

DEPARTMENT OF ELECTRICAL + COMPUTER ENGINEERING



Assistant Professors Usman Khan (left) and Babak Moaveni (right) build smart-monitoring quadcopter technologies for infrastructure such as buildings and bridges.

BRIDGING THE STRUCTURES GAP

Khan's quadcopters provide flyby smart monitoring

More than 66,000 bridges in the United States—one in nine—are structurally deficient, according to a report by Transportation for America. These bridges span more than 1,500 miles, and currently require structural engineers to physically inspect the structures to collect data. Wireless Sensor Networks (WSNs) have been proposed as an autonomous way to monitor bridges; however, WSN power sources lack the necessary energy for long-range transmission of data.

Assistant Professor Usman Khan received an NSF CAREER Award to conduct research on his novel solution to the wireless transmission problem: data collection and processing via Unmanned Aerial Vehicles (UAVs) that interface with existing WSNs to provide low-cost, low-maintenance, autonomous data collection and inspection.

In collaboration with Assistant Professor Babak Moaveni the Department of Civil and

“This smart monitoring and inspection system is a step toward improving the sustainability and resilience of the current infrastructure.”

Environmental Engineering, Khan has been testing the viability of his concept on a footbridge that spans the distance between Dowling Hall and the main Tufts campus. Moaveni outfitted the bridge with accelerometers and thermocouples that transmit data to a collection hub for analysis.

The research team will upgrade the sensors to WSNs that use RFID tags to store and transmit (partially)

Continued on page 4

IN THIS ISSUE

From the Chair 2

Congratulations to our Graduates 3

Faculty Highlight 4

Research Highlights 5

Quick Hits 5

On and Off Campus 6

Alumni News 7

MESSAGE FROM THE CHAIR



Dear ECE Alumni and Friends,

It has been another great year for the Department of Electrical and Computer Engineering. As in the past, I like to start by highlighting the accomplishments of our students. Last May, we granted 14 bachelor's degrees in electrical engineering and another four in computer engineering. At the graduate level, we continue to see strength in our program with eight master's degrees and four doctorates. Over the past few years, ECE departments nationally have seen declining enrollments and Tufts has been no exception. Working with folks both in the Dean's Office as well as the Office of Undergraduate Admissions, I am happy to say that this year at least we have managed to reverse that trend. Initial enrollments for the class of 2017 in ECE are up from 30 last year to 37 this year. This is a great sign for us, and we hope to see it continue well into the future.

This has also been a year of much success for our students and alumni. Last May, a team of undergraduates including our own Nicholas Ferrentino, Hassan Oukacha, Denise Nguyen (EE), and Mical Nobel (CE) were awarded the 2013 Ricci Prize for their project to improve an ophthalmological device used to determine the recommended course of treatment for glaucoma patients. This is the second year running where ECE students have been on the winning team! I am also thrilled to let you know that Sampathkumar (Sam) Veeraraghavan, EG10, was awarded the 2013 Tufts Young Alumni Distinguished Achievement Award in recognition of outstanding leadership and pioneering contributions in the field of large scale computing to address pressing global challenges in the field of healthcare, education, and disabilities. For this work, Sam was also honored with the 2013 IEEE-Eta Kappa Nu Outstanding Young Professional Award and the 2013 IEEE Member and Geographic Activities Achievement Award for Technological and Leadership Excellence.

Among the faculty, Assistant Professor Usman Khan was the recipient of the prestigious CAREER Award from the National Science Foundation for his work on using unmanned aerial vehicles for civil infrastructure health monitoring. The NSF also awarded John

A. and Dorothy M. Adams Faculty Development Professor Tom Vandervelde more than \$1M to construct a state-of-the-art Molecular Beam Epitaxy system to support his work in constructing the solar cell of the future. I am also happy to announce that Professor Karen Panetta has been appointed the Associate Dean for Graduate Education of Tufts School of Engineering. While we see a bit less of her around the department, Professor Panetta is doing a great job helping to move the school's graduate programs to the next level.

Should you be in the Boston area, I hope you will stop by Halligan and see what is happening, though you may not recognize the place. Among all of the other great things last year, the university completed a major renovation of Halligan, gutting the space on the second floor formerly occupied by Athletics and providing us with beautiful new offices, conference space, and open collaboration areas. With all new windows, it is literally like night and day. In the meantime, I hope to see you at the next Senior Dinner and Awards ceremony on May 9 in Alumnae Lounge.

With best regards,

Eric

Congratulations to Our Graduates

Doctoral Recipients

George Saveriades: “The Effects of Magnetic Exposure on the Nervous System: A Study on the Effects of Low-strength Low-frequency Magnetic Fields on Neurotransmitter Exocytosis and Cell Viability through Ionic Cyclotron Resonance Frequency”
Advisor: Joseph Noonan

Anjali Sharma:
“Characterization and Study of Ferromagnetic Resonance of Micro and Nano Ferrites at Microwave and Millimeter Waves”
Advisor: Mohammed Afsar

Corey M. Shemelya:
“Photonics: Photodiodes and Metamaterials for Thermophotovoltaics and Photodetection Applications”
Advisor: Thomas Vandervelde

Wangren Xu: “Metamaterials with Active Circuits”
Advisor: Sameer Sonkusale

Master of Science in Electrical Engineering

Frances E. Bell

Ninrat Datiri

Daniel James Downing

Haaris B. Ghafoor

Sid un Li

Samuel MacNaughton

Wes Uy

Clifford C. Youn

Bachelor of Science in Electrical Engineering

Edwin V. Babbitt IV

Meth A. Bandara

Thomas W. Cahill

Brennon Alexander Costello

Joshua James Elliott

Nicholas Ferrentino

Ronald James Hong

Haris Iqbal

Denise Nguyen

Hassan Oukacha

Ramanjit Singh

Scott James Staniewicz

Michael Douglas Tran

Anders Simpson-Wolf

Bachelor of Science in Computer Engineering

Ross Beighley

Tyler Heck

Daniel Unyante Kotin

Mical Judith Nobel

Graduate Student Awards

Sam MacNaughton, EG13, won the 2013 School of Engineering graduate student award for “Outstanding Contributor to Engineering Education” on Friday, April 26, 2013 at the Graduate Student Awards ceremony.

Undergraduate Award Winners

Hassan Oukacha was awarded the Morris and Sid Heyman Prize Scholarship, established in 1980 by the bequest of Mrs. Sid L. Heyman in memory of her husband, Morris Heyman, who graduated from Tufts University in 1919 with a Bachelor of Science degree in electrical engineering. The scholarship is awarded to one or more undergraduate students in the Department of Electrical Engineering based on academic achievement and future promise.

Ramanjit Singh, **Scott James Staniewicz**, and **Anders E. Simpson-Wolf** were recipients of the Harry Poole Burden Prize in Electrical Engineering established in 1973 by friends of Harry Burden, H53, dean of the College of Engineering from 1936 to 1957. The award recognizes the best design or research projects done by electrical engineering undergraduate students during the current academic year.

Anders E. Simpson-Wolf won the Lt. Commander R.J. Manning Memorial Prize, awarded annually to engineering undergraduates who are industrious, competent, and enthusiastic, and who show the same commitment to excellence that Lt. Commander Manning demonstrated throughout his life. The prize was established in 1990 by Lt. Commander Manning’s wife Nancy E. Manning, with the support of his friends and family.

Ross Beighley, **Tyler Heck**, and **Michael Douglas Tran** were recipients of the Amos Emerson Dolbear Scholarship given to seniors who have shown promise in the field of electrical engineering or physics. The awards were created by the bequest of Katherine E. Dolbear of the Class of 1897 in memory of an eminent scientist and teacher at Tufts.



School of Engineering Dean Linda Abriola, Wangren Xu, and Associate Professor Sameer Sonkusale at the Doctoral Hooding Ceremony on the Bromfield-Pearson Lawn on May 18, 2013 during commencement weekend.

Bridging the Structures Gap *Continued from page 1*

processed data to a lightweight UAV quadcopter. A network of quadcopters will autonomously navigate to the sensors placed on the bridge and process the RFID tag data. After analyzing the data, the UAVs may reprogram the sensors to sample data more frequently based on heavy traffic patterns among other scenarios. The data analysis may also prompt the UAVs to gather auxiliary information such as images of joints and beams.

Khan's investigation in dynamic task allocation, distributed path planning, and collaborative navigation builds upon some of the classical work in convex geometry and Euclidean metrics. His work

frames this distributed control problem using structured systems theory by which efficient controllability and actuation methods can be developed. By establishing rigorous analytical arguments, members of Khan's lab are working toward implementing a functional, remote monitoring and inspection prototype.

"This smart monitoring and inspection system is a step toward improving the sustainability and resilience of the current infrastructure," said Khan.

Read more about Khan's work and projects in signal processing robotics on his website: <http://spartn.ece.tufts.edu/>

FACULTY HIGHLIGHT



In July 2013, Professor Karen Panetta was appointed Associate Dean for Graduate Education. Professor Panetta was also awarded the 2013 IEEE William E. Sayle II Award for Achievement in Education, an award given annually to a member of the IEEE Education Society to recognize significant contributions over a period of years in one of the Fields of Interest of the IEEE Education Society. She was also recognized as the 2013 New England Achievement Award Winner for Engineers Week–New England.

IDBR Workshop, May 1-2

BIOLOGICAL RESEARCH INSTRUMENTATION: DEVELOPMENT AND DISSEMINATION

Associate Professors Sameer Sonkusale and Valencia Joyner Koomson were awarded support from the National Science Foundation's Instrument Development for Biological Research (IDBR) program to develop a workshop to bring together an interdisciplinary group of biologists, physicists, engineers, industry experts, and government officials to discuss best practices for the development and dissemination of instrumentation for biological research. The event will be held May 1–2, 2014 in Rosslyn VA. Register online at: <http://idbr.ece.tufts.edu/>

Notables...

Postdoc **Arvind Saibaba** was the lead author on a paper that received an Editors' Choice Award from Water Resources Research. He is currently working on optical topographic imaging methods for breast cancer detection.

Robert D'Angelo won the 2013 School of Engineering graduate award for "Outstanding Researcher" at the master's level on Friday, April 26, 2013 at the Graduate Student Awards ceremony.

Dante DeMeo, doctoral student, won an award from the NSF Engineering Innovation Fellows Program.

Doctoral student **Abbey Licht** received an NSF Graduate Research Opportunities Worldwide (GROW) award to conduct research at the NanoMIR Laboratory in Montpellier, France. At the fall 2013 Material Research Society conference, Abbey's paper received an outstanding paper award. She was also invited to submit a featured paper in the *Journal of Materials Research*.

Chiamaka Chima and **Nana Kwasi Kwakwa** presented their research conducted in Associate Professor Valencia Koomson's Advanced Integrated Circuits and Systems Lab at the 2013 National Collegiate Research Conference at Harvard University. NCRC is a platform for undergraduates from across the nation to share their interest in research.

RESEARCH HIGHLIGHTS

Assistant Professor **Shuchin Aeron** received an NSF award in support of his work on the study of high-dimensional signals and systems. This multidisciplinary effort, which includes ECE faculty as well as faculty from Tufts' Department of Mathematics, is aimed at developing novel and efficient methods for representing and processing data in applications ranging from medical imaging and video to satellite remote sensing and geophysical exploration.

Assistant Professor **Tom Vandervelde** received a \$1M grant for equipment crucial in the development of solar cells, infrared cameras, high-speed (100+GHz) circuits, lasers, and LED lighting. He received a Major Research Instrumentation award from the National Science Foundation to build a multi-chamber Molecular Beam Epitaxy system, which enables the creation of novel semiconductor materials and devices.

Professor **Mohammed Afsar** and Associate Professor **Valencia Joyner Koomson** were awarded a \$470,000 grant from the National Science Foundation for a project aimed at the development of low-cost, miniaturized devices and circuits for use in high-frequency radar and communications systems. The effort rests on integrating these devices, based on novel nanoscale hexaferrite materials, into traditional CMOS processing.

Tufts engineers and collaborators received the 2012 The Strategic Environmental Research and Development Program (SERDP) Project-of-the-Year Award in the environmental restoration area for their project modeling groundwater contaminants on military installations. At Tufts School of Engineering, Professor and Chair **Eric Miller** and colleagues in the Department of Civil and Environmental Engineering—including Professor and Dean **Linda M. Abriola**, Professor and Chair **Kurt Pennell**, and Associate Professor **Andrew Ramsburg**—collaborated with John A. Christ of the U.S. Air Force Academy to develop innovative tools that, for the first time, can provide key information about a source zone's structure and characteristics, also referred to as architecture. This work, which combines high-end computational techniques and physical models, can help explain why contamination persists, how long it will persist, and what the best options are for treating it.

Ricci Prize Winners

ECE seniors **Nicholas Ferrentino**, **Denise Nguyen**, **Mical Nobel**, **Hassan Oukacha**, and **Bianka Mejia** (engineering psychology) were the 2013 grand prize winners of the Stephen and Geraldine Ricci Interdisciplinary Prize for their project to improve an ophthalmological device used to determine the recommended course of treatment for glaucoma patients.

The Ricci Prize promotes the advancement of research at Tufts through projects that assist in translation of research discoveries from the laboratory to applications that benefit society.

The team was advised by Professor of the Practice **Ron Lasser** who "believed in our ability to tackle most of

the problems that we encountered," said Hassan. "He also brought two professional designers on board, which gave our team a huge mental boost to work harder." Hassan and Mical presented their work at the second annual Ricci Lecture in November 2013. "This experience was as close as it gets to the real world life of engineers; where we used the basic knowledge and skills to find a solution to a particular problem," said Hassan, "All team members were aware of the big impact that our device would make in lives of many people."



Watch a video about the digital tonographer device designed by the ECE team

QUICK HITS



Associate Professor **Mai Vu** and Assistant Professor **Usman Khan** have been elevated to the rank of Senior Member of the IEEE, an honor held by fewer than eight percent of more than 415,000 IEEE members. Prof. Vu was also named an Associate Editor at the IEEE Transactions on Wireless Communications.



Professor **Jeff Hopwood** and Research Assistant Professor **Alan Hoskinson** received US Air Force funding for research on excited-state

rare gas lasers. In collaboration with Emory University, the Air Force Institute of Technology, and industrial partners, the Tufts team will design low-voltage microdischarges operating at atmospheric pressure and then measure their production of the metastable atoms which are at the core of proposed laser technology.



Associate Professor **Sameer Sonkusale** was recently awarded funding from the Tufts Faculty Research Awards Committee to support

the testing and performance evaluation of miniaturized circuits and sensors that operate at terahertz frequencies, a regime of the electromagnetic spectrum of great interest for problems in sensing and communications.



The Tufts Faculty Research Awards Committee gave Assistant Professor **Usman Khan** a grant to support his research in

low-power aerial surveillance of infrastructure. Khan was recently awarded a U.S. patent as the lead inventor for work on improved methods to locate, track, and monitor resources in large-scale facilities. The system is based on advanced sensor network technology and is efficient, scalable, and requires only short-range communication. Last June, Khan also delivered a talk on quadcopter autonomous UAVs at the IEEE COMSOC/CS Maine Chapter.

ON AND OFF CAMPUS

Industry Partnerships and Capstone Experiences

Since 2002, Professor of the Practice Ron Lasser has overseen the ABET-mandated, yearlong senior design capstone course that gives undergraduate engineers a real-life, hands-on problem to solve in collaboration with industry partners such as Pepper-Dash, the Volpe Center, Mercury Computer Systems, MITRE, and MIT Lincoln Labs.

“Dr. Lasser has been aggressive about involving industry, government labs, and local hospitals in the capstone course,” says Professor and Chair Eric Miller. “This effort puts our highly capable students in contact with companies, which leads to internships and ultimately the possibility of full-time employment.”



STEINWAY & SONS CAPSTONE TEAMS

2011-12

Charles Powell (pictured)

Calvin Hopkins

Eric Formella

2012-13

Thomas Cahill

2013-14

Joshua Rapp

Shayne Hubbard

Brian McLaughlin

Seniors work with these external collaborators to generate a proposal, project plan, and a system-engineering description and diagram of the concept. In the fall semester, teams define the problem they are solving and deliver a proof-of-concept in December. In the spring term, teams demonstrate a working prototype at a poster session. In May, sponsors attend the final presentations where teams also display their project videos.

“Developing the communication skills of the capstone students is an

integral part of the design experience,” says Miller, who adds that Lasser has reached out across campus to draw on expertise from Tufts Technology Services, the Academic Resource Center, and Tisch Library. Ms. Karen Vagts, Tisch’s engineering reference librarian, helps capstone students write and cite articles on a product development topic for the Senior Project Handbook. [See: sites.tufts.edu/eese-niordesignhandbook].

This year, a senior design team is continuing work on a project with Steinway & Sons. Three years ago, Steinway proposed a potential collaboration to solve an issue of latency in the digital audio synthesis of pianos during live performances. To sync the piano with other instruments during a such a performance, students needed to first determine the origins of the latency. Professor Jeff Hopwood provided technical mentorship to help the students design the circuitry and software to process signals that eliminated the previously noticeable delay in sound. Students continued to test and redesign MIDI-output systems to ensure the sound was properly synched.

“The capstone course is about defining the problem you are trying to solve, working together to make it happen, because if it doesn’t work, it doesn’t matter,” says Lasser. “Learning the engineering method, managing the risks, working with people, and harnessing communication prepare ECE seniors for their careers in engineering and life.”

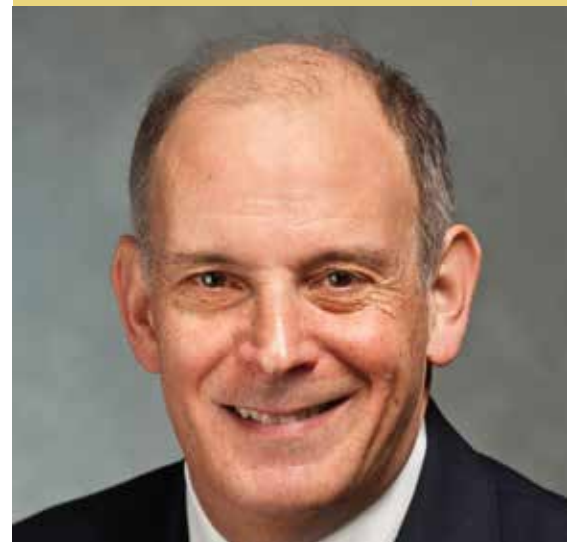
Lasser’s classroom-based efforts also extend beyond the senior capstone course. “I saw students who needed more hands-on application of the engineering theory they were learning early in their education, as well as a need to increase their comfort level with the hardware side of ECE,” says Lasser who introduced a new junior design class in the spring of 2012.

Working with Professor Hopwood and Associate Professor Sameer Sonkusale, the class centers on the construction and programming of pairs of semi-autonomous robots that must coordinate their activity to achieve a particular goal motivated by an underlying socially relevant problem such as environmental remediation. Check out an example of last year’s project here: <http://youtu.be/Yec64LmyFiM>

THEORY MEETS PRACTICE

Tufts School of Engineering’s Dean Linda M. Abriola developed the Professor of the Practice position to integrate knowledge from industry practitioners into the classroom “to help our students learn how to apply their education to the real world, bringing problems from industry onto the campus and collaborating with the students to help solve them.”

Since joining the Tufts ECE Department in 2006, Professor of the Practice Ron Lasser has drawn on his extensive industrial experience to profoundly impact the undergraduate program.



Lasser has held a variety of industrial positions since receiving his doctorate from Carnegie Mellon in 1982. He began as a member of Bell Labs’ Technical Staff and later served as Director of Engineering at General Scanning. Since 2000, Lasser has worked as Principal of Product Development Consulting, Inc. and as an independent technology and management consultant.

During the last seven years, Lasser has continued an active consulting practice focusing on medical device development, innovation management, image processing, and strategic advising while passing on this industrial experience in the classroom.

“Dr. Lasser’s efforts span the entire undergraduate experience from students’ first semester in the department to the end of their senior years,” says Miller. “He has been a leader in re-defining the design experience for our undergraduates and is among the most respected and sought-after members of the ECE faculty by our students,” says Miller, adding that it was no surprise that Lasser was awarded the 2009 Tufts School of Engineering Henry and Madeline Fischer Award annually given by graduating seniors to “Engineering’s Teacher of the Year.”

ALUMNI NEWS

Natarajan Named Executive Director of USC Viterbi ISI



Prem Natarajan leads USC's Information Sciences Institute (Photo/Courtesy of Raytheon BBN Technologies)

Last summer, Premkumar Natarajan, EG96, former Executive Vice President of Raytheon BBN Technologies, took the helm at the USC Viterbi School of Engineering's Information Sciences Institute (ISI).

"It is a privilege to be afforded the opportunity to serve as the leader of this pioneering research institute," Natarajan said. "I look forward to working closely with every single member of ISI faculty, staff, and students and with the campus faculty in advancing the mission of ISI, the Viterbi School and USC, and shaping an exciting new vision for the Institute."

Natarajan grew up in India and earned his master's degree and Ph.D. in electrical engineering from Tufts University under advisor Professor Emeritus Joe Noonan. Natarajan has recently established a research award fund in Noonan's name to support graduate research in the ECE department.

During his 17-year career at BBN in Cambridge, Massachusetts, he conducted research in speech recognition, videotext recognition, and topic classification, and served in several capacities within the

company, including as Deputy Manager of the Speech and Language Processing Department, Principal Scientist, and Executive Vice President.

Natarajan said he hopes to increase ISI's impact in areas including document processing and handwriting recognition, as well as to build on the institute's thought leadership in networking and quantum computing.

USC Viterbi Dean Yannis C. Yortsos said he looked forward to Natarajan's contribution to ISI. "In the person of Dr. Natarajan, we look for the continuation and growth of the Keith Uncapher and Herb Schorr legacies and the development of a truly exciting new vision for the Institute."

Based in Marina del Rey, ISI is a world leader in the research and development of advanced information processing, computer and communications technologies. The institute comprises more than 350 engineers, research scientists, graduate students, and staff developing various technologies, from intelligent systems to advanced electronics.

Veeraraghavan Wins Young Professional Alumni Awards

Sampathkumar Veeraraghavan, EG10, was honored with the IEEE-Eta Kappa Nu Outstanding Young Professional Award and the 2013 IEEE MGA Achievement Award for technological and leadership excellence. Veeraraghavan also was the recipient of the Tufts Young Alumni Distinguished Achievement Award in recognition of outstanding leadership and pioneering contributions in the field of large scale computing to address pressing global challenges in the field of healthcare, education and disabilities from the Tufts Alumni Association in June 2013.



Sam Veeraraghavan receives the Tufts Young Alumni Distinguished Achievement Award with mentor Professor Karen Panetta.

SENIOR DINNER AND AWARDS CEREMONY

Please mark your calendars for the annual Senior Dinner and Awards ceremony on May 9, 2014 in Alumnae Hall.



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In the Advanced Integrated Circuits and Systems Laboratory at 200 Boston Avenue, Summer Scholar Nana Kwasi Kwakwa and Associate Professor Valencia Koomson are working on building non-invasive biomedical technologies. Read more about Kwakwa's project: engineering.tufts.edu/about/news/2013/KwakwaSummerScholar.htm