, faculty and professionals.

"This is a great moment for us to recognize those who are applying knowledge to today's major challenges and questions and giving voice to the importance of moving that knowledge out into the world," said UA President Ann Weaver Hart, who presented the awards.

Powers is one of several ECE professors who have turned research into commercially available technology, and her company is among a dozen faculty startups.

ECE STARTUPS

- Acomni LLC
- Avirtek
- Bioevidence Detection Systems
- Canyon View Diagnostics LLC
- Codelucida
- EpiSys Science Inc.
- MIAO IC Design LLC
- MicroBioMonitoring Systems LLC
- MicroBioSystems of Arizona LLC
- Ocotillo ElectroMagnetics Inc.
- Signal Dynamics
- Sonoran Analytical Instruments and Diagnostics



Luck and Leadership Define ‘Most Supportive’ Professor

Whether leading the creation of new image standard JPEG2000 or standing in front of a class, UA ECE professor Michael Marcellin revels in collaboration.

Dumb luck, said Michael Marcellin, led him to engineering. A look at his achievements and career path suggest otherwise.

Since 1988, the California native and electrician’s son has called Tucson home, serving as the University of Arizona International Foundation for Telemetering Professor and Regents’ Professor of electrical and computer engineering and optical sciences.

Marcellin gained world renown for leading the international team that created the second-generation image compression standard, JPEG2000. As a professor, he has earned numerous teaching awards – including most supportive senior ECE faculty member two years running.

One of his team members on the project was associate professor Ali Bilgin. Then a graduate student being advised by Marcellin, Bilgin is now the lead on a $1.3 million National Institutes of Health study to develop image compression and transmission software for medical pathology samples. Marcellin is his co-investigator.

“Professor Marcellin is the reason I chose to attend graduate school at UA,” said Bilgin. “I knew, as a PhD student, my choice of adviser was nearly as important as the institution. I chose UA to work with professor Marcellin. It was a great decision I have never regretted.”

These days Marcellin’s research interests are mostly in signal, image and video processing alongside communications, coding and information theory. His research continues to cross borders.

Every summer since 2010, Marcellin has traveled to Spain and the Autonomous University of Barcelona to continue research with professor Joan Serra-Sagristà in the area of LAN-SAT remote imaging. Using satellites, they’re photographing agricultural areas and monitoring crop growth. Assisting them are two postdoctoral and two graduate students.

“I do very little research on my own that doesn’t involve graduate students,” said Marcellin, whose students are in fact what keep him engaged in the field.

When not in class, Marcellin can often be found in his office meeting with students – answering questions, going over assignments or tests, or just talking science.

“I really enjoy teaching. It’s actually my favorite part of the job, especially working with undergraduate students; I think I have more impact,” he said. “I have a lot of great colleagues; I’ve had great students. There’s always room to make new contributions. I’m not stopping yet.”

Classroom Creativity Earns Associate Professor Top Grade

ECE associate department head Hal S. Tharp maintains a three-point teaching philosophy: be student-centered, continuously expand your skills, and share your ideas with others.

This trifecta approach has built Tharp's reputation as a highly distinguished faculty member known for his masterful and creative ways of reaching students. It's no wonder he was chosen for the 2016 University of Arizona Foundation Leicester and Kathryn Sherrill Creative Teaching Award.

"Dr. Tharp has helped not only me, but also many others by showing the value of education and leadership in engineering," said undergraduate Cinthya Tang, chair of the UA student chapter of the Institute of Electrical and Electronics Engineers, which Tharp advises. "He develops a genuine relationship with each of his students and strives to impart wisdom while continuing to be an understanding, caring and funny professor."

A favorite instructor, Tharp helps students succeed by lending his sense of humor and decades of experience to some of the most foundational subjects of electrical engineering, including circuit theory, control theory and microprocessor organization.

"Engineering principles can be a challenge to convey, and it can be easy for students and instructors to become frustrated and discouraged. Hal doesn't give up on himself or a situation, and he certainly doesn't give up on his students," said Jim Baygents, College of Engineering associate dean for academic affairs. "He believes his students will be successful – he seems to know this inherently, and so he diligently looks for ways to enable their success."

In addition to serving as the IEEE student chapter adviser for 20-plus years, Tharp advises the Micromouse Team, whose members have placed in national robotics competitions.

"Exhibiting a caring attitude helps create a welcoming classroom environment," he explained, "which is an essential ingredient as students engage with difficult and sometimes rather abstract engineering material."

Editorial note: La Monica Everett-Haynes of UA Communications contributed to this story.

Mark Neifeld Retires After 25-Year UA Career

In an era when professors are globetrotters, Mark Neifeld is a rarity. After completing undergraduate work at Georgia Tech and earning a doctorate from Caltech, Neifeld spent 25 years at the University of Arizona. He retired in August.

Neifeld held joint faculty appointments in ECE and optical sciences. He coauthored more than 120 journal articles and 250 conference papers, and was a two-term topical editor, and a three-time special issues guest editor, for Applied Optics. Neifeld also was named a fellow of OSA and SPIE and senior member of IEEE.

Here's a summary of three of Mark Neifeld's many accomplishments.

BOOSTING COMPUTING POWER WITH LIGHT

If you've ever edited a huge computer file, you've personally experienced the limits of digital electronic technology. Scale up to big-data tasks like weather prediction, and the slowdown problem is worse.

The solution may come from Neifeld's research in optical computing, which relies on light (photons) instead of electricity (electrons) to process information. Light is faster than the electric currents used in conventional computing.

Optics, Neifeld explains, allow for higher bandwidth and massive parallelism, or many processors working together to perform calculations and program instructions.

In 2014, Neifeld began leading a Department of Defense-funded multi-university team that's creating hybrid computer architectures with electronic and optical technologies. The goal of this ongoing project: Computers that can process more data at greater speeds.

DEFEATING HACKERS

Wherever there is encryption, there are hackers. Their nemesis may emerge from research conducted by Neifeld, ECE and optical sciences colleague Ivan Djordjevic, and faculty from the University of Illinois, Boston University and Duke University. In 2013, they began collaborating on a Navy-funded project that is still underway. It intends to bring quantum key distribution, or QKD, out of the laboratory and into military and commercial use.

QKD uses quantum mechanics to guarantee communication so secure that it is considered the gold standard. It enables two parties to automatically produce a shared random secret key known only to them, which can then be used to encrypt and decrypt messages sent over a standard communication channel.

PROVING EINSTEIN RIGHT

You've probably seen the cartoon with traffic cop Einstein saying, "186,000 miles per second. It's not just a good idea, it's the law."

That cartoon is actually referring to Einstein's Special Theory of Relativity. It states that, in a vacuum, no information can travel faster than the speed of light.

However, some experimental physicists have said they've caught light breaking that speed limit. And theoretical physicists proposed that while smooth pulses of light can appear to travel faster than light, they don't contain information.

Neifeld teamed up with Duke University physicists Michael D. Stenner and Daniel J. Gauthier for a series of experiments that proved Einstein right. The trio found that information can't travel faster than light and that smooth pulses are 100 percent information-free.

New Faculty Boost Research and **Academics**

Electrical and computer engineering students saw new faces in the classroom this past year as six new faculty joined the ECE team.

"We are proud to introduce six new professors to our outstanding group of existing faculty," said Tamal Bose, ECE department head. "These new faculty, who bring expertise in such areas as data mining, cybersecurity and wireless networks, will aid the ECE department in continuing to push the boundaries of technology."

Ming Li
Associate Professor
PhD, Worcester Polytechnic Institute

Tosiron Adegbija
Assistant Professor
PhD, University of Florida

Siyang Cao
Assistant Professor
PhD, Ohio State University

Gregory Ditzler
Assistant Professor
PhD, Drexel University

Ravi Tandon
Assistant Professor
PhD, University of Maryland

Garrett Vanhoy
Lecturer
MS, University of Arizona

WHAT ARE YOUR CURRENT RESEARCH INTERESTS?

Networks, information security, cybersecurity, and privacy, especially in communications

High-performance embedded computing, dynamic optimization, and designing adaptable architectures for technologies to remain useful over time

Radar, including electronic scanning, sensing waveform design, synthetic aperture radar, and MIMO radar systems

Machine learning, bioinformatics and data mining, particularly in applied comparative metagenomics

Information theory and its applications to wireless networks, communications, security and emerging areas like data mining and big-data analytics

Cognitive radio, software-defined radio, wireless communications, machine learning and digital signal processing

WHAT EXCITES YOU ABOUT TEACHING?

Teaching is a continuous learning process both for me and my students. There is a sense of fulfillment in watching students learn and grow.

The UA provides the opportunity to interact with students and faculty from a wide variety of backgrounds and experiences. This kind of diversity of perspective is a catalyst for growth.

I am passionate about passing on knowledge to students and helping them find their own interests and realize their potential.

I am passionate about research-based education. I remember getting really excited as a student when we would go from what we covered in class to analyzing recent research articles. I am excited to do the same for my students.

The ECE curriculum at the UA is among the best in the nation. In addition to a wide variety of core courses, students can take top-notch courses in new and emerging topics.

I'm excited to be a part of raising the next generation of makers by equipping them with a fundamental understanding of engineering principles, critical thinking skills, good character, and a solid mentality for solving the problems of the far future.

Read more about faculty backgrounds and current courses at ece.arizona.edu.

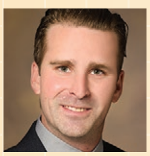

Tosiron Adegbija
Assistant Professor
PhD, University of Florida


Ali Akoglu
Associate Professor
PhD, Arizona State University


Ali Bilgin
Associate Professor
PhD, University of Arizona


Tamal Bose
Professor & Department Head
PhD, Southern Illinois University


Siyang Cao
Assistant Professor
PhD, Ohio State University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UA 1885 Distinguished Scholar &
Associate Professor
PhD, University of Nis, Serbia


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Professor
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PhD, University of Tübingen, Germany


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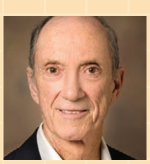
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Kenneth Von Behren Endowed Professor
PhD, Michigan State University


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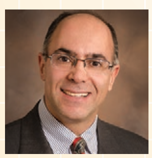
IFT Professor
PhD, Texas A&M University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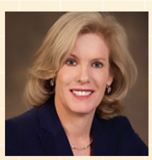
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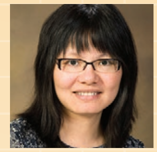
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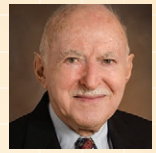
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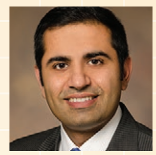
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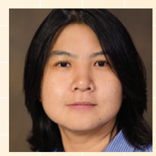
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Bane Vasic
Professor
PhD, University of Nis, Serbia


Hao Xin
Professor
PhD, MIT


Richard W. Ziolkowski
Leonis Distinguished Professor
PhD, University of Illinois

RESEARCH AREAS

Autonomous Systems and Robotics

Biomedical Technologies

Circuits, Microelectronics and Very-Large-Scale Integration

Communications, Coding and Information Theory

Computer Architecture and Cloud/Distributed Computing

Optics, Photonics and Terahertz Devices and Systems

Signal, Image and Video Processing

Software Engineering and Embedded Systems

Wireless Networking, Security and Systems

RESEARCH CENTERS AND INSTITUTES

Arizona Center for Integrative Modeling and Simulation

ACIMS is devoted to research and instruction that advance the use of modeling and simulation as means to integrate disparate partial solution elements into coherent global solutions to multi-disciplinary problems.

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Co-director: Bernard P. Zeigler
Co-director: Hessam Sarjoughian *(Arizona State University)*

BROADBAND WIRELESS ACCESS AND APPLICATIONS CENTER

BWAC researchers are developing technology and standards to create flexible, efficient, reliable and secure wireless access and application solutions to support the tremendous growth in wireless data traffic. BWAC is funded by the National Science Foundation and works with industry and academic partners to pursue large-scale research programs and create new visions for the wireless industry.

Director: Tamal Bose
Co-director: Marwan Krunz

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CAC is a National Science Foundation Industry and University Cooperative Research Center with a focus on the research and design of information systems and services that are self-managed with minimal involvement by users and administrators. The center broadly encompasses cloud computing systems and applications, including storage and networking, data center design, cybersecurity and systems software.

Co-director: Salim Hariri
Co-director: Ali Akoglu

BOOKS, MONOGRAPHS

- Djordjevic, Ivan: *Quantum Biological Information Theory*. Springer International Publishing, 2016.
- Kostuk, Raymond, *et al.*: *Holographic Applications in Solar-Energy-Conversion Processes*. SPIE Press, April 2016.
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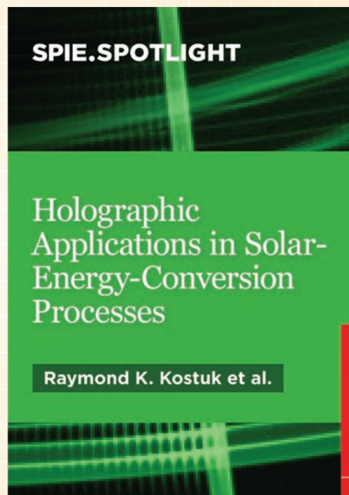

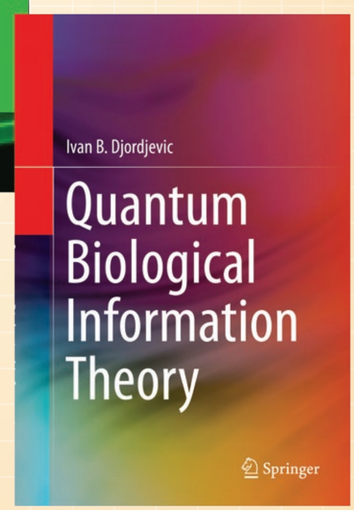

EDITORSHIPS AND PATENTS

Bilgin, Ali

Editorial Board, *IEEE Transactions on Computational Imaging*

Djordjevic, Ivan

Associate Editor, *International Journal of Optics*

Editor, *IEEE Communications Letters*

Editorial Board Member, *Frequenz: Journal of RF-Engineering and Telecommunications*

"*Rate adaptive irregular QC-LDPC codes from pairwise balanced designs for ultra-high-speed optical transports.*" Issued: June 14, 2016. Patent No. 9,367,387

"*Optimum signal constellation design and mapping for few-mode fiber based LDPC-coded CO-OFDM.*" Issued: December 1, 2015. Patent No. 9,203,555

"*Optical communication system, device and method employing advanced coding and high modulation order.*" Issued: December 1, 2015. Patent No. 9,203,544

"*Adaptive LDPC-coded multidimensional spatial-MIMO multiband generalized OFDM.*" Issued: November 24, 2015. Patent No. 9,197,249

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"*Nonbinary LDPC coded modulation without bandwidth expansion for high-speed optical transmission.*" Issued: October 20, 2015. Patent No. 9,166,728

"*Multidimensional coded-modulation for high-speed optical transport over few-mode fibers.*" Issued: July 28, 2015. Patent No. 9,094,125

"*Modified orthogonal polynomials based hybrid coded-modulation for multi-Tb/second optical transport.*" Issued: June 30, 2015. Patent No. 9,071,383

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Editorial Board, *International Journal of Prognostics and Health Management*

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INDUSTRIAL ADVISORY BOARD MEMBER PROFILE

Richard Scholes, MSEE 1996

ENGINEERING FELLOW
Raytheon Missile Systems

Q ***How did you come to be involved with the department as an advisory board member?***

When I was a department manager at Raytheon, I was invited by Tamal Bose – then ECE's newly appointed department head – to meet and discuss how to build upon the partnership we [Raytheon] had established with ECE and his predecessor. Among other things, we discussed STEM growth, joint research projects, and ways to improve graduate opportunities for Raytheon professionals.

Shortly after that first meeting, I joined the Industry Advisory Board, and I've enjoyed a great relationship.

Q ***How familiar were you with ECE prior to becoming an advisory board member?***

I received my masters in electrical and computer engineering from the UA while working for Hughes Aircraft Company. My tuition was covered by a Hughes fellowship, which enabled me to pursue a technical degree.

Q ***How would you describe your involvement with the department? Do you have any accomplishments of which you're especially proud?***

I can't take credit for all the improvements made since my initial meeting with Tamal, but I'm proud to have at least played a small part in influencing them. These include the online master's program and Raytheon's contingent of students who enroll with paid tuition and books. When my role at work changed, I introduced others at Raytheon who helped make many of these benefits happen.

I still meet regularly with ECE's administration, helping to strengthen the industry-academic relationship we share. We've learned a good deal about each other's needs, and it's been rewarding to pursue new ways to position the department for further growth.

Richard Scholes (BSEE 1993, Brigham Young University; MSEE 1996, University of Arizona) is an Engineering Fellow and a Raytheon Certified Architect. He supports new radio frequency, or RF, technology with internal research and development and new business applications for mission expansion. Scholes joined Hughes, now Raytheon, in 1994 and has supported radar system performance and signal processing in various technology roles and leadership positions in Tucson and across the Raytheon enterprise.

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