

Georgia Tech  **School of Electrical and Computer Engineering**

[2015-2016 Annual Report]

[+] From the Chair



I am proud to present to you the 2015-2016 annual report for the Georgia Tech School of Electrical and Computer Engineering. The power and possibilities that ECE unlocks are shown by our research and educational highlights and the achievements of our faculty, staff, and students.

In FY 16, we acquired \$51.7 million in research funding — a 14 percent increase over last year, and we ended Campaign Georgia Tech with a total contribution of \$174 million. These funds allow us to conduct research that is critical to the State of Georgia and to society as a whole. It allows us to implement new ways of teaching and learning that make our graduates ready to contribute on day one, both on the job and in graduate or professional school.

Our student enrollments are flourishing, thanks to redoubled recruitment efforts, and the School

awarded 924 degrees during FY 16. Many students are involved with activities that make a difference in the world or that help them create their own businesses.

Our world faces many technological challenges, and we enthusiastically and fearlessly embrace them. Whether you are a longtime supporter or are new to ECE, we invite you to join us in being at the center of dreaming, designing, and getting things done.

Sincerely,

Steven W. McLaughlin

Professor and Steve W. Chaddick School Chair

[+] ECE Overview



[RANKINGS]

National Rankings,
U.S. News & World Report

#4

E.E. undergraduate program

#6

Cmp.E. undergraduate program

#6

E.E. graduate program

#6

Cmp.E. graduate program



[ENROLLMENT]

1,492

total undergraduate enrollment, FY 16

903 E.E. students
589 Cmp.E. students

16% females
19% underrepresented minorities*

[+] Female enrollment in ECE continues to grow, with women comprising 21 percent of the incoming 2015 freshman class — its highest mark ever and the third consecutive year that women made up at least 20 percent of ECE first-year students.

1,169

total graduate enrollment, FY 16

16% females
6% underrepresented minorities*



[DEGREES]

371

total undergraduate degrees awarded

242 B.S.E.E.
129 B.S.Cmp.E.

14% female graduates
14% underrepresented minorities*

553

total graduate degrees awarded

457 M.S./M.S.E.E.
92 Ph.D.
1 Ph.D. Bioengineering
3 Ph.D. Robotics

18% female graduates
6% underrepresented minorities*

[+] The School graduated the most undergraduates in over a decade and its largest group of master's students in its history. The latter is due to a larger than normal admittance of master's level students in fall 2014 — these students graduated during the last academic year.

* All underrepresented minority percentages represent Black/African-American and Hispanic/Latino students.

In recent years, ECE has increased its recruiting efforts through tours, summer programs, and more personal contact with prospective students. During 2015-2016, 1,346 students toured ECE, either with high school groups or the School's weekly tour. The School's H.O.T. Days @ Georgia Tech camp for rising metro Atlanta high school sophomores and juniors has been offered for over 10 years and introduces students to the field through fun, hands-on ECE-related activities. The Summer Teacher Experience Program—Utilizing Physics/Engineering (STEP-UP) trains high school teachers in modern physics concepts, their applications in ECE, and their relevance to today's technology. Since 2004, 71 teachers from six metro area school systems have participated in STEP-UP and have

shared information about ECE by bringing their students to Georgia Tech for tours or talking about ECE in their classrooms.

Making the School's curriculum more flexible and offering experiential learning programs has also attracted more students to ECE. The Engineering for Social Innovation Center partnered with Youth Entrepreneurs Georgia to host the Social Innovators and Entrepreneurs Camp. This one-week immersive experience taught middle school and high school students how to apply entrepreneurial skills to launch businesses in their communities.

[+] Development

The ECE Development Office cultivates and coordinates the School's fundraising efforts with industry, alumni, and other interested people and organizations. They manage the Corporate Affiliates Partnership Program, the ECE Career Fair, and other networking and social activities to promote alumni and corporate involvement.

For more information, contact Martina Emmerson Hubbarth, director of ECE Alumni Development, at 404.894.0274; Etta Pittman, director of ECE Corporate Development, at 404.894.6888; or Anna Walker, assistant director of ECE Development, at 404.894.2273.

[FY 16 Donors]

We would like to thank the following corporations, non-profit organizations, and individuals for contributing \$5,449,022 to the School and its affiliates during FY 16.

FOUNDATIONS/NON-PROFIT ORGANIZATIONS | American Endowment Foundation • ARCS Foundation • AT&T Foundation • Boyce and Gail Dooley Family Foundation • Breast Cancer Research Foundation • Corning Glass Works Foundation • Eaton Charitable Fund • ExxonMobil Foundation • General Motors Foundation, Inc. • Harris Foundation • Harvey Hubbell Foundation • IBM International Foundation • Motorola Solutions Foundation • NFPA Education and Technology Foundation • Norfolk Southern Foundation • Otto & Jenny Krauss Charitable Foundation Trust • Renaissance Charitable Foundation, Inc. • SRC Education Alliance • Vanguard Charitable Endowment • Wallace H. Coulter Foundation • Wells Fargo Community Support Campaign

PROFESSIONAL, RESEARCH, & ACADEMIC ORGANIZATIONS | Cornell University • Electric Power Research Institute • ETRI • IDEMA (ASTC) • University of Minnesota • Northwestern University • Rutgers University • Massachusetts Institute of Technology • Michigan State University • National Rural Electric Coop Association • Old Dominion University • Radio Club of America, Inc. • Saint-Gobain Northboro R&D Center • Stanford University • University of Southern California • University of Texas at Austin

INDIVIDUALS | Behrooz Abdi • C. Dean Alford • Lawrence J. Aldrich • Mr. and Mrs. Bill Allen • William H. Allen • Anonymous 73 • Anonymous 160 • Steve A. Barton • Russell T. Beason, Jr. • Harry L. Beck • Teresa Beck • Sergio A. Borgatello • Kevin Brennan (posthumous) • Suzy Briggs • Susan Brooks • Barbara Brown • H. Austin Brown • John H. Brownlee • Robert John Butera, Jr. • Melinda Coker, P.E. • Harriett C. Coleman • Thomas J. Coleman • Thomas R. Collins • James M. Corbitt, Sr. • Alina M. DeSimone • R. Thomas Dyal • Ken R. Entreklin • Manuel Fernandez • Fay Y. Fernandez • Aldo A. Ferri • Bonnie H. Ferri • Janice L. Gaylor • Thomas K. Gaylor • Margaret M. Graff • Jesse S. Hall • Richard J. Higgins • Mary Elizabeth Hollingsworth • Martina E. Hubbarth • Thad W. Hudson • William W. Kaduck, Jr. • Arlen J. Kirchoff, Jr. • Christopher W. Klaus • Arthur Koblasz • Alan F. Krauss • Frederick G. Krauss • Tanner J. Leggett • Kenneth E. MacKenzie • Steven W. McLaughlin • Norma J. McLees • Ben R. McRee • Lynn C. Maddox • Ardella Mays • Ragnar-Miguel Myhrer • Claude A. Petty, Jr. • Etta Pittman • Donna Salisbury • Douglas R. Spear • Paul G. Steffes • Rajagopal Subramanian • Madhavan Swaminathan • Michael David Teems, Sr. • Leon M. Tolbert • Melinda L. Tourangeau • Kristin Ann Turgeon • Michael T. Tuley • Therese P. Tuley • Herbert S. Upton, Sr. • Judith Vanderboom • Patrick W. Wathen • Sabine E. Wathen • Thomas A. Wathen • Anita Wathen-Brownlee • Patricia T. Webb • Roger P. Webb • Mr. and Mrs. Claude Williams, Jr. • Douglas B. Williams • Kay Williams

New Council Forming to Advise CREATE-X

Georgia Tech has established a council to engage interested alumni and friends in advisory, mentoring, and philanthropic roles with CREATE-X, which is designed to boost students' entrepreneurial confidence and give them the tools needed to establish startups. CREATE-X is led by Raghupathy Sivakumar, the Wayne J. Holman Chair in ECE.

Membership on the council, which is limited to 20 seats, requires a two-year term and an annual gift of \$25,000/year for a total commitment of \$50,000. To learn more about the CREATE-X Council, contact Martina Hubbarth.

ECE Exceeds Fundraising Goal for Campaign Georgia Tech

Campaign Georgia Tech ended on December 31, 2015, with ECE raising a total of \$174 million, exceeding its goal of \$165 million. We are thankful to the thousands of individuals, corporations, and foundations that supported the School during this campaign and that helped us surpass our goal, which was the largest fundraising target of any school or department.

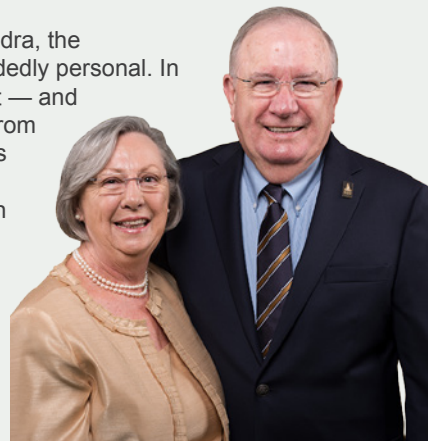
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Thackers' Support for Tech Promise is Deeply Personal

All those who have given to the G. Wayne Clough Georgia Tech Promise scholarship program since its creation in 2007 know the value of and unique role that Tech Promise plays in the lives of so many Georgia students and their families.

For Ted N. Thacker, EE 1969, and his wife, Sandra, the transformational power of Tech Promise is decidedly personal. In fact, Thacker worked full time as a Tech student — and still graduated in four years. Thacker is retired from Alcatel-Lucent, now part of Nokia. The Thackers recently made a bequest provision establishing the Sandra S. and Ted N. Thacker Georgia Tech Promise Endowment Fund, which will one day provide significant support for Tech Promise Scholars.

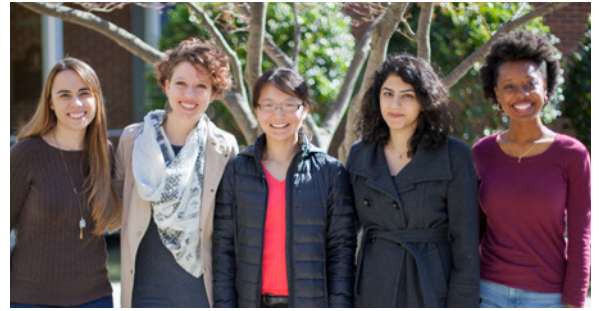
Georgia Tech Promise offers a debt-free education to qualified residents of Georgia whose annual family income falls below \$33,300.



[+] Students & Student Groups

ECE student groups provide outlets for community building and learning outside of class. Many groups also participate in K-12 outreach and service projects. Our students also take part in interdisciplinary clubs and a host of social, professional, and cultural organizations.

In 2015, ECE Ph.D. student Kaitlin Fair started a Georgia Tech Lean In Chapter with four female graduate engineering students. Inspired by Facebook COO Sheryl Sandberg's TEDTalk and book *Lean In: Women, Work, and the Will to Lead*, they have created a community for support and friendship for women as they work to reach their goals. The group also welcomes all male students and undergraduate female students to their monthly meetings.



[Student Groups]

Eta Kappa Nu • IEEE • ECE Ambassadors • Women in Electrical and Computer Engineering

[Award Winners]

Our students were honored at ECE's annual Roger P. Webb Awards Program and at campus award ceremonies. This past spring, Jonathan Tuck was recognized with Georgia Tech's highest accolade given to a graduating senior.

Georgia Tech Awards

Jonathan Tuck | Love Family Foundation Scholarship

Adam Charles, Majid Sodagar, and Amit Trivedi | Sigma Xi Best Doctoral Thesis Awards

Sean Rodrigues | Sigma Xi Best Master's Thesis Award

Roger P. Webb Awards

Alan Dong | Outstanding Electrical Engineering Senior Award

Ratchapong Tangkijvorakul | Outstanding Computer Engineering Senior Award

Westin Williams | ECE Graduate Teaching Assistant Excellence Award

Song Hu and Nelson Lourenco | ECE Graduate Research Assistant Excellence Awards



IEEE PES Brings Electric Power to Remote Haitian Health Center

In May 2016, Georgia Tech's IEEE Power & Energy Society (PES) Student Chapter installed a solar-based microgrid system to support a newly-constructed health center in the remote mountain village of Thoman, Haiti. Located about 50 miles east of Port-au-Prince, the clinic provides health and dental care for more than 4,000 people living in Thoman and surrounding villages.

Microgrids are self-contained power systems that can draw electricity from the traditional grid when available, but can also disconnect and operate as an independent energy source for single businesses or a home. The systems are gaining popularity in the developing world as a way to provide power to areas that do not have stable access to the conventional electric power grid.

The IEEE PES Student Chapter hopes to build on their experience from the Thoman microgrid project and develop a similar system for another health center in Haiti next year.

Georgia Tech Team Presented with Serious Games Students' Choice Award

Aditya Anupam and Ridhima Gupta received the Students' Choice Award at the Serious Games Competition, held November 30-December 4, 2015 during the Interservice/Industry Training, Simulation, and Education Conference (IITSEC) in Orlando, Florida.

Anupam and Gupta, an M.S. student in ECE and an M.S. student in the College of Computing (CoC)/School of Literature, Media, and Communication (LMC) respectively, received the award for developing Particle in a Box, an educational game on quantum mechanics, which they showcased at the conference.

Supported partly by a GT-FIRE Award, an interdisciplinary faculty and student team from ECE; LMC; CoC; and the College of Design created and implemented a succession of virtual worlds governed by quantum mechanics law to help students understand the counterintuitive behavior of particles at the nanoscale. The team was advised by LMC Assistant Professor Nassim JafariNaimi and ECE Associate Professor Azad Naeemi.

[+] Faculty

In FY 2016, ECE employed 110 academic faculty, nine academic professionals, 74 research faculty, and 83 administrative staff.

[New Faculty]



Stanislav Emelianov
Joseph M. Pettit Chair Professor
in Microelectronics
Microelectronics/Microsystems;
Bioengineering



Lukas Graber
Assistant Professor,
Electrical Energy



Tushar Krishna
Assistant Professor,
Computer Systems
and Software

[Faculty Awards]

ECE faculty members were honored by Georgia Tech and external groups for their excellence in teaching, educational innovation, outreach, research, and commercialization.

External Awards

Ajeet Rohatgi | Fellow, National Academy of Inventors

Faramarz Fekri, Xiaoli Ma | Fellows, IEEE

Ayanna M. Howard | A. Nico Habermann Award (given by the Computing Research Association)

Abdallah Ougazzaden | International StelLab PSA Award

Magnus Egerstedt | John R. Ragazzini Education Award (given by American Automatic Control Society)

Anthony J. Yezzi | Fulbright Award

Arijit Raychowdhury | NSF CISE Research Initiation Award and Intel Early Career Faculty Award

Bonnie H. Ferri | Regents' Scholarship of Teaching and Learning Award

Maryam Saeedifard | Atlanta IEEE Power and Energy Society Outstanding Engineer

Georgia Tech Awards

Robert J. Butera | Senior Faculty Outstanding Undergraduate Research Mentor Award

Mark A. Davenport | Center for Teaching and Learning/BP Junior Faculty Teaching Excellence Award

Omer T. Inan | Lockheed Dean's Excellence in Teaching Award

Hua Wang | Sigma Xi Young Faculty Award

[+] Research & Education Highlights



Georgia Tech Prepares for Jupiter Mission

Juno successfully entered Jupiter's orbit on July 4, 2016, five years after it was launched by NASA and the Jet Propulsion Lab and 11 years after Juno was created with ECE Professor Paul G. Steffes as an original member of the mission's science team.

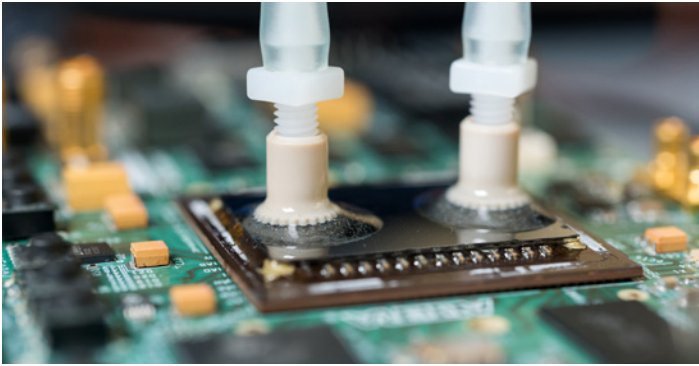
To sense what's below Jupiter's clouds, Steffes and his peers will use Juno's microwave radiometer (MWR) instrument to measure radio waves from Jupiter's deep atmosphere, providing a first-ever glimpse of the planet's composition. Once they receive the first MWR planetary data, Steffes and his Ph.D. student Amadeo Bellotti will match it with more than 6,000 microwave measurements that they and Steffes' past students have made, covering a variety of pressures, temperatures, and compounds that Juno will likely find.



Hearing Snap, Crackle, Pop May Help Heal Your Knee

Georgia Tech ECE and biological sciences researchers, led by ECE Assistant Professor Omer T. Inan, are developing a knee band with microphones and vibration sensors to listen to and measure sounds inside the joint. This work, sponsored by DARPA's Biological Technologies Office, could lead to a future device to help orthopedic specialists assess damage after an injury and track the progress of recovery.

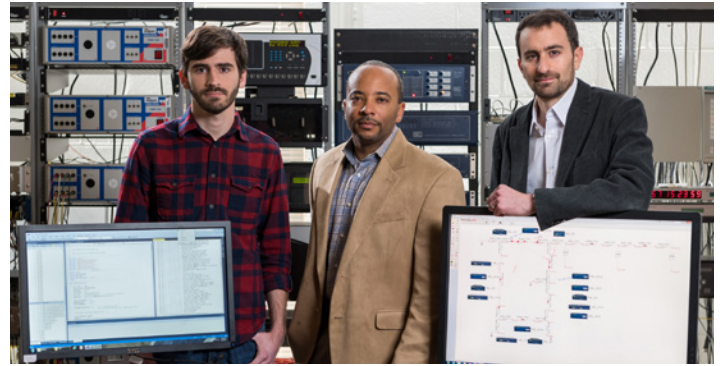
If paired with medical research, this acoustic device could lead to inexpensive, wearable monitors, which could benefit athletes who have overburdened knees and elderly patients who have slipped and fallen. DARPA's interest is to reduce repeat battlefield knee injuries and help soldiers return to duty safely.



Liquid Cooling Moves onto the Chip for Denser Electronics

New liquid cooling technologies invented at Georgia Tech could allow development of denser and more powerful integrated electronic systems that no longer require heat sinks or cooling fans on top of integrated circuits. Supported by DARPA and led by ECE Professor Muhannad S. Bakir, the research is believed to be the first example of liquid cooling directly on an operating high-performance chip.

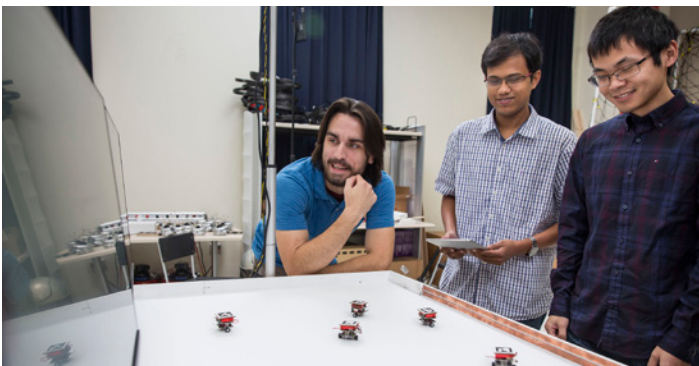
Working with popular 28-nanometer Field-Programmable Gate Array devices made by Altera Corporation, Bakir and his colleagues in ECE and mechanical engineering have demonstrated a monolithically-cooled chip that can operate at temperatures more than 60 percent below those of similar air-cooled chips. In addition to more processing power, the lower temperatures can mean longer device life and greater energy efficiency.



Device “Fingerprints” Could Help Protect Power Grid, Other Industrial Systems

ECE and mechanical engineering researchers, led by Motorola Foundation Professor Raheem Beyah, are identifying devices on electrical grid control networks, using their unique electronic “voices” — fingerprints produced by the devices’ individual physical characteristics — to determine which signals are legitimate and which signals might be from attackers.

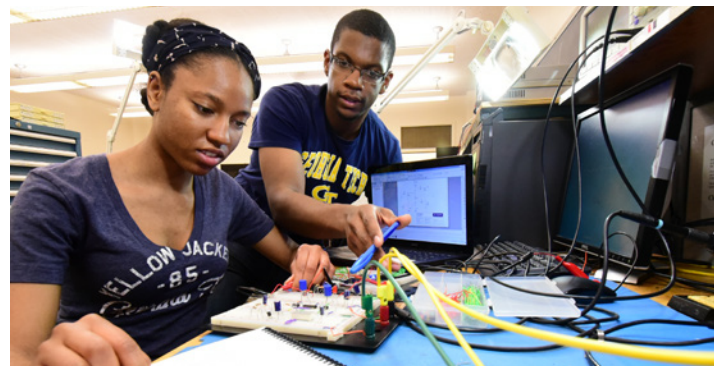
This approach, funded by NSF, could help address unique security challenges of the electrical grid and other cyber-physical systems. Networked systems controlling the nation’s electrical grid and other industrial systems often cannot run modern encryption and authentication systems, and the legacy systems connected to them were never designed for networked security. Since they are distributed around the country, often in remote areas, the systems are difficult to update using the “patching” techniques common in computer networks.



New Lab to Give Nation’s Researchers Remote Access to Robots

Georgia Tech is building a new lab that will allow roboticists at other universities in the United States, as well as middle and high school students, to remotely schedule experiments, upload their own programming code, watch the robots in real-time via streamed video feeds, and receive scientific data demonstrating the results.

Expected to house 100 ground and aerial swarm robots, the “Robotarium” is led by Magnus Egerstedt, the Julian T. Hightower Chair Professor in Systems and Controls, and includes faculty from ECE, mechanical engineering, aerospace engineering, and interactive computing. While access is one goal of this NSF-funded project, the Robotarium could build stronger collaborative research networks and show how remote access instruments can be structured in areas beyond robotics.



Using Engineering to Make a World of Difference

The Engineering for Social Innovation (ESI) Center matches Georgia Tech students with real-world projects for corporations and non-profit agencies. All projects aim to improve the lives of underprivileged people in the United States or the developing world.

Started as a pilot by ECE Academic Professional Joyelle Harris, the program supports projects such as a customized baby seat for orphanages in India, a smart wheelchair, an app for a children’s nutrition bar, a water filter program for Tanzanian villages, and a temperature and light detection system for a summer camp for children with disabilities and terminal illnesses. Harris hopes to add technology consulting to ESI, so students can help these organizations with their technology questions.



Georgia Tech, Emory Unite to Train Healthcare Roboticians

With the support of a \$2.9 million grant from the NSF National Research Traineeship program, a Georgia Tech and Emory University faculty team will create new bachelor's, master's, and doctoral degree programs and concentrations in healthcare robotics — the first degree programs in this area in the United States.

Led by Ayanna M. Howard, the Linda J. and Mark C. Smith Chair Professor in ECE, this initiative blends Emory's medical and clinical expertise and Tech's robotics and engineering know-how to train engineering students in robotics, physiology, neuroscience, rehabilitation, and psychology, so they can better understand the changing needs of patients and their caregivers and healthcare providers.

[+] Commercialization

For over 30 years, ECE faculty members and students have founded successful startup companies through the Advanced Technology Development Center. They may also have their technologies evaluated by VentureLab.

This year, an ECE team received the top award at the 2016 InVenture Prize, and two faculty-founded companies made headlines for their accomplishments.



FireHUD Wins the 2016 InVenture Prize

Two teams with ECE students — FireHUD and TEQ Charging — were among the six finalists for the 2016 InVenture Prize, held on March 16. FireHUD won the \$20,000 first place prize and advanced to the inaugural ACC InVenture Prize, where they won the \$5,000 People's Choice Award.

Invented by computer engineering major Zachary Braun and electrical engineering major Tyler Sisk, FireHUD is a real-time monitoring system and Head Up Display that provides biometric and environmental data to firefighters and officials outside and helps decrease the level of uncertainty firefighters face.

TEQ Charging is a power management system for electric vehicle chargers to reduce installation cost, increase charging efficiency, and provide greater accessibility to charging. Team members are computer engineering alumnus James Dorrier Coleman, Jr.; computer science major Mitchell Kelman; and mechanical engineering majors Joshua Lieberman and Isaac Wittenstein.

Nexidia Honored with Technology and Engineering Emmy Award

Nexidia, a leading developer of dialogue and audio analysis products and technologies and an ATDC graduate company, was honored by the National Academy of Television Arts & Sciences with a Technology and Engineering Achievement Emmy Award for Phonetic Indexing and Timing. A team from Nexidia received this honor on January 8, 2016 at the Technology and Engineering Emmy Awards, held in Las Vegas, Nevada during the Consumer Electronics Show.

The award recognized the unique, patented speech technology behind Nexidia's products for media and entertainment—which focus on search, script-based editing, and caption verification and alignment—for its novel and creative approach to solving some of the industry's most challenging problems.

Mark Clements and Peter Cardillo, founders of Nexidia and inventors of the technology, were among those receiving the Emmy and individual awards for the company. Clements is the Joseph M. Pettit Professor in ECE, and Cardillo is an M.S.E.E. graduate and Nexidia's director for Research and Development.



Cisco Acquires Lancope for \$452.5 Million

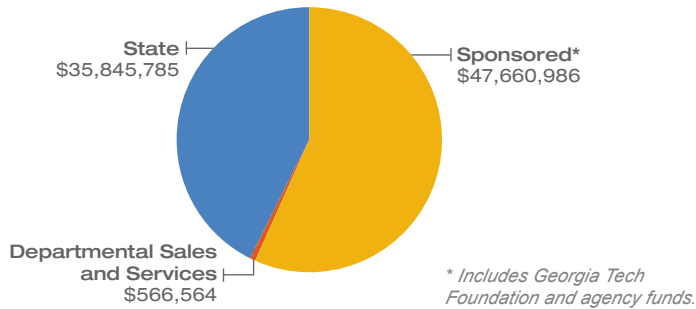
Lancope, an Alpharetta-based network security company, was acquired by Cisco for \$452.5 million in October 2015. An ATDC graduate company, Lancope provides network behavior analytics, threat visibility, and security intelligence to help protect companies against cybersecurity threats. The company was founded by ECE Professor John A. Copeland.

[+] Finances

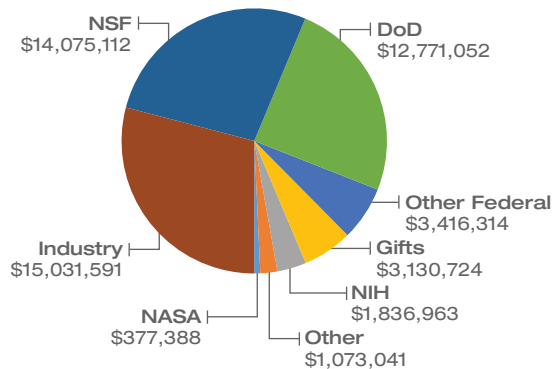
The School spent \$84,073,335 from state, sponsored research, and departmental sales and services sources. Most of this money pays for faculty, staff, and researcher salaries, while the rest is used for materials and supplies, travel, and equipment in support of our research and educational missions.

Research funding for FY 16 totaled \$51,712,185 from grants and contracts, an increase of almost 14% over last year, and includes support received through the Georgia Tech Foundation. Of that total, 29% came from industry, 63% came from federal government sources, 6% came from Georgia Tech Foundation gifts, and 2% came from other sources. Sponsored funding acquired by ECE and its affiliated research centers made up 14% of Georgia Tech's research funding portfolio (excluding GTRI) and 23% of the research funding in the College of Engineering, the largest share of any CoE unit.

FY 16 Expenditures



FY 16 Research Funding



[+] Alumni

ECE Graduates Honored at College of Engineering Alumni Awards

Three ECE alumni were honored at the 2016 Georgia Tech College of Engineering Alumni Awards, held April 26 at the Four Seasons Hotel in Atlanta.



ACADEMY OF DISTINGUISHED ENGINEERING ALUMNI

Behrooz L. Abdi
MSEE '85
President and CEO
InvenSense, Inc.
San Jose, California



ACADEMY OF DISTINGUISHED ENGINEERING ALUMNI

Leslie R. Sibert
BSEE '85
Vice President, Distribution
Georgia Power
Atlanta, Georgia



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James R. Carreker
BSEE '69
Chairman
Arbutus Hospitality Group
Adelaide, South Australia,
Australia

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Acknowledgments

The 2015-2016 annual report of the School of Electrical and Computer Engineering is produced by Jackie Nemeth and Ashlee Gardner, of the ECE Communications Office, and Sarah Collins, College of Engineering Communications Office.

Additional ECE credits: Harry Beck, Linda Dillon, and Mark Richards.

Additional contributors: Ben Brumfield, Laura Diamond, Rob Felt, Jason Maderer, John Toon, and Dan Treadaway, Institute Communications; Allison Caughey, formerly of the Strategic Energy Institute; Lyndsey Lewis, College of Engineering Communications Office; Peralte Paul, Enterprise Innovation Institute; Joe Commare, Wall Street Communications (for Nexidia).