SCHOOL OF

ELECTRICAL [+] COMPUTER ENGINEERING

2013 - 2014 ANNUAL REPORT

Georgia Tech | School of Electrical and Computer Engineering

[+] FROM THE CHAIR

I am proud to share with you the achievements of our faculty, staff, and students in the Georgia Tech School of Electrical and Computer Engineering (ECE). Having recently finished my second year as school chair, it is clearer to me, now more than ever, that a successful ECE means a successful Georgia Tech.

Our faculty members have made groundbreaking advances in many research areas, bringing in over $51 million this past fiscal year to support these efforts. That total represents 15 percent of all Georgia Tech sponsored research awards and 27 percent of the College of Engineering. It is also the largest of any school at Georgia Tech.

Undergraduate and graduate student enrollments continue to rise, with females comprising 20 percent of our incoming freshman class — its highest mark ever. The School awarded 756 degrees in the last academic year, over 50 more than were awarded in 2012-2013. Our faculty and staff are dedicated to preparing our students for graduate school, working in industry and academia, and even creating their own jobs and businesses.

I look forward to continuing our success with your help — our corporate and government partners, alumni, and friends. Please stay connected with us via social media and the web, and stop by to visit if you come to campus. Thank you for your ongoing support!

Sincerely,

Steven W. McLaughlin
Professor and Steve W. Chaddick School Chair

[+] ECE OVERVIEW

ECE at Georgia Tech offers interdisciplinary research and educational programs that are grounded in the fundamentals of engineering, science, and technology. Our 11 technical interest groups are bioengineering, computer systems and software, digital signal processing, electrical energy, electromagnetics, electronic design and applications, microelectronics/microsystems, optics and photonics, systems and controls, telecommunications, and VLSI systems and digital design.

For fiscal year 2014, our undergraduate enrollment was comprised of 1,446 undergraduate students, with electrical engineering majors totaling 925 and computer engineering majors totaling 521. Females represented 13 percent of the undergraduate population and underrepresented minorities made up 16 percent. Graduate student enrollment totaled 1,180, with 16 percent consisting of females and seven percent consisting of underrepresented minorities.

317
total undergraduate degrees awarded

[**233** B.S.E.E. + **84** B.S.Cmp.E.]

[+] **12%** female graduates
17% underrepresented minorities*

439
total graduate degrees awarded

[**335** M.S./M.S.E.C.E. + **1** M.S. in Bioengineering]
[**99** Ph.D. + **2** Ph.D. in Bioengineering + **2** Ph.D. in Robotics]

[+] **16%** female graduates
7% underrepresented minorities*

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

National Rankings, *U.S. News & World Report*

#5
E.E. undergraduate program

#6
Cmp.E. undergraduate program

#6
E.E. graduate program

#7
Cmp.E. graduate program

[+] FACULTY

In FY 2014, the School employed 110 academic faculty, nine academic professionals, 57 research faculty, and 81 administrative staff. The School welcomed four new faculty members and honored one faculty member for his contributions to the ECE instructional program and senior design project advising.

[New Faculty]

Emmanouil K. Antonakakis
Assistant Professor
Computer Systems and Software

Morris B. Cohen
Assistant Professor
Electromagnetics

Omer T. Inan
Assistant Professor
Bioengineering

Maryam Saeedifard
Assistant Professor
Electrical Energy

[Retired Faculty]

Arthur Koblasz
Associate Professor, Bioengineering
- Years of Service to ECE: 1994-2014
- Years of Service to Georgia Tech: School of Engineering Science and Mechanics (1978-89) and the School of Civil and Environmental Engineering (1989-94)

[Faculty Awards]

Georgia Tech ECE faculty members are exceptionally well-rounded, as reflected by accolades earned for teaching, research, educational innovation, mentoring, and lifelong learning. Thirteen faculty members received major awards from IEEE, SPIE, OSA, and other organizations. Mark A. Davenport and Christopher J. Rozell won top government agency funding awards for promising research, and five faculty members were chosen for the most prestigious honors given by the Georgia Tech community.

External Awards

Raghupathy Sivakumar and **Sudhakar Yalamanchili** | IEEE Fellows

Thomas P. Barnwell, III | 2014 IEEE Jack S. Kilby Signal Processing Medal

John D. Cressler | IEEE Rudolf Henning Distinguished Mentoring Award

Biing-Hwang (Fred) Juang | Fellow of the National Academy of Inventors; 2014 IEEE James L. Flanagan Speech and Audio Processing Award

Geoffrey Ye Li | 2013 IEEE James E. Avant Garde Award, given by the IEEE Vehicular Technology Society

Wenshan Cai | Joseph W. Goodman Book Writing Award, co-sponsored by SPIE and OSA

Mark A. Davenport | National Science Foundation CAREER Award; Air Force Office of Scientific Research Young Investigator Award

Christopher J. Rozell | National Science Foundation CAREER Award

Ian F. Akyildiz | Humboldt Research Award, given by the Alexander von Humboldt Foundation

Magnus Egerstedt | 2013 Alumnus of the Year Award from the Royal Institute of Technology

Morris B. Cohen | Santimay Basu Prize, given by the International Union of Radio Science

Santiago C. Grijalva | HENAAC Outstanding Technical Achievement Award

Georgia Tech Awards

John D. Cressler | Outstanding Doctoral Thesis Advisor Award

James O. Hamblen | Class of 1934 Outstanding Innovative Use of Education Technology Award

Bernard Kippelen | Class of 1934 Outstanding Interdisciplinary Activities Award

A.P. Sakis Meliopoulos | Outstanding Professional Education Award

Christopher J. Rozell | Georgia Tech Sigma Xi Young Faculty Award

John B. Peatman (far left) retired from teaching full-time in 2008, but remained with the ECE faculty on a part-time basis until May 2014, at which time he retired permanently with a total of 50 years of service to Georgia Tech. He was honored by his colleagues, former students, family, and friends "crashing" his final class, turning it into a tribute to a man who has meant so much to so many people and who has served as one of the cornerstones on which the modern day Georgia Tech School of Electrical and Computer Engineering was built.

[+] STUDENTS & STUDENT GROUPS

ECE student organizations work with the School's faculty, staff, and administrators on issues ranging from everyday student concerns to K-12 outreach to service to the greater community.

[Student Groups]

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

EcoCAR3

Our students participate in and lead engineering and science organizations, honor societies, and interdisciplinary competition teams. One of the newest is the Georgia Tech EcoCAR3 team. EcoCAR3 is a U.S. Department of Energy (DOE) Advanced Vehicle Technology Competition series, where the U.S. DOE and General Motors will challenge Georgia Tech and 15 other North American teams to redesign a Chevrolet Camaro into a hybrid-electric vehicle, while maintaining the muscle and performance expected from this iconic American car.

[Student Awards]

Our students were honored at ECE's annual Roger P. Webb Awards Program and at several annual Georgia Tech events. Three recently graduated Ph.D. students were honored with Sigma Xi doctoral thesis awards, while James Sutehall (pictured below on the left) received the highest award bestowed on an undergraduate engineering student.

Individual Awards

Mehdi Kiani, **Qing Li**, and **Wencen Wu** | Georgia Tech Sigma Xi Ph.D. Thesis Awards

James Sutehall | Davidson Tau Beta Pi Senior Engineering Cup; Outstanding Electrical Engineering Senior Award

Joseph Guinta and **Brian Nemsick** Henry Ford II Scholar Awards

Priya Bajaj | ECE Undergraduate Research Award

Jiaqi Xue | Outstanding Computer Engineering Senior Award

Neal Jean, **Jason McElrath**, and **Eric Squires** | ECE Senior Scholar Awards

Daniel Murdock | ECE Graduate Teaching Assistant Excellence Award

Ahmad Beirami and **Lu Lu** | ECE Graduate Research Assistant Excellence Awards

### Eta Kappa Nu Tapped for Outstanding Chapter Award

For the eighth year in a row, our Beta Mu Chapter of Eta Kappa Nu (HKN) was named as an Outstanding Chapter at the ECE Department Heads Association Annual Meeting, held during March

2014 in Orlando, Fla. The award was presented to HKN Senior Advisor Clay Cook and HKN Faculty Advisor Thomas K. Gaylord at the 2014 Roger P. Webb Awards Program by ECE Senior Associate Chair Douglas B. Williams.

Georgia Tech Team Wins Top Prize at ACC Clean Energy Challenge

A Georgia Tech team developing a new electrical power grid technology with an Internet-like control architecture won the third annual ACC Clean Energy Challenge and a $100,000 grand prize from the U.S. DOE. The event took place on March 26, 2014 in College Park, Md.

The team — made up of ECE Ph.D. students Mitch Costley, Jennifer Howard, and Marcelo Sandoval and Scheller College of Business M.B.A. student Eric Crane — then represented the southeast region in the U.S. DOE's National Clean Energy Business Plan Finals in Washington, D.C. Costley, Howard, and Sandoval work in the Advanced Computational Electricity Systems Laboratory and are advised by ECE Associate Professor Santiago Grijalva.
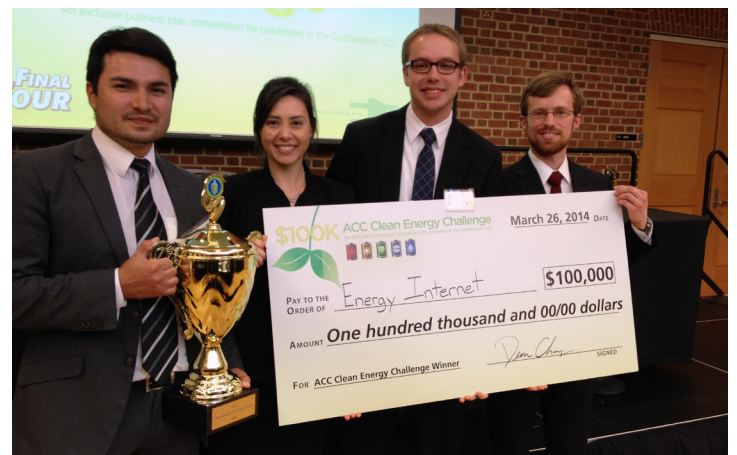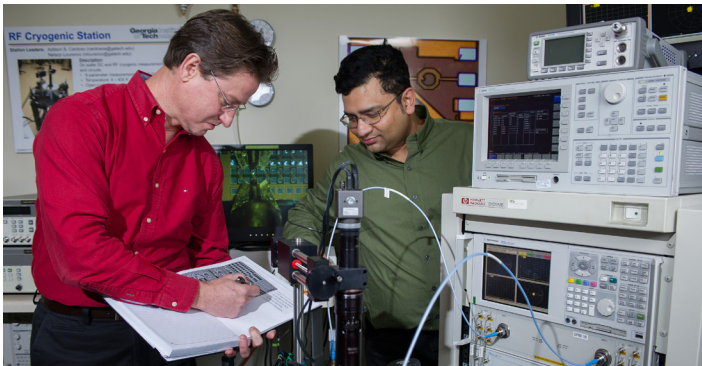
Silicon-Germanium Chip Sets New Speed Record

A research collaboration between Innovations for High Performance (IHP) Microelectronics in Germany and Georgia Tech has demonstrated the world's fastest silicon-based device to date. Investigators operated a silicon-germanium (SiGe) transistor at 798 gigahertz (GHz) maximum oscillation frequency, exceeding the previous speed record for SiGe chips by about 200 GHz.

Although these operating speeds were achieved at extremely cold temperatures, research suggests that record speeds at room temperature aren't far off, said ECE Professor John D. Cressler. Speeds at room temperature would allow for world changing progress in high data rate wireless and wired communications and in signal processing, imaging, sensing, and radar applications. Cressler believes that the goal of breaking the silicon "terahertz" speed barrier is also within reach.


Neuromorphic Computing "Roadmap" Envisions Analog Path to Simulating Human Brain

ECE Professor Jennifer Hasler and her colleagues have published a "roadmap" that details innovative analog-based techniques that could make it possible to build a practical neuromorphic computer.

A core technological hurdle in this field involves the electrical power requirements of computing hardware. Although a human brain functions on 20 watts of electrical energy, a digital computer that could approximate human cognitive abilities would require tens of thousands of large supercomputers, each requiring millions of watts of electricity or more.

The Georgia Tech roadmap proposes a solution based on analog computing techniques, requiring far less electrical power than traditional digital computing. The more efficient analog approach would help solve the size, weight, power, and cost problems that presently make digital neuromorphic hardware systems impractical.
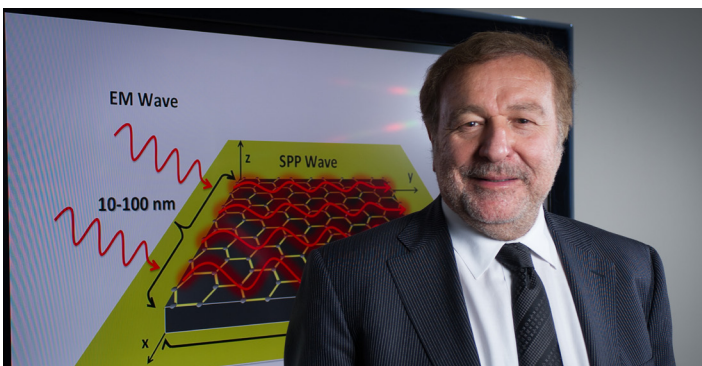
Graphene-Based Nano-Antennas May Enable Networks of Tiny Machines

Networks of nanometer-scale machines offer exciting potential applications in medicine, industry, and defense, but with antennas made from conventional materials like copper, communication between low-power nanomachines would be virtually impossible. By taking advantage of the unique electronic properties of graphene, researchers now believe they're on track to connect devices powered by small amounts of scavenged energy.

Based on a honeycomb network of carbon atoms, graphene could generate an electronic surface wave, allowing antennas just one micron long and 10 to 100 nanometers wide to do the work of much larger antennas. While operating graphene nano-antennas have yet to be demonstrated, ECE Professor Ian F. Akyildiz said his team's modeling and simulations show that nano-networks using the new approach are feasible with the alternative material.

Tongue-Controlled Wheelchair Outperforms Popular Wheelchair Navigation System

In a recent clinical study, individuals with paralysis were able to use a tongue-controlled technology to access computers and drive their wheelchairs at speeds significantly faster than those using sip-and-puff, but with equal accuracy. This study is the first to show that the wireless and wearable Tongue Drive System outperforms sip-and-puff, the most popular assistive technology for controlling a wheelchair, in terms of information transfer rate.

Developed by ECE Associate Professor Maysam Ghovanloo, the Tongue Drive System holds promise for patients who have lost the use of their arms and legs. A magnetic tongue stud lets them use their tongue as a joystick to drive the wheelchair. Sensors mounted on a headset relay the tongue's position to a smartphone, which then executes up to six commands based on the tongue position. Partners in the clinical study include Atlanta's Shepherd Center, the Rehabilitation Institute of Chicago, and the Northwestern University Feinberg School of Medicine; GTRI engineers have also joined the Tongue Drive System team.

Georgia Tech Team Supports Open Architecture Software Standards for Military Avionics

Georgia Tech researchers are helping the U.S. military make key changes in how aircraft electronic systems, called avionics, are produced. The effort, part of the U.S. Navy's Future Airborne Capability Environment (FACE™) project, focuses on modifying the design of avionics software, especially in how it interfaces with an aircraft's hardware and other software.

Georgia Tech's work mainly involves validating and maturing the FACE Technical Standard by producing reference software built according to the new FACE standards. This work is being conducted by GTRI Research Scientist Douglas A. Woods and ECE Professor George F. Riley. The FACE standard allows for streamlining software production and software upgrades, which are vital for keeping U.S. pilots safe and delivering the nation's military capabilities.

Getting Down to Business in Startup Lab and Startup Summer

Encouraging, fostering, and supporting student entrepreneurship is at the center of both ECE 2893/ME 2803 Startup Lab: Introduction to Technology Ventures and the Georgia Tech Startup Summer Program. These new activities are led and taught by ECE Professor Raghupathy Sivakumar.

First offered in spring 2014, Startup Lab began with guest lecturers speaking about their experiences in a startup or entrepreneurial environment and how opportunities are identified. Students then teamed up to develop a business model for a startup idea of their own under the guidance of co-instructors from Georgia Tech VentureLab.
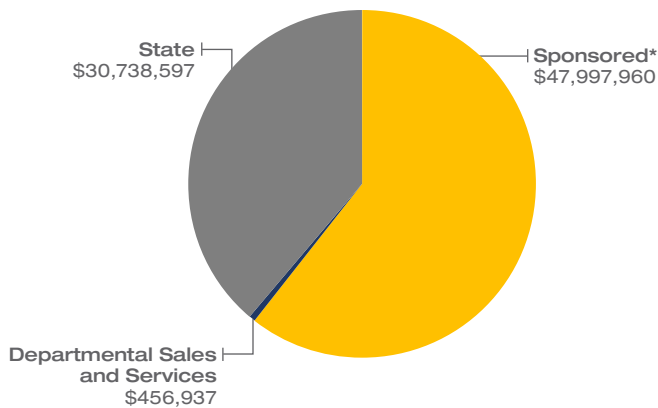
Also held for the first time in 2014, the Georgia Tech Startup Summer Program coached undergraduate student teams on how to launch startups based on their ideas, inventions, and prototypes. The goal is for teams to assess the value of their ideas and to prepare them to meet with potential investors.

[+] COMMERCIALIZATION

ECE faculty members and their students have founded many successful startup companies through the Advanced Technology Development Center and currently have 16 opportunities under evaluation by VentureLab. On the international front, Georgia Tech and ECE commercialization ambitions now extend to Europe with the opening of Institut Lafayette.

Institut Lafayette

Georgia Tech leadership, dignitaries from the United States and the Lorraine region of France, and research and corporate partners gathered last May at Georgia Tech-Lorraine in Metz, France, for the official inauguration of the new building that will house the Institut Lafayette. Led by its two co-presidents, ECE Professors Bernard Kippelen and Abdallah Ougazzaden, Institut Lafayette is about to become a central point for innovations in optoelectronics and advanced semiconductor materials technology and commercialization. Advanced semiconductors are the foundation of a broad spectrum of applications in energy, security, well-being and healthcare, and information and communication technologies. Examples of new products include sensors to monitor vital signs and the environment, next generation and more energy efficient light sources, high power conversion efficiency solar cells, smart watches, and other wearable wireless electronic devices.

Zyrobotics

When an NSF grant led to development of an input device that allows children with disabilities to operate tablet computers, ECE Professor Ayanna Howard wanted to commercialize the technology, so that kids could actually use it.

After talking with more than 100 potential users, Howard learned the need was for a generic interface system that connects different input devices — such as big button switches, joysticks, and sip-and-puff straws — to tablet computers. The market turned out to be larger than she imagined, extending to adults with disabilities and potentially even persons with Alzheimer's.

Howard has now launched a company, Zyrobotics, to commercialize the device, and a version has recently been released on the market. The company will help children with disabilities do what all kids want to do: play video games and interact with computers. Assistance with refining the device came through the Innovation Corps, an NSF program that helps NSF-funded researchers learn about starting up a company — and by talking to potential customers, to determine whether a market exists for their work.

[+] FINANCES

The School spent $79,193,494 from state, sponsored research, and departmental sales and services sources. A large percentage of this total pays for faculty and staff salaries, while the rest is dedicated to materials and supplies, travel, and equipment in support of our research and educational missions.
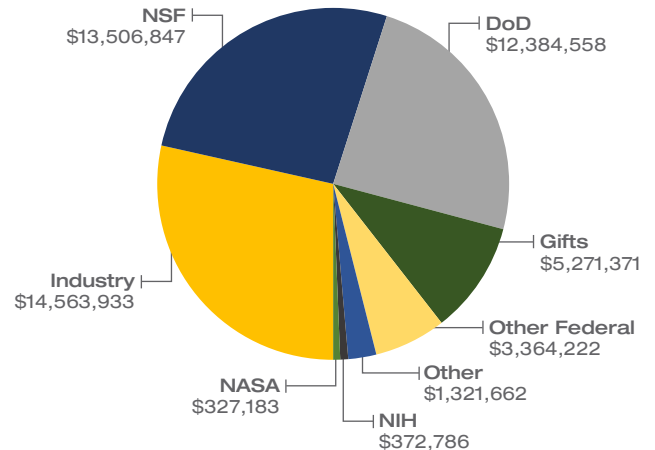
Research funding for FY 14 totaled $51,112,562 from grants and contracts, which also includes support received through the Georgia Tech Foundation. Of that total, 29% came from industry, 58% came from federal government sources, 10% came from Georgia Tech Foundation gifts, and 3% came from other sources.

FY14 Expenditures

State $30,738,597
Sponsored* $47,997,960
Departmental Sales and Services $456,937

Includes Georgia Tech Foundation and agency funds.

FY14 Research Funding

NSF $13,506,847
DoD $12,384,558
Industry $14,563,933
Gifts $5,271,371
Other Federal $3,364,222
Other $1,321,662
NASA $327,183
NIH $372,786

[FY14 Donors]

ECE relies on the generosity of corporate partners, non-profit organizations, and individual donors who contributed $5,271,371 to the School and its affiliates for Campaign Georgia Tech. ECE has the largest fundraising target — $165 million — of any school or department on campus. As of June 30, 2014, $146.2 million had been raised toward that goal.

COMPANIES

AirWatch
Alcoa, Inc.
Allied Energy Services, LLC
Apple, Inc.
AT&T
Avago Technologies, Inc.
Boeing Company
CableLabs
Cisco Systems, Inc.
Colgate-Palmolive Company
ConocoPhillips Corporation
Corning, Inc.
Deere & Company
ExxonMobil Corporation
Georgia Power Company
Global Communication Semiconductors, LLC
Harper Laboratories, LLC
HESM&A, Inc.
Huawei Technologies Co., Ltd.
Huawei Technologies Canada Company, Ltd.
Intel Corporation
Linear Technology Corporation
Lockheed Martin
LyondellBasell Industries
The MathWorks
Microsoft Corporation
Mitsubishi Electric Information Technology Center
National Instruments
Northrop Grumman

Oracle America, Inc.
Oracle Corporation
Prudential Cleanroom Services
Qualcomm, Inc.
Raytheon Company
Robert Bosch Corporation
SanDisk Corporation
Sapient Corporation
Schneider Electric North America
Shell Oil Company
Southern Company Services, Inc.
Texas Instruments, Inc.
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The Workplace Group, Inc.
Williams Benator & Libby, LLP
ZTE USA, Inc.

FOUNDATIONS/ NON-PROFIT ORGANIZATIONS

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AT&T Foundation
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Broadcom Foundation
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Eaton Charitable Fund
ExxonMobil Foundation
Fidelity Investment Charitable Gift Fund

General Motors Foundation
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Lockheed Martin Corporation Foundation
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Otto & Jenny Krauss Charitable Foundation Trust
Radio Club of America
SRC Education Alliance
Schwab Charitable Fund
Vanguard Charitable Endowment
Wallace H. Coulter Foundation
Wells Fargo Community Support Campaign
The Wells Fargo Foundation

PROFESSIONAL, RESEARCH, & ACADEMIC ORGANIZATIONS

Electric Power Research Institute
Eta Kappa Nu Society
ETRI
Vanderbilt University

INDIVIDUALS

C. Dean Alford
Jane Barnes
Steve A. Barton

Thomas A. Bavis
Russell T. Beason
Harry L. Beck
Amanda S. Betts
Suzy Briggs
H. Austin Brown
Robert J. Butera
Mr. and Mrs. James M. Carpenter
Melinda Coker
Thomas R. Collins
Diane M. Conger
Leyla S. Conrad
Ashlee T. Cribb
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Richard M. Cureton
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Michael T. Tuley
Kristin Ann Turgeon
Judith Vanderboom
Anita Wathen-Brownlee
Sabine E. Wathen
Roger P. Webb
Douglas B. Williams
Qi Zhou

[+] DEVELOPMENT

The ECE Development Office cultivates and coordinates the School's fundraising efforts with industry, alumni, and other interested individuals and organizations. They manage the Corporate Affiliates Partnership Program, and they plan the James R. Carreker Distinguished Lecture, the ECE Career Fair, and other activities to promote alumni and corporate involvement with the School.

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, corporate relations manager, at 404-894-2273.

Holman Family Creates Endowed Professorship Focused on Entrepreneurship

The Wayne J. Holman Chair Professorship was established by Wayne J. Holman, III in memory of his grandfather, Wayne J. Holman, Sr., EE 1901, and his father, Wayne J. Holman, Jr., EE 1928, to honor their lifetime accomplishments and their legacies at Georgia Tech.

ECE Professor Raghupathy Sivakumar (pictured at left), who leads the Center for Engineering and Technology Entrepreneurship, was named to this distinguished faculty position.

Holman, Sr., was a member of one of the first classes of electrical engineering graduates and was captain of the football team. He built a career with Central Hudson Gas and Electric Company in New York and later founded and led his own utility company.

Holman, Jr., served as president of his senior class at Georgia Tech. He later joined his father at Central Hudson Gas and Electric and later became president of Chicopee Manufacturing Corporation. Maintaining a strong loyalty to his alma mater, Holman, Jr. served as a trustee of the Georgia Tech Foundation and headed the Greater New York Georgia Tech Alumni Club. He also established the first Class Memorial Fund as a way for alumni to give back in commemoration of the 50th anniversary of their graduation.

ECE Graduates Honored at College of Engineering Alumni Awards

Three ECE alumni were honored at the 2014 Georgia Tech College of Engineering Alumni Awards in three different categories. The event was held April 5 at the Ritz-Carlton in Atlanta.

COUNCIL OF OUTSTANDING YOUNG ENGINEERING ALUMNI

James A. DeBardelaben
Ph.D. EE '98
President & CEO, IvySys Technologies, LLC
Arlington, Virginia

ACADEMY OF DISTINGUISHED ENGINEERING ALUMNI

Thomas J. Quigley
BEE '84
Senior Technical Director (Retired), Broadcom Corporation
Franklin, North Carolina

ENGINEERING HALL OF FAME

Warren L. Batts
BEE '61
CEO (Retired), Tupperware
Chicago, Illinois

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