ECE NEWS

Spotlight

NC STATE Engineering

ISSUE FOCUS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING | COLLEGE OF ENGINEERING NORTH CAROLINA STATE UNIVERSITY 2015

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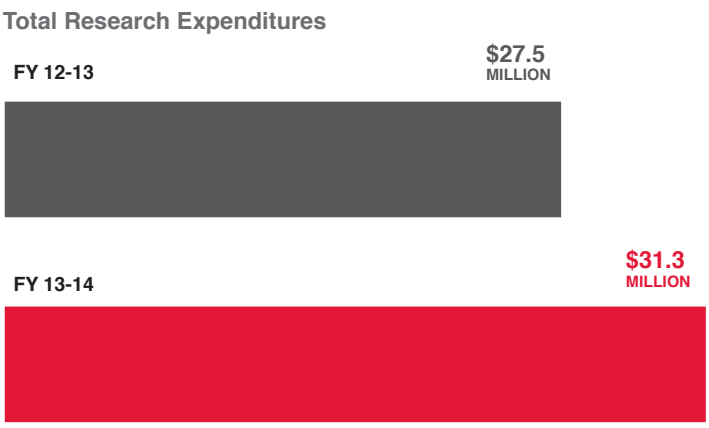
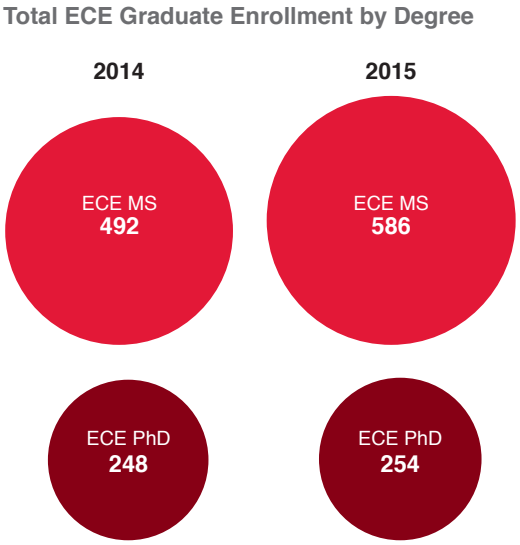
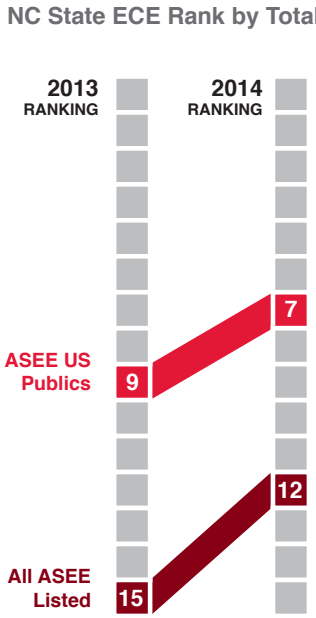






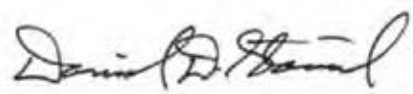
In previous issues of the ECE News Spotlight, I've dedicated this space to the evidence of exciting research and growth at NC State.

This frequently meant numbers, charts, and emphasizing metrics like our $31 million in total research expenditures as a lead-in to more numbers and articles that highlight our work and our team's accomplishments. You'll find the same type of numbers and similar articles throughout this issue, but with this message I'd like to take a different approach.

Very often quantifying achievements can mean stripping away all things that are not empirically measurable. That's fine for arriving at the numbers, but sometimes in doing so, we fail to recognize the support network that helped those landmarks become a reality. What do I mean? An award is often given to a single person—but that person in turn, almost always, thanks a litany of people. Our own Alper Bozkurt, one of our ECE Primary Faculty, on receiving the honor of being named to *Popular Science's* "Brilliant 10" said, "I can only accept this honor on behalf of the entire team."

It underscored a reality that we must not overlook as we produce our year end lists. And that is that we can only achieve what we do because we have a great scaffolding of support. Our donors, industrial supporters, advisory boards and alumni, and of course the students and the faculty are critical components of this scaffolding. But it also includes my ECE colleagues in other universities with whom we interact and collaborate.

To another year of collaborative work towards the greater good,



Daniel D. Stancil
ECE Department Head

Baliga Wins Global Energy Prize

Electrical engineer Jay Baliga, lauded by *Scientific American* as one of the heroes of the semiconductor revolution, has scored another scientific honor. The professor was awakened at 4:30 in the morning on April 23 with news from Moscow that he is a 2015 winner of the Global Energy Prize.

Baliga shares the honor with Shuji Nakamura, a UC Santa Barbara professor who won the Nobel Prize in physics last year for inventing the blue LED. The annual award presented at the St. Petersburg International Economic Forum in June comes with a cash prize of 33 million rubles, equivalent to about $645,000.

> **“...efficiency gained by using the IGBT has resulted in saving over 1 trillion gallons of gasoline...”**

Baliga, an ECE faculty member and director of NC State’s Power Semiconductor Research Center and a distinguished professor of electrical and computer engineering, is renowned for his invention of the insulated-gate transistor or IGBT, a power semi-conductor device primarily used as an electronic switch in modern appliances, from electric cars to air conditioners. The IGBT is used in every sector of the economy to improve the quality of life for billions of people around the world. The improved efficiency gained by using the IGBT has resulted in saving over 1 trillion gallons of gasoline and reducing electrical energy consumption by more than 50,000 terra-watt-hours (equivalent to not having to build 600 one-gigawatt coal-fired power plants). This has saved consumers $15 trillion while reducing carbon dioxide emission by more than 75 trillion pounds.

Baliga has received numerous awards in a career spanning four decades, including the 2014 IEEE Medal of Honor, the 2012 North Carolina Award for Science, the 2011 National Medal of Technology and Innovation from President Obama, the 1999 IEEE Lamme Medal, the 1998 IEEE Ebers Award, the 1998 O. Max Gardner Award, the 1993 IEEE Liebman Award, and the 1992 Pride of India Award, among others. He is a member of the Rensselaer Alumni Hall of Fame, the Electronic Design Engineering Hall of Fame, the European Academy of Sciences and the National Academy of Engineering, and is an IEEE Life Fellow.

Story by University Communications

Duke Energy Grant to Fund Renewable Energy, Diversity Efforts at NC State

Duke Energy CEO, President, and Vice Chairman Lynn Good in April announced a $2.5 million grant to NC State to support research in renewable energy and efforts to attract and retain underrepresented groups in the university's College of Engineering.

"We greatly appreciate our university's long-term relationship with Duke Energy and its ongoing support of NC State," said NC State Chancellor Randy Woodson. "This generous grant further advances NC State's leadership role in developing the critical technologies and diverse workforce needed to drive the engineering and energy industries of the future."

> **"Graduates of these programs will help shape the future of our energy industry."**

The multi-year grant, distributed through the Duke Energy Foundation, includes $1.5 million to establish an endowment for the Future Renewable Electric Energy Distribution and Management (FREEDM) Systems Center based in the College of Engineering. The FREEDM Systems Center, a prestigious National Science Foundation Engineering Research Center, is a collaboration of leaders in research, industry and engineering education, working to revolutionize the nation's power grid and facilitate the development and implementation of new renewable electric-energy technologies.

An additional $1 million of the grant will support annual workforce development programs and scholarships that attract and retain underrepresented groups in the College of Engineering, as well as K-12 outreach programs to create a pipeline of students interested in engineering careers. "Duke Energy has supported NC State University for more than 25 years and values its relationship with an institution that prepares the next generation workforce through competitive programs in engineering and energy," said Good. "Graduates of these programs will help shape the future of our energy industry." Good announced the grant April 8 at a luncheon at the Park Alumni Center on NC State's Centennial Campus.

Story by Matt Shipman

FREEDM System Center based in the College of Engineering

Bozkurt Named to *Popular Science's* "Brilliant 10"

Alper Bozkurt, an assistant professor of electrical and computer engineering, has been named one of *Popular Science's* "Brilliant 10" for his work establishing the foundations of the "internet of bionic things" in areas ranging from human-animal communication to insect biobots to human health monitoring devices. "This is very exciting, because my work is based on outside-the-box thinking and I didn't know what other people might think of it," Bozkurt says. "Knowing that the work is exciting to others makes me want to work even harder."

> **"This is very exciting, because my work is based on outside-the-box thinking and I didn't know what other people might think of it."**

The Brilliant 10 is an annual feature profiling 10 young scientists and engineers who are doing truly ground breaking work in their fields. Features on each of the awardees appeared in the October issue of *Popular Science*. "At *Popular Science*, we believe many of the world's most challenging problems can be solved through brilliant science and engineering," Executive Editor Jennifer Bogo said in a statement. "Our 10 honorees are at the bleeding edge of their fields – and are already well on their way to making the world a better, safer, smarter place."

Since arriving at NC State in 2010, Bozkurt and his team in the Integrated Bionic MicroSystems Laboratory have done extensive work on technologies to facilitate human-animal interactions and monitor human health. Working with NC State faculty members David Roberts and Barbara Sherman, Bozkurt developed a comprehensive suite of technologies that can be used to enhance communication between dogs and humans, with applications in everything from search and rescue to service dogs to training our pets. This collaborative

work involves the creation of both hardware and software, as well as making novel use of existing technologies, and incorporating all of the technology into a harness that can be worn by dogs.

Bozkurt has also developed technology that allows cyborg cockroaches, or biobots, to pick up sounds with small microphones and seek out the source of the sound. In addition, he developed technology that can be used as an "invisible fence" to keep the biobots in a defined area. As part of a collaborative effort with NC State faculty members Edgar Lobaton and Mihail Sichitiu, this technology is designed to help emergency personnel find and rescue survivors in the aftermath of a disaster. This builds on his earlier work in developing systems to control cockroaches and equip them for use in disaster-response situations.

On a more fundamental research level, Bozkurt developed methods for electronically manipulating the flight muscles of moths and for monitoring the electrical signals moths use to control those muscles. The work opens the door to the development of remotely controlled moths for use in emergency response.

Bozkurt has also received funding from NC State's Chancellor's Innovation Fund and the National Institutes of Health to support his research into the capability of a miniaturized, wireless system to monitor sleep and detect sleep disorders with a long term goal of developing a low-cost, low-power, low-noise, ultra-miniaturized, wireless system for assessing sleep physiology. Specifically, Bozkurt's technology uses sensors to monitor blood flow and the oxygen level in the blood using near-infrared light.

Bozkurt has also received funding from the Chancellor's Innovation Fund and National Science Foundation to develop smart fabrics with sensors integrated into textile fibers to monitor health and wellness.

In addition, Bozkurt is testbed leader for the National Science Foundation's Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Center at NC State. In that capacity, Bozkurt builds and evaluates prototypes that draw on his research and that of other ASSIST collaborators to advance wearable health-monitoring technologies.
"I believe my lab is contributing to the 'internet of things' in a unique way by focusing on developing novel interfaces between technology and biological organisms ranging from insects to humans," Bozkurt says. "We work with collaborators in diverse disciplines. Those collaborators, and the graduate students in my lab, are essential partners in this innovative work that resulted with the prestigious recognition from *Popular Science*. I can only accept this honor on behalf of the entire team."

Story by Matt Shipman

Professor Franzon Named Distinguished Professor

Professor Paul Franzon has been named Distinguished Professor of Electrical and Computer Engineering, effective Feb. 1, 2015. This was the culmination of a process that included recommendation by a committee of peers, and approval by the Dean, Provost and Chancellor.

Professor Paul Franzon has been with NC State since joining the Department as assistant professor in 1989.

His research activities have included design and CAD of 3D processors, interconnect structures and circuits, and application specific chips. He has also been a leader in the Department and University in online education, including offering the University's first open, online course (OOC). Among his many awards are the Australian Defense Medal, the ALCOA Distinguished Research Award, the Alumni Distinguished Undergraduate Professor Award, and induction into the NC State Academy of Outstanding Teachers. He is a Fellow of the IEEE.

Story by Dan Green

Lighting Amsterdam's Rainbow Station

If you're passing through the Amsterdam central train station, you may be pleasantly surprised to see a vibrant rainbow projected on the large arch that spans over its platforms.

It's the "Rainbow Station" project by artist Daan Roosegaarde, and it was made possible by technology adapted specifically for the project through collaboration with ECE Professor Michael Escuti and ImagineOptix Corporation, the company he founded to pioneer patterned liquid crystal optic technologies.

What Escuti developed was a "spectral filter," based on a type of technology called geometric phase holograms. In layman's terms, it's a filter that takes in bright white light and turns it into a rainbow, "dispersing" the colors in a precise, controlled way. Spectral dispersing elements are essential to applications in fields such as astronomy, optical telecommunications, chemical and biological sensing, semiconductor fabrication, and nanotechnology.

> **"It's a filter that takes bright white light and turns it into a rainbow..."**

Conventional techniques to create a rainbow, such as a prism or a regular diffraction grating, had at least one of two disqualifying limitations for this project: either the color dispersion wasn't wide enough (meaning the colors would be washed out) or the majority of the light would have "leaked" (meaning it would have gone almost anywhere but into the rainbow). But Escuti's technology puts about 99 percent of the light into the rainbow, allowing only about one percent of the light to leak out.

"That was particularly important for this installation, because Roosegaarde is using a four kilowatt spotlight and any leaked light could be unsafe for train operators or passengers," Escuti says. In other words, they didn't want leaked light to temporarily blind anyone.

The work was done by Escuti, in conjunction with Studio Roosegaarde and collaborators at NC State and Leiden University. Roosegaarde had a vision for what he wanted to achieve with the installation and reached out to researchers Frans Snik and Michiel Rodenhuis at Leiden. Snik then reached out to Escuti, who he was already working with to develop astronomical instruments and technologies.

"They wanted a rainbow pattern with a specific arched profile and dispersion of colors, without leaked light blinding a passersby - which was determined to be impossible with existing technology," says Escuti, who directs the Opto-Electronics and Lightwave Engineering Group at NC State. "So we had to make something new."

To meet the artist's vision, Escuti and his team at ImagineOptix turned to their line of geometric phase holograms, which are thin films of liquid crystal that control the angle and color dispersion of light waves. The best-studied member of this family is a polarization grating, which can be thought of as a pattern of vertical lines representing the orientation of liquid crystal molecules.

However, since the installation required a precise rainbow arch and color dispersion, Escuti and his team developed a modified polarization grating, where the parallel lines are in the form of concentric circles. This geometric phase hologram directs the light into a complete, full-circle rainbow. But by manipulating the input light's polarization, this element produces only the upper portion of the circle and suppresses the lower, creating the characteristic arch of a common rainbow.

In addition to limiting light leakage, the project posed another significant technical challenge. The technology needed to provide a wide dispersion of the rich, saturated colors that Roosegaarde wanted - which was particularly problematic for the full range of colors between deep red and violet.

"We achieved a wide dispersion of clear, crisp colors by incorporating specific design characteristics into the geometric phase hologram," Escuti says. "Specifically, we used a two-dimensional pattern with a feature size of 1.5 microns, meaning the concentric rings are 1.5 microns apart. This really separates the different wavelengths of light, making them more distinct. One of the tools we used to create these features, a directwrite laser scanner, is something my students, postdocs and I created at NC State." Directing the full range of colors between deep red and violet onto the train station facade presented a different problem, since very few technologies are capable of manipulating this wide range of colors within a single layer. "We addressed this by incorporating multiple layers of liquid crystal into the geometric phase hologram," Escuti says. "It's a structure we developed at NC State called a multitwist retarder, and in this case we used it to reach an amazingly wide range of color. It actually includes many more colors than our typical smartphones and TVs can produce, or that our digital cameras can capture."

ECE Professor Michael Escuti

Once the design work was completed at ImagineOptix, Escuti worked with graduate students in his lab, Leandra Brickson and Kathryn Hornburg, and postdoctoral scholar Jihwan Kim, to fabricate a "master" of the geometric phase hologram. The master was then replicated by ImagineOptix to create the final version for use at the Amsterdam Central train station, another unique process created at NC State.

Story by Matt Shipman

Undergraduates Win Best Energy Efficiency Award

In July 2015, a team of four ECE undergraduate students won the Best Energy Efficiency award at the final competition of the Institute of Electrical and Electronics Engineers (IEEE) International Future Energy Competition (IFEC) at the University of Sheffield, UK.

Winning team: Taha Arif, Steffon Brigman, Pedro Torres and Shawn Grimsley

The IEEE IFEC is an undergraduate student competition for innovation, conservation and effective use of electrical energy, open to college and university student teams from recognized engineering programs around the world.

The 2015 competition focused on developing a high density, high efficiency energy storage device capable of mimicking a synchronous generator, a topic that is highly relevant as people around the world seek more efficient energy storage solutions for renewable sources.

Most renewable energy sources, such as wind and solar, are not constant and are location-dependent, causing many challenges for grid operators in the integration of wind and solar generation. One solution is to adopt storage systems that can efficiently store renewable sources.

The team implemented an advanced storage design (utilizing the latest high voltage GaN power transistor) and achieved a battery-to-grid energy conversion efficiency of more than 93 percent, beating out six other highly ranked universities from around the world, including schools from Taiwan, China, Bangladesh and the United States.

The winning team members are Taha Arif, Steffon Brigman, Pedro Torres and Shawn Grimsley. Mentored by Professors Alex Huang and Ruiyang Yu, the three rising seniors and one rising junior worked for more than six months to get their storage device fully functioning in time for the competition. The FREEDM Systems Center, ECE Department and the Kenan Institute of Engineering provided financial support for their travel to participate in this highly visible competition. The next IFEC competition will be held in Taiwan in July 2016.

Story by Ashley McKinney

Lubkeman and Rotenberg Elevated to IEEE Fellows

Professors' outstanding achievements recognized by the world's largest professional association for the advancement of technology.


Professors Lubkeman (left) and Rotenberg (right)

Lubkeman receives this honor for contributions to power system distribution systems and Rotenberg for his contributions to the microarchitecture of high-performance and reliable microprocessors. The IEEE Grade of Fellow is conferred by the IEEE Board of Directors upon a person with an outstanding record of accomplishments in an IEEE field of interest. The total number selected in any one year cannot exceed one-tenth of one percent of the total voting membership. IEEE Fellow is the highest grade of membership and is recognized by the technical community as a prestigious honor and an important career achievement.

"Becoming an IEEE Fellow is a particular honor since it is the result of peers recognizing the significance and impact of one's contributions," said ECE Department Head Professor Dan Stancil, "It also reflects well on the Department and University by demonstrating once again that our faculty and students are involved in innovative and cutting-edge research."

The IEEE is the world's leading professional association for advancing technology for humanity. Through its more than 400,000 members in 160 countries, the association is a leading authority in areas ranging from aerospace systems, computers and telecommunications to biomedical engineering, electric power and consume electronics. They publish 30 percent of the world's literature in the electrical and electronics engineering and computer science fields, and have developed more than 900 active industry standards. The association also sponsors or cosponsors nearly 400 international conferences each year.

Story by Rebecca Register

Professor Solihin Listed in the HPCA Hall of Fame

ECE Professor Yan Solihin has been listed in the "HPCA Hall of Fame," which recognizes authors who have published six or more papers in HPCA over its 20 years of existence.

Newly recognized by the Hall of Fame, ECE's Professor Yan Solihin

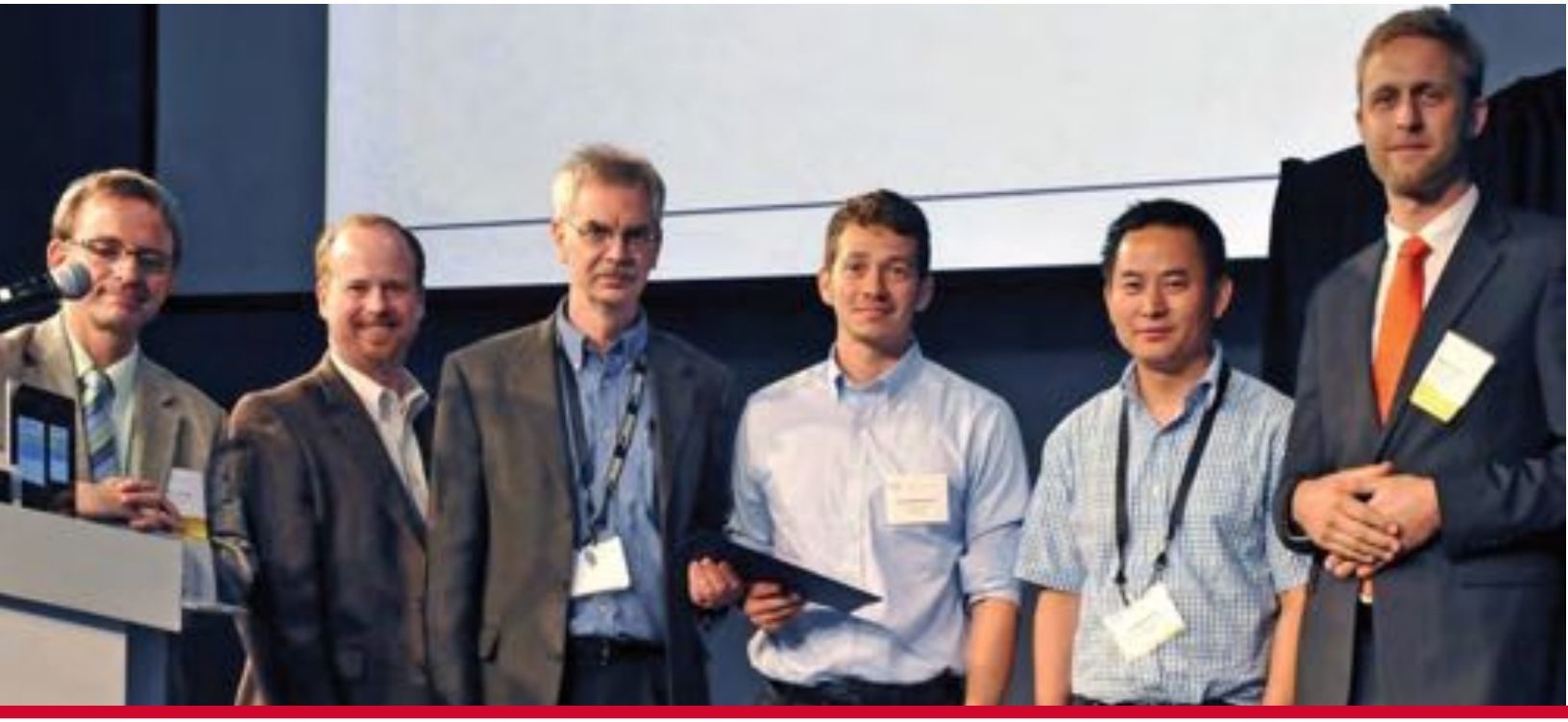
Professor Solihin is currently tied for the second rank with Professor Antonio Gonzales and Professor Anand Sivasubramaniam, each with 13 papers. Currently, 47 authors have achived this distinction.

High Performance Computer Architecture (HPCA) is the flagship conference for high performance computer architecture and one of the four top-tier computer architecture conferences. HPCA is a symposium organized by the IEEE Technical Committee on Computer Architecture (TCCA).

Professor Solihin has published papers on workload cloning, network on chip architecture, hardware queuing support, hardware support for Operating System survivability, bandwidth partitioning, cache partitioning, DRAM caching, architecture support for software reliability, secure processor systems, and high performance caches.

Researchers Prove Need for ASSIST Technologies

Hosted on the MIT campus, the IEEE Body Sensor Networks Conference 2015 brought a diverse group of military and corporate entities along with academic researchers and physicians together in an open colloquium.



Dieffenderfer (fourth from the left) accepts the 'Best Paper Award' at BSN 2015.

The IEEE Body Sensor Networks Conference 2015 brought a diverse group of military and corporate entities along with academic researchers and physicians together to discuss key issues and innovative solutions for sensors, communications, algorithms, systems and applications of body sensor networks.

> **"The Body Sensor Network conference was a unique opportunity to converse with both industry and academia."**

ASSIST graduate student and graduate research assistant in Integrated Bionic MicroSystems Laboratory at North Carolina State University James Dieffenderfer presented ASSIST's multi-university and multi-disciplinary research "Wearable Wireless Sensors for Chronic Respiratory Disease Monitoring." Authors on this paper include Drs. Alper Bozkurt, Jesse Jur, and David Peden along with ASSIST students Dieffenderfer, Henry Goodell, Brinnae Bent, Eric Beppler, Rochana Jayakumar and Murat Yokus. With a novel focus on correlated sensing of environmental and physiological vitals, the paper garnered "Best Paper Award" at BSN 2015.

Dieffenderfer says "the Body Sensor Network conference was a unique opportunity to converse with both industry and academia. It was great to see how well our research was received and we plan on attending the conference next year as well to present the next generation version of our system."

Dieffenderfer, left, and undergraduate Eric Beppler work on the SoliBand, a solar-powered health monitoring device that is worn on the wrist.

This research focuses on the current state of wearables in relation to environmental and physiological sensing. As an exploratory first step, the team aggregated commercially off-the-shelf systems into the ASSIST "Gen-0" testbed platforms to prove effectiveness of the current products on market. Both the wristband and chest patch constructions overconsumed power, requiring 78mW and 33mW respectively. While fundamentally this research is novel due to the nature of low power correlated sensing between the two parameters on a single platform, this research sheds light to the necessity of ASSIST nano-based ultra-low power electronics and energy harvesting research.

Story by Shanna Rogers

Byrd Elected to IEEE Computer Society Board of Governors

Professor Greg Byrd to serve three years in a strategy and policy guidance capacity

"I am honored to be elected to the Board by fellow computer engineers and computer scientists. Service on the Board is a chance to contribute to the profession, and a chance to work with very creative and dedicated people" noted Dr. Byrd. Candidates for the Board of Governors are selected by the Society's Nominations Committee or by petition by its members. "Strong leadership is critical to the vitality of the IEEE Computer Society," said Nominations Chair David Alan Grier. The seven candidates – including Professor Byrd, who received the most votes – assumed seats on the board starting in January 2015. The 21 board members serve rotating three-year terms in groups of seven. The Board of Governors sets the direction and determines the strategy for the Computer Society, and provides guidance at the policy level to all Society organizational entities.

Professor Byrd has been a member of IEEE for over 30 years. He has served on the Computer Society Publications Board for the past three, and the Constitution and Bylaws Committee for one year.

IEEE Computer Society is the world's leading computing membership organization and the trusted information and career-development source for a global workforce of technology leaders including professors, researchers, software engineers, IT professionals, employers, and students. The unmatched source for technology information, inspiration, and collaboration, IEEE Computer Society is the source that computing professionals trust to provide high-quality, state-of-the-art information on an on-demand basis. The Computer Society provides a wide range of forums for top minds to come together, including technical conferences, publications, and a comprehensive digital library, unique training webinars, professional training, and a TechLeader Training Partner Program.

Story by Abadir Francois

Far left and far right, husband and wife team, Professors Salah Bedair and Nadia El-Masry

Professor Salah Bedair awarded Holladay Medal

Professor Salah Bedair is one of five professors to receive the 2015 Alexander Quarles Holladay Medal for Excellence, the highest faculty honor bestowed by the trustees and NC State.

The 2015 honorees are Roger Barker, Burlington Distinguished Professor, College of Textiles; Hugh Devine, Professor of Parks, Recreation and Tourism Management, College of Natural Resources; Trudy Mackay, William Neal Reynolds and Distinguished University Professor of Genetics and Entomology, College of Sciences; and Coby Schal, Blanton J. Whitmire Distinguished Professor. The Holladay Medal is named for Col. Alexander Quarles Holladay, the university's first president. It recognizes career contributions of faculty members in teaching, research and service.

> **“These contributions affect our everyday lives and point the way to future renewable and efficient sources of energy.”**

Winners receive a medal and a certificate, and their names are inscribed on a plaque in the NC State Faculty Senate chambers.

Bedair is a scientific pioneer who has significantly advanced four different areas of electrical and computer engineering. His research on solar cells, light-emitting diodes, atomic layer deposition and spin electronics is having a major impact on development of new, innovative devices for energy applications. These contributions affect our everyday lives and point the way to future renewable and efficient sources of energy.

A faculty member for 37 years, Bedair has published more than 400 articles, attracted $25 million in research funds and graduated 46 Ph.D. students.

Story by Dan Green

Krim Selected as Signal Processing Society Distinguished Lecturer

Dr. Hamid Krim has been selected as a 2015 Distinguished Lecturer by the IEEE Signal Processing Society. The Society's Distinguished Lecturer Program provides means for chapters to invite individuals who are well known educators and authors in the field of signal processing to lecture at Chapter meetings.

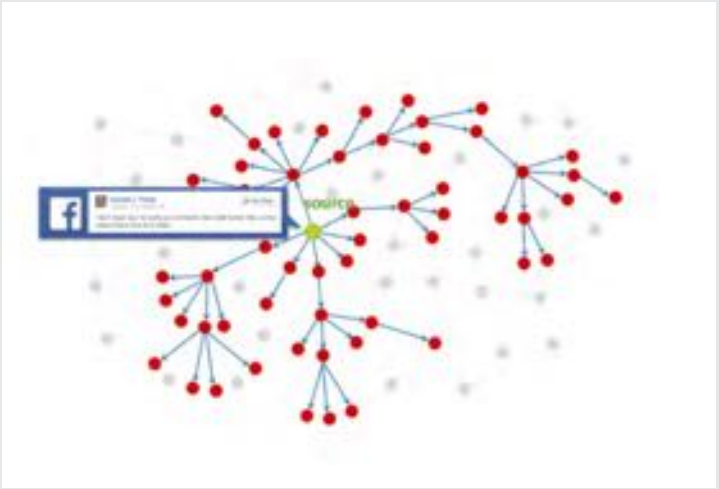
"It is a high honor bestowed by peers and leaders in research in the area. It is a vehicle to disseminate research results," noted Dr. Krim.

Dr. Krim's research interests are in statistical signal processing and mathematical modeling with a keen emphasis on applications. He has been particularly interested in introducing geometric and topological tools to statistical signal processing problems and applications. His research has primarily centered on estimation theoretic problems and modeling. Dr. Krim has published extensively on these areas with an impact amounting to over 5000 citations to date.

Story by Dan Green

ECE Researchers Investigate Social Networks in Award-Winning Paper

Congratulations to ECE PhD student Xin Xu and Associate Professor Do Young Eun - the Best Paper Award winners at the IEEE International Workshop on Network Science for Communication Networks (NetSciCom), 2015, part of IEEE Infocom, Hong Kong.



Dr. Eun's research describes how an item of information or rumor appearing in online social networks spreads out over time.

The goal of NetSciCom was to a provide a forum where a diverse group of researchers - from engineers to behavioral scientists - could meet and exchange ideas leading to deeper insights into the design of future robust communication networks. The award-winning paper by Xu and Eun was entitled, "Modeling Time-Sensitive Information Diffusion in Online Social Networks." Their focus was on the complex issue of how to predict how many users will forward or comment on information posted in online social networks. After a piece of information is released, will it spread to the entire network or reach only a small population of users?

Story by Ashley McKinney

ECE Kicks Off Alumni Hall of Fame

2015 saw the creation of the NC State Department of Electrical and Computer Engineering Alumni Hall of Fame. With nearly 13,500 alumni, only a select number will be chosen as ECE Hall of Fame members, making this a truly noteworthy distinction for the 34 exceptional alumni inducted in its inaugural year.

2015 Hall of Fame Inductees Dr. Larry K. Monteith and Dr. Laura Bottomley

After four years as an aviation electronics technician in the United States Navy, Larry K. Monteith enrolled in North Carolina State College of Agriculture and Engineering in 1956 and graduated with a Bachelor of Science degree in Electrical Engineering in 1960. After graduation, he was employed by Bell Telephone Laboratory and gained limited experience from the production of military ground to air missiles and the Telstar communication satellite while enrolled at Duke University, graduating with a Master of Science degree in 1962. Dr. Monteith then worked for the developing Solid-state Micro-electronics division of the Research Triangle Institute and established programs supported by NASA before graduating from Duke with a PhD in 1965. He then joined the faculty at the renowned North Carolina State University at Raleigh in 1968 as an associate professor in the Solid State Micro-electronics division of the Department of Electrical Engineering. Dr. Monteith was active in developing research, graduate, teaching, and extension programs when appointed in 1974 as head of the department and then in 1978 as the dean of engineering. After a decade as a dean, Dr. Monteith accepted the position of interim chancellor and then chancellor in 1988 and 1989 respectively, before retiring in 1998 after thirty years of service. Monteith's efforts during his tenure improved undergraduate, graduate, research and centennial campus programs which brought substantial growth and prominence to the institution.

Nominations are based on profession and service achievement, entrepreneurship and contributions to professional societies. Examples of such noteworthy activities that would warrant a nomination may include (but are not limited to):

- Recognized by technical organizations at a high level (e.g. IEEE fellow)
- Published a significant number of influential technical papers or patents in the ECE field
- Recognized as a successful university faculty member
- Founded a successful small to medium business
- Served at the senior management level in a large corporation
- Recognized by a national community organization for their impact
- Participated at a leadership level in a nationally recognized community service organization (eg. United Way, Red Cross, Habitat for Humanity)

During this year's inaugural induction, ECE Department Head Dr. Daniel Stancil communicated the pride the department has in its alumni and in their extraordinary accomplishments.

Congratulations to our 34 inaugural inductees: Tülay Adali, Greg E. Bottomley, Joseph S. Colson, Jr., Wesley B. Covell, William H. Dean, John M. Eubanks, Cataldo U. Falco, Edward D. Graham, Jr., Christina M. Hammock, John R. Hauser, Clayton Scott Hinnant, Irwin R. Holmes, J. Stuart Hunter, Michael A. Littlejohn, Robin E. Manning, Stephen H. Marbut, John S. Mayo, Thomas R. McPherson, Jr., Darrell V. Menscer, Tony L. Mitchell, Sharat Nagaraj, Sanjay Nayak, Billy B. Oliver, Larry Nixon, John L. Prince, III, Deborah S. Proctor, Jason P. Rhode, Wesley E. Snyder, Jim Stritzinger, William F. Troxler, J. Turner Whitted and Scot Wingo.

Nominations are now being accepted for 2016 induction into the Hall of Fame. For more information, please visit www.ece.ncsu.edu/alumni/hall_of_fame.

Story by Ashley McKinney

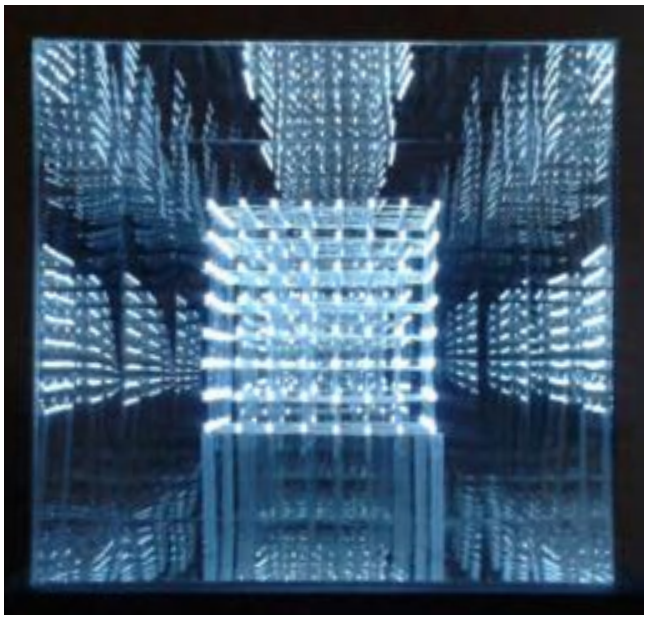
Laura Bottomley, ASEE Fellow, is the Director of Women in Engineering and The Engineering Place for K-20 Outreach and a Teaching Associate Professor in the Colleges of Engineering and Education at NC State University. She teaches an "Introduction to Engineering" class for incoming freshman in the College; "Children Design, Invent, Create," a course for elementary education students that introduces them to engineering design and technology; as well as various electrical engineering classes.

In 2009 Dr. Bottomley was selected for a Presidential Award for Excellence in Mathematics, Science and Engineering Mentoring by the White House Office of Science and Technology Policy and by the Educational Activities Board of the IEEE for an Informal Education Award. She was also inducted into the YWCA Academy of Women in 2008 for her contributions to eliminating racism and empowering women and was selected as the 2011 Woman of the Year by the RTP chapter of Women in Transportation. In 2013 she was named one of 125 Transformational Women by NC State University.

Bottomley received her bachelor's and master's degrees in electrical engineering from Virginia Tech in 1984 and 1985, respectively. She received her Ph.D. in electrical engineering from NC State in 1992. She has previously worked at AT&T Bell Labs on ISDN standards and Duke University teaching classes and directing a lab in the electrical engineering department.

Art, Engineering and Infinity: ECE Students Alongside Escher and da Vinci

The concept of infinity and the desire to illustrate the creative process have given a team of college students the opportunity to showcase an electronic display they developed alongside the works of M.C. Escher and Leonardo da Vinci.



The opportunity stems from a collaboration between NC State University and the North Carolina Museum of Art (NCMA), as part of a series of STEAM initiatives which combine science, technology, engineering and math (STEM) with art and design to promote innovation.

Because of its interest in STEAM, NCMA came to NC State with the idea of having engineers use electronics to create a visual display that tied together the works of da Vinci and Escher. The resulting student exhibition, *Engineering Infinity,* will coincide with the museum's upcoming exhibitions *The Worlds of M. C. Escher: Nature, Science, and Imagination* and *Leonardo da Vinci's Codex Leicester and the Power of Observation.*

The project was a part of the senior design course for Evan Heiman, Andy Tong, Robert Jamison, and Jesse Davi. All four undergraduate students graduated May 9 with degrees in electrical and computer engineering.

The team developed a cube made up of 512 light-emitting diodes (LEDs), 64 on each side, which is suspended on translucent columns. The LEDs are programmed to display 19 different visual routines. Video of the cube in action can be seen online.

The LED cube is surrounded by a second cube made of two-way mirrors, allowing viewers to see inside, but essentially trapping and reflecting light from the LEDs. "This was a collaboration with NCMA to develop a display that both expressed the STEAM concept and was consistent with the subjects of Escher's work, such as infinity, fireworks and tessellations," Heiman says.

"The LED cube makes the first image, but it is reflected repeatedly - back and forth between the mirrors - making the images appear to retreat into infinity. Much like Escher did in his work," says Jamison.

The team documented their work according to the so-called "design cycle" (ask, imagine, plan, create and improve). The cube will be displayed alongside sketches, schematics and other materials documenting the process. These process-oriented artifacts connect to da Vinci's Codex Leicester, a 500-year-old notebook featuring the artist's notes, sketches, and observations, and providing a glimpse into the artist's scientific mind.

"We are thrilled to partner with NC State's College of Engineering to explore the creative process of innovation," says Michelle Harrell, associate director of education at the NCMA. "These students have created an interactive solution that not only required great technical skill but a great deal of imagination and a fine eye for design."

Video of the cube in action can be seen at https://youtu.be/j5fhjTrBzoM.

Story by Matt Shipman

Dr. Louis A. Martin Vega, Dean, College of Engineering (right) presents Distinguished Engineering Alumnus award to Irwin R. Holmes, Jr.

Holmes Honored with Distinguished Engineering Alumnus award

The College of Engineering honored ECE alumnus Irwin R. Holmes, Jr. with the Distinguished Engineering Alumnus award at a ceremony held on Sept. 25 at the Park Alumni Center on NC State's Centennial Campus.

Holmes earned a bachelor's degree in electrical engineering from NC State in 1960. The first African-American to earn an undergraduate degree from the university, he stands among a distinguished group of trailblazers who had the courage to integrate institutions of higher learning in the South.

After earning his NC State degree, he received a master's degree in electrical engineering from Drexel University and then worked for several companies including IBM, where he spent 19 years as a senior manager of computer development.

Holmes has been an active supporter of the NC State Engineering Foundation and the university's Minority Engineering Program. Holmes was a scholar and had high academic achievement.

He was inducted into the electrical engineering honor society, Eta Kappa Nu, in his junior year. He was also an athlete and ran track, played intramural basketball and varsity tennis.

He earned a letter in tennis in his sophomore year. Holmes was the first athlete to integrate the Atlantic Coast Conference and in his senior year he was made co-captain of the tennis team.

As a Senior Manager of Computer Development at IBM he earned two patents and was a key member of the task force that led to the development of the IBM PC product line. Holmes has also been an entrepreneur and developed a shopping center in Durham, NC, started a gourmet restaurant, and developed other real estate ventures. He is now semi-retired but still serves as chief financial officer for his family's staffing company which he founded with his wife.

Story by Brent Lancaster

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