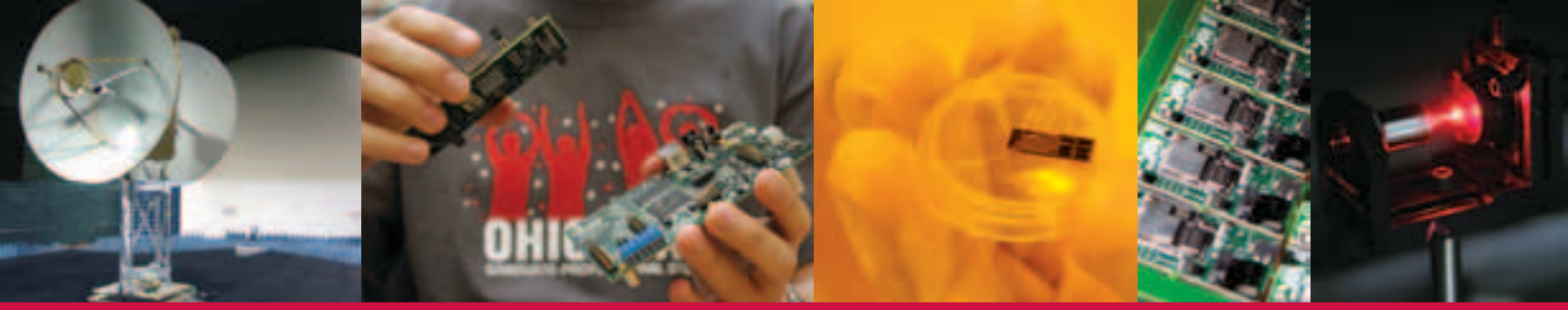


THE OHIO STATE UNIVERSITY
Department of Electrical & Computer Engineering
2009-2010 Annual Report

Points of Pride

$21 million research award funding 2009-10

11th best value nationwide

2nd highest in nation in industry-sponsored research

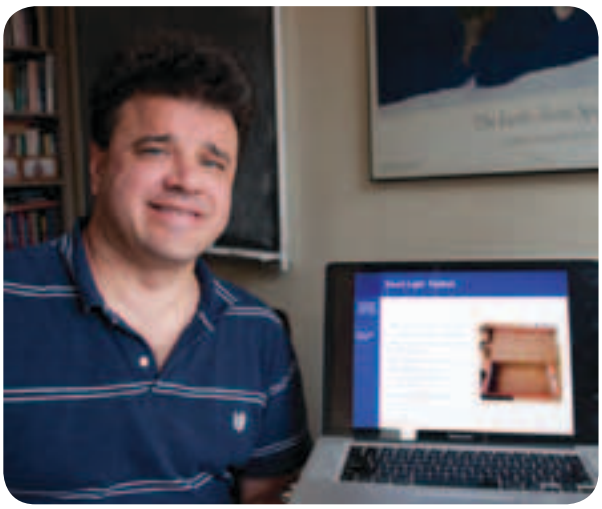
inside

Creating the Next Phase in Smart Lighting

Kevin Passino, professor of electrical and computer engineering, and his team of graduate students found solutions to the distributed control problems of the next phase of smart lighting from an unlikely source: honey bees.

Most people are familiar with the currently-available type of smart lighting that automatically turns on when someone walks into a room and turns off when it is empty.

The next phase of smart lighting, as Passino envisions it, is the modulation of lights based on the overall level of illumination in the room. This means that future smart lights will be able to sense what is happening throughout a room and adjust their intensity as needed to keep the lighting uniform overall. So, for example, when sunlight is shining intensely into a room, the lights closest to the window may automatically dim, while lights on the other side of the room remain unchanged.



Kevin Passino

Not only will the lights be able to adjust themselves based on changes in the environment, but they will also be able to communicate with one another to react to disturbances, Passino explains.

"The lights will be able to communicate to the extent that one light can inform another that it will be turning down, and maybe the other light needs to turn itself up to compensate," says Passino. "Our goal is to have good control of the lights with the least amount of communications between them."

The lights will provide energy savings by taking advantage of natural light in order to use the least amount of energy necessary to uniformly light a room. They will also provide maximum comfort for users.

"I became interested in this research because of the energy savings and because of the intellectual challenge of controlling lights using as little information as possible," says Passino, who is also director of the College of Engineering's Center for Energy, Sustainability and the Environment.

Passino is currently working with Energy Focus, Inc. to fine-tune a shoebox-sized, testbed model of an office building and modulate the testbed lights using a computer. The model is divided into zones, each with its own lights and sensors, to simulate the effects of modulated lighting in a real room.

"This requires both central and distributed control strategies," says Passino.

Part of the solution to the difficulties involved in creating distributed control strategies came from an unlikely source: honeybees. Passino and his team applied research on the mechanisms underlying swarm guidance and cohesion—another of Passino's research areas—to distributed agreement problems, including control of smart lighting.

Bees in a swarm give each other cues about where to go so that the overall swarm agrees on a flight direction. This gave the researchers the idea of letting the lights know which direction to modulate their intensity so that the overall light in the room is uniform. The method was deployed on the model office building and has produced promising results. ■

Message from the Chair

Robert Lee, Chair

This year's annual report has a greater emphasis on energy and power since many faculty members in the power area have greatly expanded their research programs. Faculty members in allied areas are also starting to shift their research emphasis to address this critically important topic to our nation and the world in general.

The ECE department, which is in its 115th year of existence, continues to do well. Our enrollment numbers have remained relatively steady over the past two years, with undergraduate numbers rising for the first time in six years (up 6%). Research funding remains strong with more than $21 million in new awards for the 2009-2010 academic year. Due to retirements, our tenure track faculty size has decreased slightly to 43 FTE with three additional research faculty members. Twenty of these faculty members are IEEE Fellows.

A major initiative within the department this past year was the expansion of the ElectroScience Laboratory (ESL), which is the oldest and arguably the most renowned laboratory in the College of Engineering. Over the past five years, ESL's funding has doubled, and it was clear that better facilities were needed. By the end of 2010, a new $7.3 million building will be completed that will house not only a good portion of ESL, but also companies that will work jointly with ESL researchers on projects.

Several new centers were established this past year in the department. With $9 million in funding from state, federal and industry sources, the Center for High Performance Power Electronics was established under the leadership of Professor Longya Xu. An NSF IUCRC in surveillance was also established under the leadership of Professor Lee Potter. This center will be the second NSF IUCRC in the department. Recently, the state awarded $3 million to Professor John Volakis to establish a center in terahertz sensing.

In addition to the large research awards, we were also one of only nine university recipients of the Department of Energy Workforce Retraining Grant and the only one specifically targeting the area of smart grids. The $2.5 million funding for this education initiative led by Professor Jin Wang will revolutionize how we teach power within the department. ■

Three Junior Faculty Receive Awards

Atilla Eryilmaz

Ronald Reano

Fernando Teixeira

Three ECE faculty received national awards this year. **Fernando Teixeira**, associate professor, received a 2010 Outstanding Young Engineer Award from the IEEE Microwave Theory and Techniques Society. Teixeira was recognized for his outstanding contributions to numerical methods and CAD techniques for RF and microwave applications. The award recognizes outstanding MTT-S members under the age of 39 who have distinguished themselves through technical achievements, exemplary service to the society, or both.

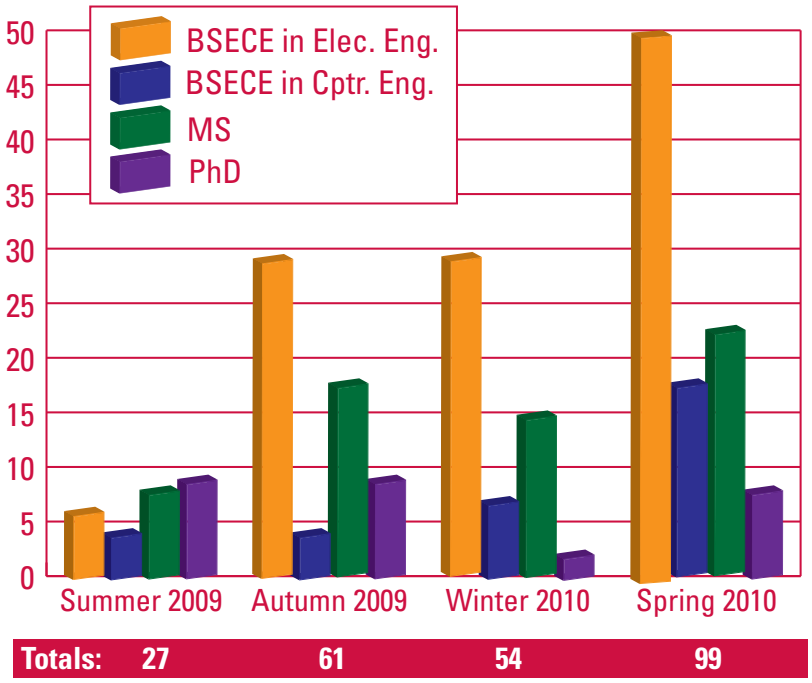
Assistant professors **Atilla Eryilmaz** and **Ronald Reano** were awarded Faculty Early Career Development awards from the National Science Foundation in 2010.

Eryilmaz's $462,716 grant will support his research on "Theoretical Foundations for Wireless Network Algorithm Design: Satisfying Short-Term and Long-Term Application Requirements." Eryilmaz and his research group will help develop the theory and methodologies for the systematic design of efficient and practical communication protocols that can serve a variety of essential applications. Such protocols are paramount for the satisfactory operation of many future-generation wireless networks, including both commercial and military networks expected to serve a wide range of applications with diverse performance requirements imposed by entertainment-based, healthcare, rescue-related, security and automated control applications.

Reano was awarded $400,000 for "Creating a New Class of Organic-Inorganic Dispersion Engineered RF-Optical Modulators." His research objective is to efficiently convert high-frequency electrical signals into the optical domain using planar lightwave circuits. Combining the advantages of optics and electronics in hybrid systems addresses concurrent demands for greater bandwidth and mobility, thereby impacting the networking, computing, and sensing industries. ■

STUDENT STATISTICS

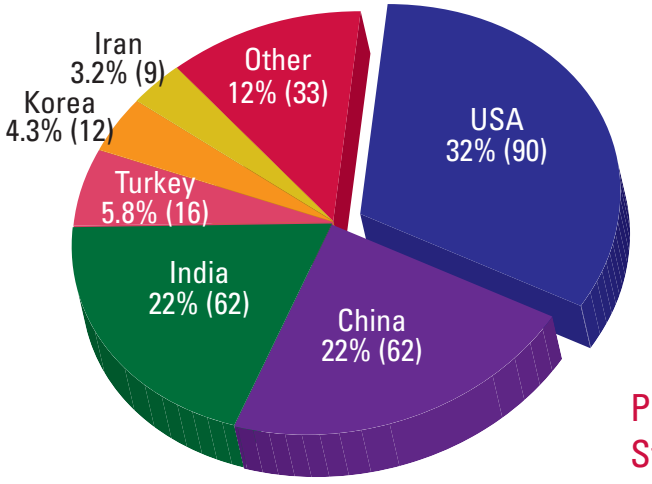
Degrees Conferred 2009-2010



University, Industry & ECE Supported Students	
Graduate Teaching Associate	29
Graduate Research Associate	107
Graduate Administrative Associate	2
Fellowships	28
Total:	166

Supported Graduate Students for 2009-2010

Graduate Student Overview 2009-2010	
Total Number of Graduate Students (Au 2009)	278
New Applicants	1155
Number Admitted	141
Average GRE (quantitative)	758



Percentage of Graduate Students Enrolled by Country

The molecular beam epitaxy system at Ohio State is used for growth of III-Nitride semiconductors with atomic precision.

Advancing the Emerging Field of Diamond Electronics

Researchers worldwide have recognized the promise of diamond electronics for several years, but multiple challenges have prevented diamond from being used widely. New research by faculty at The Ohio State University aims to advance this emerging field.

Electrical and computer engineering faculty members, Siddharth Rajan, Steven Ringel and Roberto Myers, in partnership with Ohio State physics faculty, aim to investigate diamond, as well as the combination of diamond and gallium nitride, at the nanoscale level in order to create new materials for use in high-power electronics and other applications.

Gallium nitride is another emerging semiconductor material that has various applications in lighting, power electronics and communications.

"Diamond is the best semiconductor for power application by a wide margin, but it's hard to make, costly and requires more research on its science and physical properties in order to use it," says Siddharth Rajan, assistant professor of electrical and computer engineering and materials science and engineering.

Ohio State researchers' efforts to combine diamond and gallium nitride are unique since these materials have never been used before in a hybrid semiconductor device.

The combined materials show promise in many areas, including high-power applications such as the use of diamond transistors in hybrid cars. In high-frequency communications, diamond transistors could help shrink the size of cell phone towers, allowing for the installation of more towers and eventually helping increase the speed of wireless internet on mobile devices. Researchers are also excited at the prospect of using diamond as chemical sensors and biosensors. Made up of harmless carbon atoms, diamond is a safe material for biosensors, yet is robust enough to resist corrosion and degradation.

In order to perform this work, researchers must first grow the needed crystalline or polycrystalline diamond and gallium nitride. Unlike natural diamond — which is valued for its reflective properties and color, qualities that are the result of impurities — man-made diamonds are completely pure, as needed for use in electronics, and therefore completely transparent.

A recent National Science Foundation Major Research Initiative Award provided $500,000 to Ohio State to fund the purchase of two systems, one to grow the diamond and one to grow the gallium nitride. These systems enable researchers to grow the materials with nanometer scale control on properties such as composition and doping density. Ohio State contributed an additional $250,000 in cost-share funding for the project.

"These new systems allow us to do cutting-edge work on diamond electronics here at Ohio State," says Rajan.

Once the materials are grown, researchers add electronic systems and dice them into small wafers, each only a few centimeters long. Engineers then test the resulting transistors for performance and make design changes as needed.

While electrical and computer engineers are working to make devices for energy efficient applications, physics faculty, including Ezekiel Johnston-Halperin, principal investigator for the NSF grant; and Fengyuan Yang, are examining the applications of electronic spin in diamond nanostructures for quantum computation. Another investigator in this project, Physics Professor Harris Kagan, is an expert on diamond radiation detectors for accelerator facilities such as those at CERN, the European Organization for Nuclear Research.

"We believe that the close collaboration at Ohio State between physicists and electrical engineers could be a promising path to take fundamental physics knowledge into an applied area such as computation," says Rajan. ■

"We believe that the close collaboration at Ohio State between physicists and electrical engineers could be a promising path to take fundamental physics knowledge into an applied area such as computation."

The diamond plasma chemical vapor deposition system to be installed at Ohio State will enable the synthesis of diamond electronic devices.

Third Frontier Funding Expands Power Electronics Research

A new research center at Ohio State will focus on the commercialization of semiconductors for electrical power handling in the military and civil aircraft industry.

The Ohio Third Frontier commission awarded Ohio State a $3 million grant to establish the Center for High Performance Power Electronics.

Through the center, Ohio State researchers will focus on technical development in power electronics for GE and the U.S. Air Force Research Laboratory. The university also will be a source of power electronics knowledge and trained engineers for Ohio's power electronics manufacturers. GE, the Air Force Research Laboratory and Ohio State will provide the new center with an additional $6 million in funding, equipment and services.

Much of the research that will be conducted at the center will focus on aerospace technology, particularly in developing the uses for silicon carbide (SiC), a transparent crystalline compound that is one of the hardest known substances and considered to be the front runner in the "wide-band gap" power semiconductor revolution. The substance can be used in power semiconductors that operate at higher temperatures, higher switching frequencies and lower switching losses for engine starting, emergency power, battery charging and circuit breakers.

"In advanced military aircraft, such as the F-35 fighter, all of the generated electrical power is controlled with power electronics and virtually all of the loads are driven with power electronic converters," says Longya Xu, professor of electrical and computer engineering and the principal investigator of the Third Frontier grant. "The U.S. Department of Defense has targeted silicon carbide as the critical switching element in game changing electrical power handling."

Today, the power semiconductors of choice are silicon-based. However, silicon carbide-based semiconductors offer 50 to 100 degrees centigrade higher operating temperatures, three to 10 times higher switching frequencies and more efficient converters.

Although initial applications of silicon carbide power electronics will likely be in the aerospace market, future applications will include the electric and hybrid electric vehicle industry, renewable energy systems, including wind and solar, and eventually consumer products. ■

ECE Awarded $2.5 Million to Reinvigorate Power Engineering Education

The ECE department was awarded $2.5 million in Recovery Act Funds from the U.S. Department of Energy to reinvigorate electrical power engineering education. Jin Wang, assistant professor of electrical and computer engineering and supervisor of the High Voltage and Power Electronics Laboratory, will lead the project at Ohio State.

The award will be used to develop an interdisciplinary curriculum to train the next generation of power engineers on smart grid technologies.

The curriculum will include a hardware-in-the-loop based Virtual Smart Grid Test Platform, which will simulate the functions of a real smart grid in an integrative environment. In addition, a comprehensive distance learning system will be implemented, allowing both new engineers and current technicians to learn about smart grid technologies. The project will also include a hands-on summer workshop for high school teachers and provide classroom materials.

"The drive to implement smart grid technologies presents a great challenge and opportunity for power engineers," says Wang. "This grant supports our efforts to provide students with the latest skills and training necessary to be at the forefront of those activities." ■

Jin Wang

ECE Establishes Surveillance Center

Ohio State has been awarded a National Science Foundation (NSF) Industry/University Collaborative Research Center (IUCRC) in surveillance. The Center for Surveillance Research aims to develop a principled theory and advanced practice for modern surveillance systems. CSR is a collaborative effort by academia, government and industry to conduct pre-competitive research and to train students as the next generation of technology leaders.

The Center for Surveillance Research has two university sites: The Ohio State University and Wright State University. This is the second IUCRC in the Department of Electrical and Computer Engineering and supports the department's efforts to increase research in the sensors area. Lee Potter, associate professor of electrical and computer engineering, directs the center, with Randy Moses, professor of electrical and computer engineering and associate engineering dean for research, as co-director. The center supports seven PhD students.

"The NSF IUCRC program is ideally suited to facilitate our partnerships with industry and government laboratories," reports Potter. "I believe the center award is a recognition of both the relevance of our research and the high regard our partners hold for Ohio State students."

Surveillance and situational awareness for disaster mitigation/ management and environmental monitoring are critical technologies needed to address societal needs of safety and security. The key to addressing these crucial issues lies in the effective use of sensors and sensor systems. While individual sensor technology is advancing, there is a compelling need to understand composite surveillance systems. The challenge is to design quantitative tools that aid in designing surveillance systems to achieve particular inference goals and to develop a theory for predicting surveillance performance.

CSR's scientific research program addresses the breadth and depth of surveillance science. The core disciplines include sensor exploitation, signature prediction, computation and functional baseline descriptions. Currently, investigators in the center come from five different departments.

The center's seven members are the Air Force Research Laboratory, Army Research Laboratory, Boeing, Etegent, Raytheon, SAIC and SET Corporation. ■

Ohio State Among Finalists for International Robotics Competition

Ohio State's Control & Intelligent Transportation Research Lab will take part in the $1.6 million Multi Autonomous Ground-Robotic International Challenge (MAGIC) November 2010 in South Australia. MAGIC 2010 aims to develop next-generation, fully autonomous ground robots that can be deployed effectively in military operations and civilian emergency situations.

One of team Cappadocia's unmanned vehicles

The competition is organized by the U.S. and Australian departments of defense.

MAGIC competitors must accurately and completely explore and map the challenge area, as well as correctly locate, classify and recognize all simulated threats within 3.5 hours.

Ohio State is part of Turkish team Cappadocia, which is led by military electronics company ASELAN, with Bilkent University, Bogazici University and Middle East Technical University.

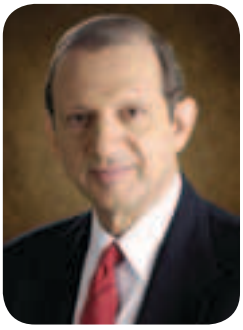
The Control & Intelligent Transportation Research Lab, led by Ümit Özgüner, professor of electrical and computer engineering, is responsible for several pieces of Team Cappadocia's effort, including creating the indoor testbed and simulation environment, as well as two of the simulator software modules. The two modules, the dynamic mission planner and high-level controller, are responsible for the central task assignment/mission completion and independent decision making of each robot.

Six finalist teams were selected out of the 23 entries received. The finalists are Cappadocia (Turkey), Chiba (Japan), Magician (Australia), RASR (USA), Team Michigan (USA), and the University of Pennsylvania (USA). ■

Distinguished Alumni


Paul Ryan


Sam Lee


John Makhoul


Patrick Y. Yang

Four ECE alumni were honored by the Ohio State College of Engineering at the 2010 Excellence in Engineering & Architecture Alumni Awards.

Innovator and businessman Paul Ryan received the Benjamin G. Lamme Meritorious Achievement Medal, the college's premier award. This is the second year in a row that an ECE alumnus received this honor.

Paul Ryan is a 1956 electrical engineering graduate. Three years after graduation, Ryan formed Dytronics Company, Inc. to develop and produce precision instrumentation for aerospace applications. Significant contributions were made to the Apollo space program, with special recognition for developing a primary method of measuring the phase angle between two electrical signals. The resulting product, called the "Primary Phase Angle Standard," was supplied to every aerospace metrology laboratory, both government and private, as well as the metrology laboratories of all NATO nations.

In the 1970s, Ryan developed a weather mapping system called the Ryan Stormscope for pilots and in 1981 established Ryan International Corporation to continue improvement of flight safety. His Traffic Advisory System, which generates a map of aircraft traffic up to 50 miles away for pilot viewing, is used in thousands of aircraft today.

In 2005, Ryan sold his company, which merged with Avidyne Corp., a leading producer of avionics.

ECE alumni Sam Lee, John Makhoul and Patrick Y. Yang each received a 2010 Distinguished Alumnus Award.

Sam Lee, MS 1972 and PhD 1974, electrical engineering, is a managing director of Fina Ventures, an international venture fund investing in technology companies. Earlier in his career, he served in executive positions at Global Communication semiconductors, NeoPad Technologies, Fairchild Semiconductor International, Raytheon Semiconductors, TRW LSI Product Division, Motorola and AMCC.

John Makhoul, MS 1965, electrical engineering, is a chief scientist at BBN Technologies, where he works on various aspects of speech and language processing and is the director of the science development program. Makhoul has made a number of contributions to the mathematical modeling of speech signals, including an understanding of linear prediction, which models the evolution of a signal over time, and vector quantization, allowing for the efficient coding of signals and parameters. These formulations have had applications in various aspects of speech processing, including speech analysis and synthesis, speech coding, and speech recognition.

Patrick Y. Yang, PhD 1975, electrical engineering and computer science, is executive vice president and global head of technical operations of Roche Pharmaceuticals, based in Basel, Switzerland, where he is responsible for the company's worldwide biopharmaceutical manufacturing operations, process research and development, engineering, regulatory, quality and compliance, supply chain management and manufacturing collaboration functions. ■

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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Columbus, OH 43210-1272
14450 017000 61801

International & National Student Awards, 2009-2010

Student	Award	Advisor
Damoun Ahmadi	Best Presentation Award of Session C2L, 2010 IEEE Applied Power Electronics Conference	Jin Wang
Josh Ash	2009 IEEE Signal Processing Magazine Best Paper Award	Randy Moses
Sidharth Balasubramanian	Third Place, Circuit Design Technologies Category, 2010 TSMC Outstanding Student Research Awards	Waleed Khalil
Kenneth Browne	Second Place, 2010 IEEE Antennas and Propagation Society Student Paper Competition	Robert Burkholder John Volakis
Titus Chen	Tom R. Burkes Exceptional Undergraduate Student Award, 2010 IEEE International Power Modulator and High Voltage Conference	Donald Kasten
Christopher Church	Best Presentation Award of Session A5, Institute of Navigation's Global Navigation Satellite Systems 2009 Conference	Inder J. Gupta
Kerry Dungan	Best Student Paper Award, 2010 SPIE Algorithms for Synthetic Aperture Radar Imagery XVII Conference	Lee Potter
Timothy Hartley	Best Student Paper Award, 2010 ACM International Symposium on High Performance Distributed Computing	Ümit V. Çatalyürek
Kevin Huggins & Michael McGrath	First Place Award, Grand Challenge: Signals of Opportunity, 2009 IEEE National Aerospace & Electronics Conference	Yuan F. Zheng
Justin Kasemodel	2009 IEEE Antennas and Propagation Society Doctoral Research Award; Best Student Paper Award, 2009 Antenna Applications Symposium	John Volakis and Chi-Chih Chen
Gil Young Lee	Third Place, Student Paper Competition, 2010 Applied Computational Electromagnetics Society Conference	John Volakis and Chi-Chih Chen
Tyler Merz	2010 Barry M. Goldwater Scholarship	Leonard Brillson
Andrew O'Brien & Kyle Hayhurst	Best Presentation Award of Session E2, Institute of Navigation's Global Navigation Satellite Systems 2009 Conference	Inder J. Gupta
Ioannis Tzanidis	First Place, 2010 IEEE Antennas and Propagation Society Student Paper Competition	Kubilay Sertel and John Volakis