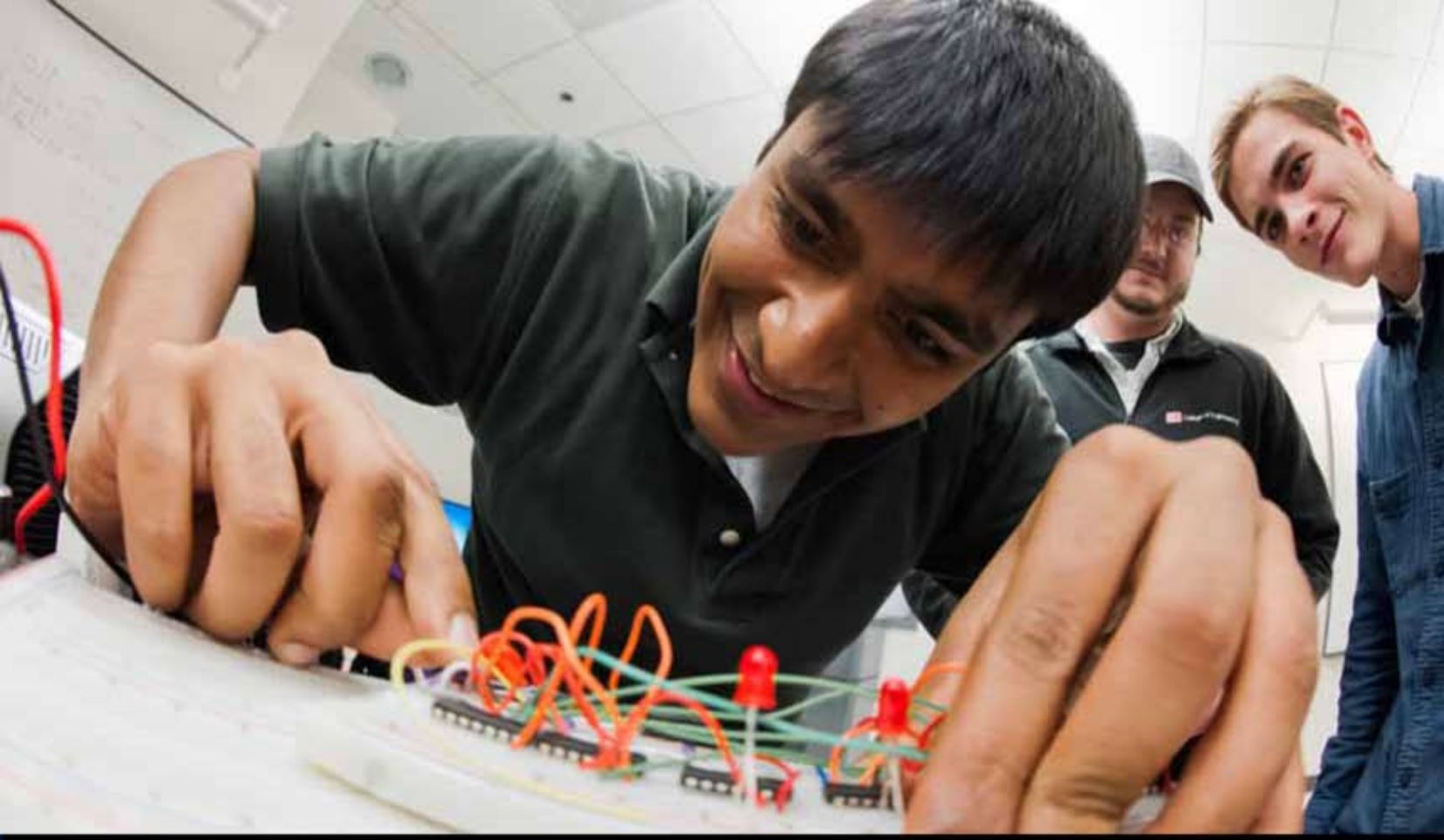


Boston University College of Engineering
Department of Electrical & Computer Engineering

Annual Report
2012–2013

Table of Contents

Department of Electrical & Computer Engineering
Annual Report 2012-2013

Production: Rachel Harrington
Content: Rich Barlow, Sneha Dasgupta (COM '13), Mark Dwortzan, Rachel Harrington, Art Jahnke, ECE staff, and ECE faculty

Front cover: Top photo- Nilesh Khaitan (ECE '15) tinkers with a circuit on a bread board as other students look on in Assistant Professor Ajay Joshi's Introduction to Engineering course. Bottom photo - Students listen to Dr. Supratik Guha, Director of the Physical Sciences Department at IBM Research, during an ECE Distinguished Lecture.

Back cover: Pictured are backlight optical fibers from Associate Professor Siddharth Ramachandran's research. Insets: Camera images of intensity (up) and phase (down) of light with orbital angular momentum, measured at the output of the vortex fiber. These novel fibers enable the use of orbital angular momentum as an additional degree of freedom for data transmission, thereby helping scale bandwidth. Inset photos by Nenad Bozinovic; background photo by INMAGINE Limited.

This report provides a look into the Department of Electrical & Computer Engineering at Boston University during the 2012-2013 academic year. Instructional activities are reported from Fall 2012 through Summer 2013 semesters while scholarly activities and budget information are reported from July 1, 2012 to June 30, 2013.

Boston University's policies provide for equal opportunity and affirmative action in employment and admission to all programs of the University.

For more information or to download this report as a PDF, please visit our website at www.bu.edu/ece.

A Message from Our Chair

This was another excellent year for Boston University's ECE Department, which saw continued enhancement of our research and academic programs. In spite of the sunset of the American Recovery and Reinvestment Act funding, our research funding increased by 24% over the previous year. In this highly competitive funding climate, our faculty are attracting the needed resources to support a world-class research program.

Our faculty continue to receive significant professional recognition. Ioannis Paschalidis was named Editor-in-Chief of a new journal, *IEEE Transactions on Control of Network Systems*. He joins Clem Karl and Selim Ünlü as Editors-in-Chief of current major IEEE journals. Ted Moustakas was named a Charter Fellow of the National Academy of Inventors, along with two other Boston University Professors, James Collins and Mark Grinstaff. Siddharth Ramachandran was appointed Distinguished Lecturer for the IEEE Photonics Society. Mark Horenstein was selected as International Fellow of the European Federation of Chemical Engineering. Martin Herbordt served as General Chair of the 2013 International Parallel and Distributed Processing Symposium and will be General Chair of the 2014 IEEE Symposium on Field Programmable Custom Computing Machines, and Janusz Konrad is the General Chair for the 2013 IEEE International Conference on Advanced Video and Signal-Based Surveillance.

Our young faculty members are also receiving significant recognition. Doug Densmore was chosen by the National Academy of Engineering (NAE) to attend the U.S. Frontiers of Engineering Symposium. Bobak Nazer received the Communications Society and Information Theory Society Joint Paper Award for his work with Michael Gastpar, "Compute-and-Forward: Harnessing Interference Through Structured Codes." Both Densmore and Nazer were awarded NSF CAREER awards this year, and as a result, every Assistant Professor that has been with the Department more than one year now holds a CAREER award. Internally, both Densmore and Ayse Coskun were named Junior Fellows at the Rafik B. Hariri Institute for Computing and Computational Science & Engineering, in recognition of their outstanding multidisciplinary computing programs.

Regarding our increased research portfolio, this year we initiated several large efforts. One of these new grants is for Smart City Research led by Christos Cassandras, which builds on former work on sensor networks to develop technologies for future cities. This research involves Boston University's Sustainable Neighborhood Lab, an unusual collaboration with the City of Boston that will allow for the evaluation of new system concepts in the field. Another significant effort involves novel algorithmic approaches to personalized health care, led by Ioannis Paschalidis, and a point-of-care technology research center in primary care, led by Selim Ünlü.

Our academic programs continue to grow, too. This year, 21 PhDs advised by our faculty graduated. Our Master's program has grown to a total of 166 students, and our PhD program remains steady, with 100 full-time students in the program. Our undergraduate enrollments are also increasing, particularly in the Computer Engineering area. We're seeing an increase in the number of students with double majors and minors as students seek a broader preparation for graduate school and the job market. Our undergraduates received significant recognition: BU's International Genetically Engineered Machine team won a gold medal at the IGEM competition, and one of our senior design teams, Team Pitch, advanced to the finals of the Microsoft Imagine Cup and won the SkyDrive Boost Award for their innovative software system for document management.

In terms of our faculty, Michelle Sander and Jonathan Klamkin joined us this past January and are ramping up their research programs. Their research involves strong experimental components in lasers and optical systems, so they spent their first semester instrumenting their lab facilities. We are looking forward to working with our newest colleague, Vivek Goyal, who joins us this coming January and will transfer his research from MIT. Vivek has a broad research portfolio, involving information theory and signal processing, with applications that range from optical sensing, medical imaging, communications and portable device interface. In addition, this fall we welcome Robert Gray, who joins us after relocating to Massachusetts following his retirement from Stanford. Our administration continues to be supportive of our development and has approved ECE-related searches for new faculty in five areas next year.

In summary, our ECE Department is continuing its strong growth path, thanks to the contributions of our faculty, students and staff. I look forward to reporting further improvements next year.

David A. Castañón

David Castañón
Department Chair
November 2013

» electrical & computering engineering at a glance «

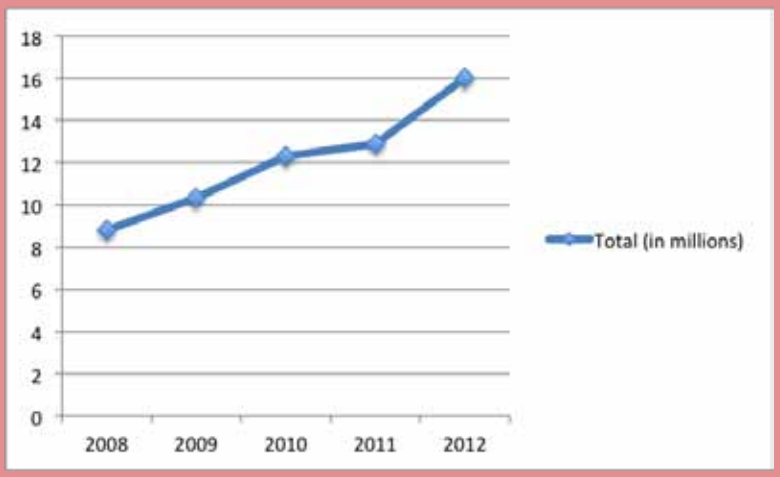
NUMBER OF STUDENTS ENROLLED

Undergraduates: 299
MS: 56
MEng: 108
PhD: 99

NUMBER OF DEGREES AWARDED

Undergraduates: 67
MS: 32
MEng: 36
PhD: 21

RESEARCH FUNDING



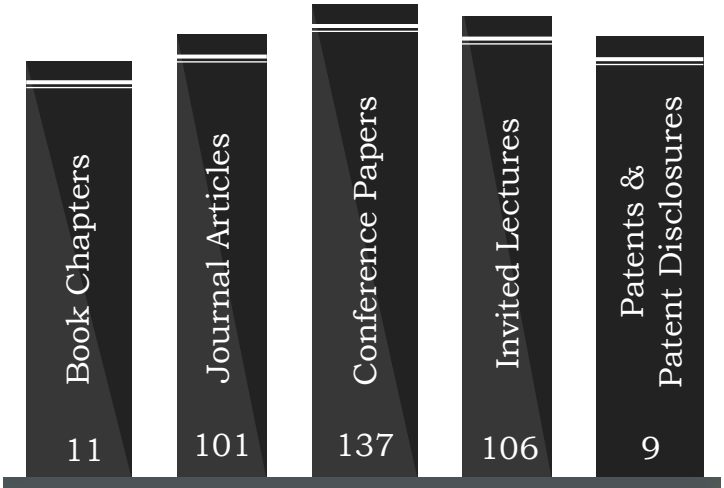
HISTORY OF EXTERNAL FUNDING

Total Grant Funding: $16M

Average Amount Per Faculty Member: $320K

OUR 2012-13 FACULTY INCLUDE:

A Nobel Prize Winner
National Academy of Engineering Members (2)
Former Presidents of IEEE Societies (2)
Professional Society Fellows (16)
Editors-in-Chief of Scientific Journals (3)
Former Editors-in-Chief of Scientific Journals (2)
Chairs of Upcoming Conferences (2)
2013 NSF CAREER Winners (2)



NUMBER OF PUBLICATIONS BY FACULTY

2012-2013 Department Highlights

Research and Grants

Ramachandran Research Promises Breakthrough in Internet Bandwidth

New Fiber Optic Technology Could Ease Internet Congestion, Video Streaming

In an increasingly data-driven world where everything from cell phones to cities are getting "smarter," demand for Internet data traffic capacity continues to soar. But it will become harder and harder to meet that demand unless new approaches emerge to dramatically increase the bandwidth, or amount of data per second that can be transmitted across the network's communications channels. Now a new fiber optic technology developed by Associate Professor Siddharth Ramachandran (ECE) offers hope of increasing bandwidth considerably, enabling Internet providers to offer much greater connectivity – from decreased network congestion to on-demand video streaming – at a comparable cost.

Described in the June 28 issue of the journal *Science*, the technology centers on donut-shaped laser light beams called optical vortices, in which the light twists like a tornado as it moves along the beam path, rather than in a straight line. Widely studied in molecular biology, atomic physics and quantum optics, optical vortices (also known as orbital angular momentum (OAM) beams) were thought to be unstable in fiber, until Ramachandran recently designed an optical fiber that can propagate them. In the paper, he and collaborators from University of Southern California, OFS-Fitel (a fiber optics company in Denmark) and Tel Aviv University demonstrate not only the stability of the beams in optical fiber but also their potential to boost Internet bandwidth.

Associate Professor Siddharth Ramachandran (ECE)

"For several decades since optical fibers were deployed, the conventional assumption has been that OAM-carrying beams are inherently unstable in fibers," said Ramachandran. "Our discovery, of design classes in which they are stable, has profound implications for a variety of scientific and technological fields that have exploited the unique properties of OAM-carrying light, including the use of such beams for enhancing data capacity in fibers."

Funded by the Defense Advanced Research Projects Agency under the Information in a Photon (InPho) program, the technology could not come at a better time, as one of the main strategies to boost Internet bandwidth is running into roadblocks just as mobile devices fuel rapidly growing demands on the Internet. Traditionally, bandwidth has been enhanced by increasing the number of colors, or wavelengths of data-carrying laser signals - essentially streams of 1s and 0s - sent down an optical fiber, where the signals are processed according to color. Increasing the number of colors has worked well since the 1990s when the method was introduced, but now that number is reaching physical limits.

Pictured are backlight optical fibers from Associate Professor Siddharth Ramachandran's research. Insets: Camera images of intensity (up) and phase (down) of light with orbital angular momentum, measured at the output of the vortex fiber. These novel fibers enable the use of orbital angular momentum as an additional degree of freedom for data transmission, thereby helping scale bandwidth. Inset photos by Nenad Bozinovic; background photo by INMAGINE Limited.

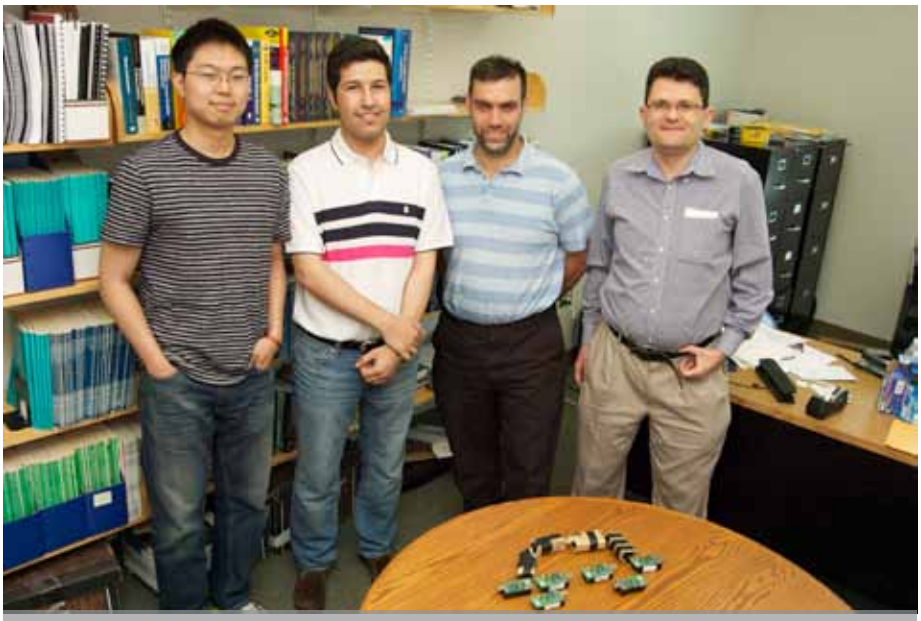
An emerging strategy to boost bandwidth is to send the light through a fiber along distinctive paths, or modes, each carrying a cache of data from one end of the fiber to the other. Unlike the colors, however, data streams of 1s and 0s from different modes mix together; determining which data stream came from which source requires computationally and energy-intensive digital signal processing algorithms.

Ramachandran's approach combines both strategies, packing several colors into each mode, and using multiple modes. Unlike in conventional fibers, OAM modes in these specially designed fibers can carry data streams across an optical fiber while remaining separate at the receiving end. In experiments appearing in the *Science* paper, Ramachandran and his collaborators created an OAM fiber with four modes (an optical fiber typically has two), and showed that for each OAM mode, they could send data through a one-kilometer fiber in 10 different colors, resulting in a transmission capacity of 1.6 terabits per second.

That's the equivalent of being able to transmit eight Blu-RayTM DVDs every second.

-Mark Dwortzan

Designing a Lighter, Cheaper, More Reliable Vehicle



Pictured from left to right, Wei Si (PhD '15), Morteza Hashemi (PhD '16), and ECE Professors Ari Trachtenberg and David Starobinski, who are working with General Motors Research to determine if using wireless sensor networks might be a greener way to construct tomorrow's vehicles.

Auto technology has come a long way over the years and includes recent advances ranging from night vision to automatic high-beam controls. With these new developments come more physical wires that will increase the cost, weight, and maintenance of a car.

"In the future, as much as four kilometers of wires may be necessary for a car to operate," said Wei Si (PhD '15). "On top of that, these wires could weigh as much as 40 kilograms, an amount that would have a bad effect on fuel consumption."

To solve this potential problem before it happens, Si and Morteza Hashemi (PhD '16) have been working with Electrical & Computer Engineering Professors David Starobinski and Ari Trachtenberg, as well as General Motors Research, to determine if using wireless sensor networks (WSN) might be a greener way to construct tomorrow's vehicles.

Some research has already been done on wireless car sensors and electronic control units (ECU) arranged in a single-hop model, but the BU research team thinks this can be improved.

"[In existing models], if some sensor-to-ECU links experience high power loss, then the quality of service degrades," they wrote in an abstract about their work. Instead, they're working on a multi-hop model that uses different sensors to cooperate and relay information in the car.

"Our results show that the transmission rate of previous models can be as low as 78 percent while our network performs at higher than 95 percent," they wrote in their abstract, adding that their design provides energy savings as well.

Spending more than three years of work on the project, the researchers' efforts are paying off. After competing in Scholars Day, the annual Boston University graduate student research symposium, Hashemi and Si have won both the Center for Reliable Information Systems and Cybersecurity Award as well as the Provost's Award.

"We were very proud of Morteza and Wei for this accomplishment," said Trachtenberg. "They had stiff competition from some very good researchers."

Trachtenberg and Hashemi both said that they think their research stood out because it was easy to understand and could be applied to a real-life issue.

"One of the critical skills we try to teach is being able to talk about your research to those outside of your field," said Trachtenberg. "They did a very good job in presenting their work in a way that was clear to a non-engineering audience."

Still, finding success wasn't always easy. The students met many challenges, including having only three weeks to test their work on a Cadillac Escalade and quickly discovering their initial design needed to be altered significantly.

"Sometimes, we'd stay up all night working," said Hashemi, "but we've learned a lot along the way and hope the learning process continues."

After seeing the long hours his students are putting into the project, Starobinski has noticed that the Ph.D. candidates are gaining confidence in their research, too.

"This project involves possessing a good understanding of various fields including wireless networks and low system processing," said Starobinski. "They've done a great job using what they've learned in courses and applying it to a real-world application."

-Rachel Harrington

The research team tested out sensors, like this one attached to the suspension system of the front wheel, on a Cadillac Escalade.

Life is Suite

A group of software apps helps synthetic biologists work faster and better

As biologists continue the decades-long race to map the genomes of living things, a group of forward-thinking BU engineers is asking the kind of questions that engineers can't help but ask: what if we built a different genome?

Known as synthetic biologists, they believe that with some skillful genomic tweaks, living organisms, such as cells and microbes, can be put to work doing things that are too dangerous or not even possible for higher life-forms like ourselves.

"There are so many possibilities," says Douglas Densmore, the Richard and Minda Reidy Family Career Development Assistant Professor in the College of Engineering Electrical & Computer Engineering Department. "Some are biotherapeutic. For example, we use chemotherapy to kill cancer cells, which is horribly damaging to the body. We may be able to noninvasively use bacteria that are already in your body to kill cancer cells. Or we can use bacteria to make clean energy."

In the last few years, as computing power has multiplied and the cost of decoding and synthesizing DNA has nose-dived, synthetic biological possibilities have started to look more like probabilities. Oil spill cleanup is also high on the things-to-do list for customized microbes. So is weapons detection, which may explain why the Office of Naval Research is funding a $7.5 million project called Utilizing Synthetic Biology to Create Programmable Micro-Bio-Robots. The project, which involves Densmore and two other BU engineers as well as researchers from Harvard, MIT, Northeastern, and the University of Pennsylvania, intends to create a dynamic trio of humans, robots, and genetically engineered bacteria, all of which will work together to detect whatever the bacteria are programmed to detect. That could be explosives or toxins or heat or light. The customized bacteria will talk to one another, and they will report to miniature "chaperone robots," a mere 10 to 100 centimeters long, that will each control thousands of microbes. Finally, the chaperone robots will wirelessly report back to humans.

While all of that sounds fantastical - new life-forms reporting to robots reporting to humans - it seems perfectly doable to the BU engineers who are working on the project. They include James Collins, a William Fairfield Warren Distinguished Professor and an ENG professor of biomedical engineering, who is regarded as one of the founders of the field of synthetic biology. Collins will determine the DNA modifications required for the project. Calin Belta, an ENG associate professor of mechanical engineering, systems engineering, and bioinformatics, will help design and assemble both the microbiotic robots and the chaperone robots. Densmore will find the best way to assemble and verify the DNA used to enable the microbes to sense specific environmental signals.

"The idea," says Densmore, "is to engineer living organisms - in this case bacteria - that respond to external stimuli in the environment. They will generate a fluorescent or chemical signal that can be measured by the chaperone robots, which can produce signals as well that the bacteria can detect. So you have a two-way communication system. And finally, we will create chaperone robots that can also communicate with human users."

Douglas Densmore is the Richard and Minda Reidy Family Career Development Assistant Professor. A $1.1 million grant from the National Science Foundation will help Densmore take Clotho from proof of concept to viable commercial software. Photo by Jessica Scranton

Traditionally, as much as anything can be traditional in a field that is just a few years old, finding the correct DNA sequences would be a painstakingly slow and error-prone process, but Densmore has some help in the form of a software tool suite called Clotho. He describes Clotho, named for the youngest of the Three Fates in Greek mythology and the one who spins the thread of life, as an app environment, similar to the iPhone software platform, where a variety of tools can perform specific yet interconnected tasks. In this case, however, the tools connect to repositories of biological "parts" organized in such a way that they can be used to transform descriptions readable by humans into gene networks, designing DNA assembly commands for liquid-handling robots or archiving designs to share with other labs. Densmore admits that he's a big fan of Clotho - and he should be. He built it.

The idea came to him in 2007, when he was finishing a Ph.D. in electrical engineering at the University of California, Berkeley. He had heard about a talk given by biological engineering expert Chris Voigt, then at UC San Francisco and now at MIT, and it struck him that the genetic circuits Voigt was describing looked very much like the digital circuitry of his own studies in electrical engineering.

Densmore teamed up with friend and colleague J. Christopher Anderson, now an assistant professor at UC Berkeley, and the two of them came up with a schema of how to organize biological information. "It works like this," says Densmore. "Let's say there's this small molecule X floating around in the environment. You want to design a bacterium so that if it sees X, it glows green, and if it doesn't see X, it glows yellow. We have programming languages that let me literally write, 'If X, glow green, if no X, glow yellow.' Then we also have our database of parts connected to Clotho. Clotho apps take these programming instructions and compile them."

Finally, he says, the information goes to another Clotho app, called Puppetshow, which has "a whole bunch of instructions about what has to happen biologically to make this work. Then it sends code to a liquid-handling robot, and the robot effectively says, 'You need to go to your fridge and get sample A and put it together with sample B.'

"Basically," says Densmore, "it's fancy domain-specific data management and work-flow management, but it's one of the things that this field desperately needs."

In November 2011, Clotho apps helped a team of undergraduates from BU and Wellesley edge out teams from the United States, Europe, and Asia to win in the Best Software Tool category at the International Genetically Engineered Machine (iGEM) World Jamboree at MIT. The team had earlier won a gold medal for its overall performance at the iGEM Americas Regional Jamboree in Indianapolis.

The undergrad team designed five software apps that could speed the assembly of DNA sequences that modeled gene interactions of the bacterium that causes tuberculosis - information that could lead to more effective diagnostics and drugs for TB.

In February, Clotho and Densmore got a big vote of confidence from the National Science Foundation in the form of a three-year grant of $1.1 million. The grant, he says, paves the way for Clotho to go "from proof of concept to viable commercial software." The project includes collaborations with other researchers at BU, as well as at UC Berkeley and the University of Washington.

Three months later, the Office of Naval Research gave Densmore more than $400,000 to buy machinery that will give him a better understanding of the behavior of DNA and proteins in biological systems. And while Clotho has yet to be widely adopted by synthetic biologists, Densmore says it has at least 10 power users and several groups that use it collaboratively. Collins, who also is codirector of the BU Center for Biodynamics and a core founding faculty member of the Wyss Institute for Biologically Inspired Engineering at Harvard, says Clotho "is a novel computer-aided design platform for the field, one that will help fast-track efforts to reprogram organisms."

Avi Robinson-Mosher, a Wyss Institute researcher who is reengineering caffeine production in E. coli, agrees. Clotho reduces the likelihood of errors, he says, and allows him to work much faster. "I heard that Doug was developing this," he says, "and I contacted him. He said, 'Come on over.'" Densmore's graciousness is typical in the field of synthetic biology. "In general," he says, "we like to share."

Which doesn't mean that synthetic biologists are welcome everywhere. "There is a group of biologists out there who say, 'Biology is way too complicated to engineer,'" Densmore says. "Biology is complicated, but that doesn't mean you shouldn't try to push the boundaries. We are saying, 'Let's not wait. We are going to learn things and we are going to predict things and we are going to build things.'"

BU is poised to become a synthetic biology powerhouse

The age of synthetic biology was turned on, literally, with a switch built by two BU researchers 13 years ago. James Collins, now a William Fairfield Warren Distinguished Professor and a College of Engineering professor of biomedical engineering, and his graduate student Timothy Gardner (ENG '00) altered the genes of E. coli bacteria so that they could be made to produce proteins or not produce proteins, essentially creating a two-gene on/off switch for a biological circuit.

The researchers described the achievement in a paper published in *Nature* in January 2000, an issue that also described a three-gene oscillating circuit built with the same genetic components by two Princeton physicists. Exactly 10 years later, *Nature* described the work done at BU and Princeton as the "defining pair of experiments" that mark the start of synthetic biology.

BU's synthetic biology dream team (from left): Ahmad "Mo" Khalil, James Collins, Douglas Densmore, and Wilson Wong. ENG's James Collins says synthetic biology is "genetic engineering on steroids." Photos by Kalman Zabarsky

In those days, says Collins, who is also a Howard Hughes Medical Institute investigator, the Human Genome Project had captured the attention of cutting-edge biologists, as well as of the press. It would be years before the appellation "synthetic biology" entered the vernacular, and more important, before the science was distinguished from genetic engineering. Today, he says, the difference between the two fields is almost as clear as on and off.

"What genetic engineers were doing was cutting and pasting," says Collins. "They were introducing genes to enable organisms to be production organisms - they were essentially swapping a red lightbulb for a green lightbulb." By contrast, he says, synthetic biologists design and build the circuits that power the bulb. "Introducing the lightbulb is not engineering. That's home design. Designing the circuit is engineering. Synthetic biology is genetic engineering on steroids."

Collins' standard definition of the field goes like this: "Synthetic engineering is a new field that is bringing together engineers and biologists who design and construct biomolecular components and synthetic gene networks to reprogram cells, endowing them with novel functions."

The novel functions he refers to include the production of new fuels and medical treatments. Collins was recently awarded a Bill & Melinda Gates Foundation grant to engineer a yogurt bacterium that will respond to, and kill, cholera bacteria in the human intestine.

Synthetic biology has intrigued scientists at dozens of research institutions, but the field's alpha schools are generally considered to be the University of California, Berkeley, and the University of California, San Francisco, on the West Coast, and Harvard and MIT on the East. Recently, however, with encouragement from President Robert A. Brown, as well as Jean Morrison, University provost and chief academic officer, and Kenneth Lutchen, ENG dean, Collins has been strengthening the ranks of synthetic biology expertise at BU.

Douglas Densmore, the Richard and Minda Reidy Family Career Development Assistant Professor in the ENG electrical and computer engineering department, came to BU two years ago from UC Berkeley. Ahmad "Mo" Khalil, an ENG assistant professor of biomedical engineering and a former postdoctoral fellow under Collins, joined BU last fall. Also last fall, Collins helped to recruit Wilson W. Wong, an ENG assistant professor of biomedical engineering and previously a postdoctoral scholar in cellular and molecular pharmacology at UC San Francisco. The recruits, who like Collins work in a large, new state-of-the-art lab at 36 Cummington Mall, belong to a happily incestuous community: Khalil earned a Ph.D. at MIT, which is a member of SynBERC, the Synthetic Biology Engineering Research Center, where Densmore was a postdoc. Collins is also affiliated with Harvard through that university's Wyss Institute for Biologically Inspired Engineering.

"You could build it around the four of us," Collins says. "And I don't think there's much doubt that BU is a major player in this exciting new field."

-Art Jahnke, Bostonia

New Research Could Help Trace Source of Bioterror Agents

Through genetic manipulation or growth in the laboratory, microbes can be engineered for either harmful aims, such as anonymous anthrax attacks, or beneficial purposes, such as vaccines, fuel cells or pollution control systems. A better understanding of how the conditions in which a bacterial cell is grown impact its metabolism and biochemical composition could lead to new tools to help counter potential bioterror threats and advance the development of a wide range of peaceful applications.

Now an interdisciplinary team of systems engineers, computer scientists, microbiologists and biochemists – including Boston University researchers (Professor Yannis Paschalidis (ECE, SE) and Associate Professor Daniel Segré (Biology, BME, Bioinformatics), as well as the University of Texas and Harvard University – seeks to establish clear links between bacterial cells' growth conditions and their resulting composition by developing and testing advanced mathematical methods. Funded by a $7.5 million grant from the U.S. Army Research Office, the five-year project could lead to new ways to track the source of a bacterial pathogen, and to help discriminate between natural infectious outbreaks and the deliberate spread of pathogens.

Bacterial cells are typically grown in a nutrient-rich broth containing all the raw materials they need to grow and multiply. The growth medium and environmental factors particular to a lab, such as temperature or pH, constitute the growth conditions that collectively influence the metabolism and biochemical composition of a microorganism.

To draw links between a bacterial cell's growth conditions and its current composition, the researchers plan to model the cell as a system with inputs (growth conditions) and outputs (cell composition), and devise a functional mapping, or mathematical formulas, that transform inputs to outputs and vice versa.

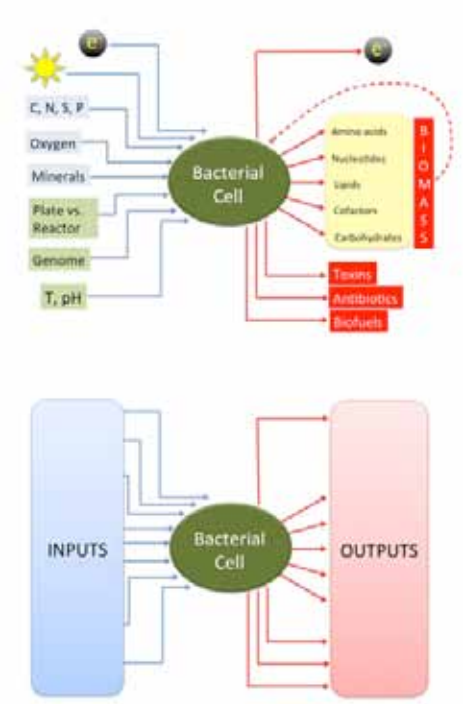
Paschalidis plans to apply optimization techniques to produce these mappings.

"If we observe the cell composition, what can we say about the environment and growth factors impacting that composition?" he says. "The challenge in identifying the source of a bioterror attack is to solve this problem and infer the input from the output."

Segré, an expert in the use of mathematical models to drive biological discovery, will develop computer simulations of microbial metabolism and growth under a wide range of possible laboratory conditions. Based on these simulations and experimental measurements to validate their accuracy, Paschalidis will infer how various growth conditions impact the composition of a bacterial cell.

"The composition of the microbial cell may carry information on where it grew and how it evolved, like a hidden signature, that we will try to characterize and interpret," Segré observed. "If a bacterium grew under unusual circumstances, or was artificially evolved in a lab, this will likely be reflected in the cell composition."

-Mark Dwortzan



A bacterial cell receives several inputs from its environment, including the availability of different nutrients and the ambient temperature and pH. Based on these inputs, a bacterium controls its growth rate and molecular composition, which can be thought of as the output of the system. By combining experimental measurements and mathematical models, Paschalidis and Segre aim to gradually decode this input-output relationship and thereby predict the output given the input or vice versa, enabling researchers to track the source of potential pathogens.

BU-Led Team Wins $1M NSF Grant for Smart City Research

Imagine driving in a city where you never have to search for a parking spot, traffic tie-ups are rare, and information on nearby accidents is displayed on your dashboard almost instantaneously. If a research team led by Professor Christos Cassandras (ECE, SE) achieves its goals, such "smart cities" could become commonplace across the U.S. in the coming decade.

The team – which includes Professors Yannis Paschalidis (ECE, SE), Azer Bestavros (CS) and Assaf Kfoury (CS, SE) from Boston University; University of Massachusetts-Amherst Professor Weibo Gong (ECE); and University of Connecticut Professor Robert Gao (ME) – has received a $1 million grant from the National Science Foundation to create the technological infrastructure for a wide range of Smart City applications aimed at reducing the congestion, pollution, fossil fuel consumption, accidents, cost, and sheer inconvenience associated with operating motor vehicles in urban environments.

"Our Smart City focus has the potential of revolutionizing the way we view the city in the future: from a passive living and working environment to a highly dynamic one with new ways to deal with transportation, energy and safety," said Cassandras.

These new ways include a Smart Parking system that assigns and reserves parking spaces based on a driver's requested destination and price range, a traffic regulation system that dynamically controls traffic lights based on real-time road conditions to improve the flow of vehicles throughout a city, and electric vehicle charging stations where drivers can pay to download electric power to their vehicle from a smart grid – or get paid to upload excess electric power from their vehicle to the grid.

To create an infrastructure for these and other Smart City applications, the team plans to design a mobile sensor network of motor vehicles, each equipped to collect data from its onboard sensor and quickly transmit it across the network from one vehicle to the next. Using the network, a driver who comes across an accident scene could, for instance, punch a dashboard menu button and transmit the accident location to every other motor vehicle in the network.

The mobile sensor network that the researchers envision will collect and exchange data such as accident locations or hazardous road conditions; dynamically allocate resources such as available parking spaces or electric vehicle charging stations; ensure secure and reliable data exchange across

Securing Our Future Privacy

Professor Alexander Sergienko (ECE)

A growing amount of confidential or private information is shared using computers or phones that aren't always secure, despite researchers' best efforts.

Part of the reason for this, Professor Alexander Sergienko (ECE) said, is because current telecommunication security relies on complex coding schemes.

"It's a very difficult and time-consuming task, but all of these codes could potentially be cracked using sufficient computer power," said Sergienko. "Many previously secure messages have been accessed recently thanks to the development of more efficient and powerful computers."

Sergienko and his research team at Boston University think quantum mechanics – and more specifically quantum cryptography – may be the solution.

When using quantum mechanics, the security of legitimate users is protected by not allowing a rogue party to make copies or clones of passwords or messages as they travel in the telecommunication fiber or free space.

"Quantum cryptography has the potential to code messages in a way that is unbreakable and secure forever," said Sergienko. To support this research, the Defense Advanced Research Projects Agency (DARPA) has awarded Boston University $1.3 million through the new program, "Quiness: Macroscopic Quantum Communication." The funding is part of a larger $4 million grant that will be shared with researchers at the University of Maryland, Baltimore, and University of Rochester, who will work with BU to develop secure quantum cryptographic communication technology.

Sergienko will work closely with researchers such as Gregg Jaeger (CGS), an associate professor of natural sciences and mathematics, and University of Maryland's James Franson, a professor of physics. Jaeger is the author of several related books including *Quantum Information* and *Philosophy of Quantum Information and Entanglement*. He also teaches quantum information and quantum theory at BU.

"Quantum cryptography has its roots in and is intertwined with the study of the foundations of quantum theory and quantum entanglement," said Jaeger, who added that entanglement typically occurs when elementary particles interact then separate. "Entanglement is a property characteristic of the quantum world and is of tremendous interest to physicists and philosophers, as well as engineers working with quantum information."

At this time, one of the drawbacks of quantum cryptography, which is sometimes known as quantum key distribution, is that it runs at a significantly slower speed than that of a regular telecommunication signal and cannot travel as far.

"The main task of the DARPA Quiness program is to develop new engineering solutions that would bridge this gap and allow quantum cryptography to run at faster speeds over longer distances," said Sergienko.

Improving secure data exchanges has been a main focus of government and private agencies over the last decade, including the United States Department of Defense.

Sergienko, who has studied quantum optics for more than 20 years, has played an active role in searching for telecommunication security solutions. Working with BBN Technology, Inc. and Harvard University in 2004-06, he helped establish an operational Boston DARPA quantum network, a culmination of previous work.

He and his research team will continue to make advances in the field with this latest project.

-Rachel Harrington

the network; and make real-time decisions, such as coordinating sets of traffic lights, without compromising the safety of drivers, bikers or pedestrians. To achieve those objectives, they will advance new sensing, data acquisition, decision-making and dynamic resource allocation capabilities.

The team will test these capabilities via the Sustainable Neighborhood Lab (SNL), a BU-organized living laboratory for sustainable urban development in Boston's Back Bay in cooperation with the Neighborhood Association of Back Bay, local commercial groups, the City of Boston and the local electricity distribution utility. At BU, a garage is already partially instrumented and will be fully equipped to implement the Smart Parking system, which will also be tested with on-street parking in collaboration with the SNL and the City of Boston.

"The whole concept of a Smart City is beginning to gain prominence in the U.S. and abroad," said Cassandras. "Our approach is unique in its focus on sensor network infrastructure, its use of optimization techniques for dynamic resource allocation, and its development of a new software framework for real-time, Smart City applications."

-Mark Dwortzan

Professor Christos Cassandras (ECE, SE) and systems engineering graduate student Yanfeng Geng (PhD '13) developed a preliminary version of a Smart Parking system that enables a driver to enter a desired destination and price range into a mobile device and reserve a vacant, appropriately priced parking space that's closest to the destination.

Opening Movements

Associate Professor Prakash Ishwar (ECE) performs a hand gesture to unlock a computer screen as Professor Janusz Konrad (ECE) and Ph.D. student, Jonathan Wu, look on.

To the casual passerby, Janusz Konrad seems a bit fanatical about tai chi: standing in his office, waving one arm to and fro, then spreading both arms and bringing them together. Duck inside, however, and you'll notice he's not stretching for his health; he's stretching for a camera, and images on a computer monitor are responding to each gesture – zooming in and out of photos or leapfrogging through a photo series.

Konrad, a College of Engineering professor of Electrical & Computer Engineering, and Prakash Ishwar, an associate professor, designed the computer's software to recognize specific body motions. They're not making video games. This, they hope, is the future security portal to your smartphone, tablet, laptop, or the locked door: software programmed to recognize a gesture, from your torso, your hand, or perhaps just your fingers.

Armed with an $800,000 grant from the National Science Foundation and collaborating with colleagues at the Polytechnic Institute of New York University, the BU duo is developing algorithms for ever-smarter motion sensors. In doing so, they have to thread a tricky technological needle. "On the one hand," says Ishwar, "you want security and privacy; nobody else should be able to authenticate on your behalf" by aping your gesture. On the other hand, if the system demands a perfectly precise gesture, you may have to flail your arms or other parts 10 times to get into your own account. "That's annoying," says Ishwar. (And people may think you're either crazy or infested with lice.)

A workable system must be able to screen out distractions, like the motion of someone moving behind you or of the backpack you're wearing, or changes in ambient lighting.

Yet using gestures as keys to cyber-locks would have some great advantages. A gesture, like a lateral swipe of your hand, has "subtle differences in the way people do it," Ishwar says – and people vary in arm length, musculature, and other traits that might help a detector distinguish between you and Arnold Schwarzenegger or Elle Macpherson. True, gestures aren't as unique as fingerprints or as irises or faces, for which there are authentication scanners. But unlike those traits, which theoretically are vulnerable if someone hacks the database storing them, an authenticating gesture that's been compromised by an impostor can be replaced immediately, whereas getting a new fingerprint – well, "you wouldn't like it," says Ishwar.

Security passwords pose another problem: the most effective ones tend to be inconveniently complex. Konrad surveyed one of his classes and found that no one used a smartphone passcode longer than four digits. An effective motion sensor could "simplify, make more secure and more pleasant the process of logging in," he says. He and Ishwar are working to develop gesture-based authentication software to be test-run on Microsoft's motion-sensing Kinect camera, used with the Xbox video game and the Windows computer operating system. "It can track your body," says Ishwar, "get some skeleton approximation for your body, and then that information is provided to you in some real-time format."

They also hope to use start-up company Leap Motion's smaller motion-sensing device for notepads and laptops. The company claims that its device, the size of an iPod, will be able to read "micro-motions of your fingers," says Konrad. In the next three to four years, "we want to develop something that's extremely simple, inexpensive, and can be imbedded into other products and could be used daily by millions of people."

One thing that is clear is that certain body parts, like hands, lend themselves to identity authentication better than others. "The degree of freedom that you have with your hands is significantly higher," Ishwar says. "Maybe if I'm a yoga master, I can move my right leg and put it across my left shoulder, but most people can't do that." They'd like to experiment also with the torso, says Konrad, since people's posture can vary. Then there's Leap Motion and its potential finger recognition.

"We plan to involve more and more body parts" as the research progresses, Konrad says. If that sounds vaguely Frankenstein-ish, consider that today's security technology already involves fingerprints, iris scans, and face recognition. "Wouldn't it be nice," muses Ishwar, "if we could do that using our everyday body language or gestures?"

-Rich Barlow
This article originally appeared in BU Today.

Faculty

Densmore, Nazer Named NSF CAREER Award Winners

Assistant Professor Douglas Densmore (ECE, BME)

Assistant professors Douglas Densmore (ECE, BME) and Bobak Nazer (ECE) are among the latest members of Boston University's Department of Electrical & Computer Engineering to win an NSF CAREER Award. Since 2011, five ECE faculty members have received the prestigious prize.

Assistant Professor Ramesh Jasti (Chemistry, MSE) was also named a recipient, and collectively, they will receive $2 million over the next five years to work on high-impact projects that combine research and educational objectives.

Densmore was awarded for his work aimed at assembling DNA more efficiently. Synthetic biology, a relatively new area of scientific research that has the potential to improve everything from disease treatment to green fuels, has gained attention over the last decade, but the field needs better computational tools to have a greater impact.

Densmore plans to use the award to advance a synthetic biology platform that assembles DNA in order to create novel living systems. He believes his design could reduce the time, costs and complexities associated with the process. According to Densmore's proposal, "the project's software will be the first of its kind publicly available."

"This award will allow my research group to push the boundaries of what is possible with DNA assembly automation," he said. "Our research will not only advance the science and engineering required to perform this work but also introduce a paradigm shift where researchers no longer focus on the tedium of laboratory work but rather on the intellectual exercise of designing new biological systems."

The new platform will assemble DNA with automated, optimized and efficient open-source software and liquid handling operations suitable for a wide range of applications.

The award will also help Densmore to continue introducing synthetic biology and DNA assembly techniques to underrepresented students and other researchers ranging from elementary school students to postdoctoral fellows, including College of Engineering students who participate in the annual International Genetically Engineered Machine (iGEM) software division competition.

Densmore also recently cofounded two nonprofits, both designed to create community among those interested in synthetic biology, that will be funded in part by the award. The first, the Bio-Design Automation Consortium (BDAC), will hold workshops, help create field standards and foster broad collaborative research in bio-design automation. The second, the Nona Research Foundation, will house open source software for synthetic biology.

Nazer plans to use his CAREER award to research a novel approach to wireless communication that could potentially lead to substantially higher data rates. The conventional wisdom is that interference between users is a source of noise to be avoided at all costs. For instance, modern wireless systems operate by assigning users to dedicated time or frequency slots. However, interfering signals are not simply noise: they encode data sent by other users and often have considerable structure.

Nazer has discovered a technique that can harness the inherent algebraic structure of interference; properly applied, it may eventually enable many users to simultaneously occupy the same channel while operating at extremely high data rates.

"Although wireless connectivity is now available almost everywhere, we still only employ wireless communication for the last hop in a network, owing in large part to the interference bottleneck," said Nazer. "By designing protocols that can harness the structure of interference, we hope to create networks that can effortlessly scale to handle more users while maintaining high throughputs."

Beyond its applications to wireless, Nazer's research will lay the foundation for an algebraic network information theory to tackle challenging problems in decentralized information processing, compression, and communication.

Nazer's project also incorporates interactive presentations on cellular communication for high school students, tutorials, workshops and other outreach efforts. In particular, he hopes to get high school students excited about Science, Technology, Engineering, and Mathematics (STEM) fields by showing them how algebra is connected to the design and operation of smartphones.

Jasti, the third award winner, hopes to use the grant funding to design new ways to synthesize well-defined, uniform structures from which carbon nanotubes could be fabricated. The nanotubes, thin, hollow cylinders made up of carbon atoms, have unique properties that could be applied toward new solar energy materials, single-molecule biosensors, and faster electronics.

Densmore credits some of the ECE Department's recent achievements in garnering NSF CAREER awards to workshops hosted by the College of Engineering designed to help junior faculty navigate through the application process.

Assistant Professor Bobak Nazer (ECE)

"I think researchers in our department have had success since we are able to take foundational research topics and then expand them into new areas and apply them in novel ways to interesting problems," said Densmore. "Being creative and thinking out of the box is a big part of the process and we excel at that."

-Mark Dwortzan
Rachel Harrington also contributed to this article.

EFCE Awards Horenstein Title of International Fellow

Professor Mark Horenstein (ECE)

Professor Mark Horenstein (ECE) has been named an International Fellow by the European Federation of Chemical Engineering (EFCE) Static Electricity in Industry Group.

Awarded only every four years, the honor recognizes dedicated service and notable contributions to the advancement of the field of industrial electrostatics as a researcher and teacher.

"Being awarded was a total surprise," said Horenstein. "It's an incredible honor."

Horenstein received the award in April during Electrostatics 2013, the 12th International Conference on Electrostatics that took place in Budapest, Hungary. As part of the honor, Horenstein also gave one of the event's keynote talks.

"We loved Budapest," said Horenstein, who, along with his wife, took advantage of their chance to visit Hungary. "The residents were unbelievably hospitable and there was so much to do and see."

Horenstein's current research interests include applied electromagnetics, electrostatics, and microelectromechanical systems (MEMS). He is the editor-in-chief of the *Journal of Electrostatics* and is an Honorary Life Member of the Electrostatics Society of America (ESA).

The EFCE has promoted scientific collaboration and supported the work of scientists and engineers in 30 European countries since 1953. The organization represents more than 100,000 chemical engineers in Europe.

-Rachel Harrington

Paschalidis Named Editor-in-Chief of New IEEE Journal

The Control Systems Society of the Institute of Electrical and Electronics Engineers (IEEE) has chosen Professor Ioannis Paschalidis (ECE, SE) to be the inaugural editor-in-chief of the journal, *IEEE Transactions on Control of Network Systems* (*TCNS*).

TCNS will publish high-quality papers on systems with interconnected components, emphasizing topics related to the control of these systems. The scope of the new publication will be broad and include topics such as communication networks, cyber-physical systems, biological networks, electric power networks, and social/economic networks.

"The launch of this journal is exciting because there is quite a bit of work done at BU on networks with innovative and, at the same time, 'non-traditional' applications including robot networks, network security, smart cities, and networks arising in biological contexts," said Paschalidis. "This new journal offers a venue for such work, which has so far been missing."

The journal will be sponsored primarily by the IEEE Control Systems Society (CSS) as well as the IEEE's Communications Society, Computer Society, and Robotics and Automation Society.

Paschalidis said that he hopes *TCNS* will become the premier journal for the emerging and growing network systems field.

"Moreover, having the editorial office located at BU presents opportunities to organize events that bring some of the leaders of this research arena to campus," said Paschalidis.

The first issue is scheduled to come out in March 2014 and is expected to coincide with a symposium at Boston University that same month. The journal will be published quarterly.

The IEEE is a professional association dedicated to technological innovation and excellence. The group consists of more than 425,000 members from more than 160 countries.

Submissions for the inaugural issue will be accepted beginning in July until September 20. The journal will seek articles that describe previously unpublished contributions to network systems research. Visit sites.bu.edu/tcns for more information.

-Rachel Harrington

Professor Ioannis Paschalidis (ECE/SE)

Moustakas Named National Academy of Inventors Charter Fellow

Collins, Grinstaff, and Gilchrest also to be honored

Many engineers would be thrilled about having even one patent to their names, but Professor Theodore Moustakas (ECE, MSE, Physics) goes above and beyond.

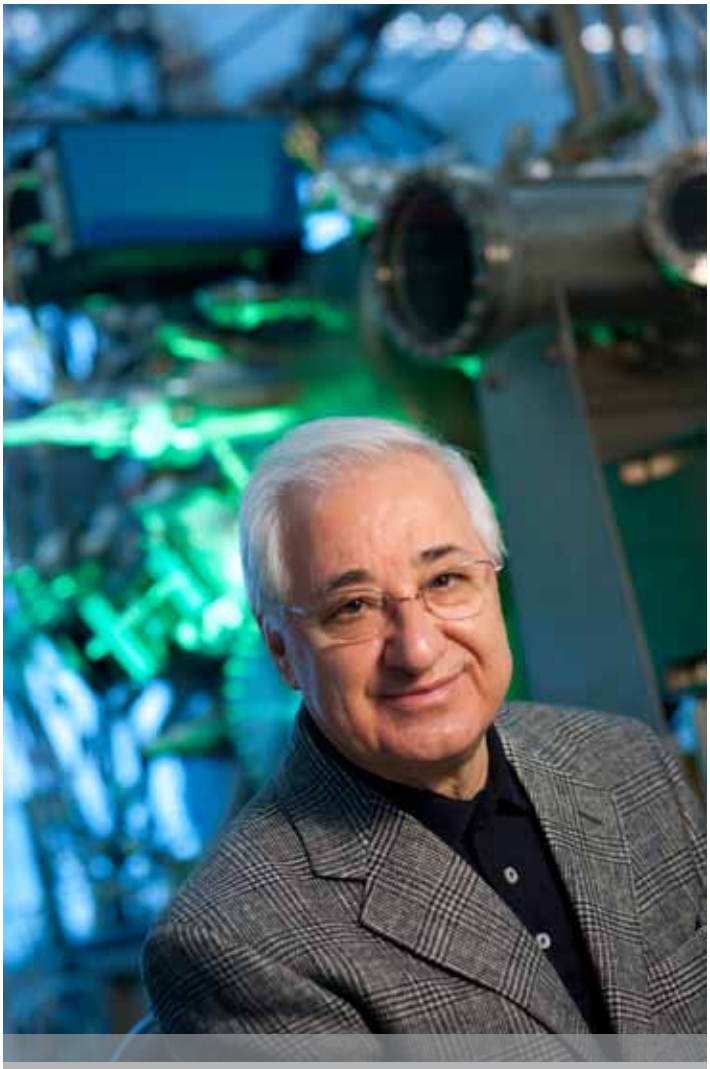
The inventor currently has 31 patents on projects, 17 of which he earned as a professor in Boston University's Department of Electrical & Computer Engineering.

Moustakas earned many of these through his work developing nucleation steps for growing gallium nitride on glass, silicon, sapphire and other substrates. This discovery is an essential component of manufacturing blue LEDs, which are used in both solid state lighting applications and highly-efficient deep ultraviolet LEDs, which will likely provide air and water purification in the future.

In recognition of his accomplishments, the National Academy of Inventors (NAI) recently named Moustakas a Charter Fellow, the society's highest professional distinction.

"This is a very important honor in my career, and I am very pleased to have a chance to play a greater role in the academy," said Moustakas, adding, "I look forward to contributing."

The recipients represent more than 3,200 U.S. patents and 54 prestigious research universities and non-profit research institutes. The Fellows include eight Nobel Laureates, two Fellows of the Royal Society, 11 inductees of the National Inventors Hall of Fame, and three recipients of the National Medal of Technology and Innovation.



Professor Theodore Moustakas (ECE, MSE, Physics)

"Professor Moustakas was a pioneer in discovering the properties and potential applications of the nitride family of semiconductors," said Professor David Castañón, ECE Department Chair. "Since joining Boston University in 1987, he has created a world class program involving fabrication, characterization and application of semiconductors using this family of materials."

Moustakas is among 98 innovators, including BU College of Engineering Professors James Collins (BME, MSE, SE) and Mark Grinstaff (BME, MSE), to earn this title.

"I'm not surprised to see two other Fellows from the College on the list," said Moustakas. "Boston University has become a powerhouse when it comes to research, and Professors Collins and Grinstaff are leaders in their areas."

Moustakas has had an incredible impact on his field, too. In addition to his list of patents, which continues to grow, he has written hundreds of scientific journal papers and invited lectures, co-edited eight books, and holds more than 8,000 citations in research literature. He is also a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and a Fellow of the American Physical Society and Electrochemical Society.

Recognized as an incredible professor, too, Moustakas was awarded the ECE Award for Excellence in Teaching in 1998.

"Beyond his prolific scientific output, his work has generated numerous patents and practical commercial applications in lasers and light-emitting diodes, making his program a paragon for translational basic research at Boston University," said Castañón.

Today companies like Philips Global, Cree Inc., Osram, and the Nichia Corporation continue to make use of his early patents.

"Now you can find LEDs used in everything from computer displays to televisions," said Moustakas. "You're starting to see them used more in outdoor lighting, too, such as in traffic lights, and they are progressively adapted for general illumination."

Currently, much of Moustakas's work focuses on finding ways to provide the same amount of light for less than half the energy through white-light LEDs. He is also exploring how UV-radiation might be used to kill harmful bacteria and viruses.

Moustakas, Collins, and Grinstaff will be inducted as Fellows by the U.S. Commissioner for Patents, Margaret A. Focarino, during the 2nd Annual Conference of the National Academy of Inventors, on February 22, in Tampa, Florida, where they will receive a trophy and rosette pin. In addition, NAI Fellows will be recognized with a full page announcement in *The Chronicle of Higher Education* on January 18, in the January 2013 issue of *Inventors Digest,* and in a future issue of *Technology and Innovation – Proceedings of the National Academy of Inventors*.

The mission of the NAI is to honor academic invention; recognize and encourage inventors; enhance the visibility of university and non-profit research institute technology and innovation; encourage the disclosure of intellectual property; educate and mentor innovative students; and translate the inventions of its members to benefit society.

Barbara Gilchrest, professor and chair-emeritus of the Department of Dermatology at Boston University School of Medicine and Boston Medical Center, was also elected as an NAI Charter Fellow.

-Mark Dwortzan and Rachel Harrington

Students

Top Senior Design Projects Named at ECE Day '13

Winners of the P. T. Hsu Memorial Award for Outstanding Senior Design Project, Team 17 - Calibration Device for Microarray Slides, demonstrate their project to judge, Bradley Rufleth (ECE '04). Pictured from left are Jyotsna Singh (ECE '13), Allison Marn (ECE '13), Ryan Lagoy (ECE '13), Rufleth, and Sasha Gazman (ECE '13).

Recently in the Photonics Center, passersby were met with a curious sight on the ninth floor. In a small setup resembling a couple of grocery store shelves, a robot, aptly named ShopBot, was picking out items from a grocery list.

Designed by seniors Jeffrey Chang, John-Nicholas Furst, Ngozi Nwogwugwu, Gurwinder Singh, and Hei Po Yiu, the Grocery Shopping Robot was one of 17 senior design projects on display as part of Boston University's Department of Electrical & Computer Engineering's annual ECE Day.

"We wanted to come up with a cheap, automated way to find groceries in a store," said Singh during their presentation. Their robot uses a pathfinding algorithm to take the shortest path possible and scans barcodes to find its items.

Singh was one of 74 students showing the results of two semesters of work to faculty, friends, parents, and guests on May 6. Additionally, three seniors opted to write an honors thesis and presented their posters during the event.

The projects, one of the last requirements for seniors before they earn their undergraduate degrees, allow students to design a prototype, electronic device or software system. Teams work with real world customers that include BU professors and companies like Microsoft and Bell Labs – Alcatel-Lucent.

"This year's senior design class has been one of the very best," said Associate Professor of the Practice Alan Pisano (ECE), the senior design advisor. "I have enjoyed working with such a talented and dedicated group."

This year's projects ranged from a deshredder, designed to test if shredding is secure with today's computing techniques, to an application that would allow professors to more easily track how a student is performing using BU's education software, Blackboard.

Six alumni who previously completed senior design projects, David Lancia (ECE '02, MS '04), Craig LaBoda (ECE '11), David Mabius (ECE '07, MS '09), Mike Kasparian (ECE '12), Aaron Ganick (ECE '10), and Bradley Rufleth (ECE '04), returned to their alma mater in the roles of judges.

Said Pisano: "The ECE Day judges told me that the job of selecting the winners was most difficult this year because of all of the excellent projects, and they wished we had more awards to give."

After much deliberation, the judges awarded Calibration Device for Microarray Slides the top prize, the **P. T. Hsu Memorial Award for Outstanding Senior Design Project**. Sasha Gazman, Ryan Lagoy, Allison Marn, and Jyotsna Singh worked with Professor Selim Ünlü (ECE, BME) to develop a system for detecting target proteins, allergens, and diseases on microarray slides.

"Our system improves upon the accuracy of fluorescence based testing and is compact, portable, and user-friendly," Singh said during her team's presentation.

"Overall, we're increasing the accuracy of diagnostics," added Lagoy, who also was awarded the **Michael F. Ruane Award for Excellence in Senior Capstone Design**.

In a show of solidarity, the graduate students in Ünlü's Optical Characterization and Nanophotonics Laboratory turned out to support the undergraduates during their team presentation.

The day centered around the seniors' accomplishments, but two teachers were awarded as well. David Castañón, ECE professor and department chair, presented Ari Trachtenberg with the **ECE Award for Excellence in Teaching** and Molly Crane was named the **GTF of the Year**.

Other awards at this year's ECE Day included:

Center for Space Physics Undergraduate Research Award
Chris Hoffman

Senior Honors Thesis Award
Beat Wave Generation and Interactions with Space Plasmas at Gakona, Alaska: Lisa A. Rooker

Entrepreneurial Award
Pitch: Brad Berk, Nick Lippis, Patrick Maruska, and Robins Patel

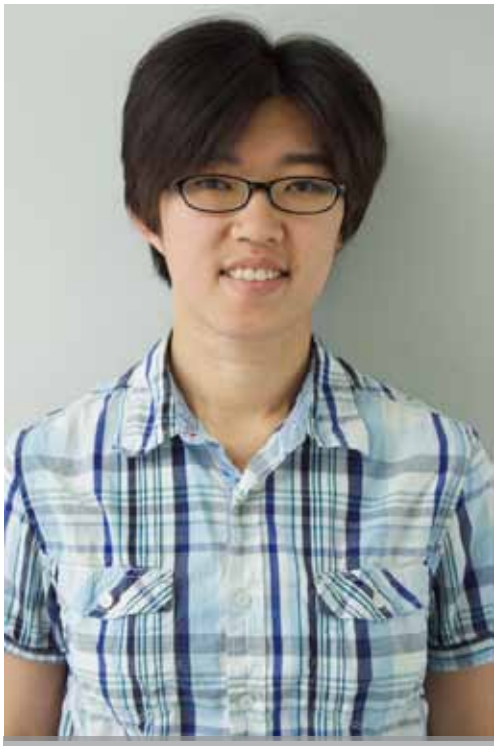
Design Excellence Awards
Choreographed LED Artwork: Chris Davis, Mike Gurr, Chris Hall, Matt Lee, and Kevin Meyer

Automated DNA Assembly Platform for Bioengineering: Alejandro Pelaez Lechuga and Janoo Fernandes

-Rachel Harrington

Chris Hall, a member of Team 3 - Choreographed LED Artwork, shows his team's project during ECE Day.

Ph.D. Student Haiyao Huang Named Google Anita Borg Memorial Finalist



Ph.D. student, Haiyao Huang

Computer scientist Anita Borg began programming in 1969 and helped pave the way for women working in science and technology by establishing the Institute for Women and Technology and the Grace Hopper Celebration of Women in Computing.

After she passed away in 2003, Google started a scholarship in her memory that is meant to remove any barriers keeping women from entering the computing and technology fields.

Google recently selected this year's 30 scholars and 30 finalists for the Google Anita Borg Memorial Scholarship and named Boston University Ph.D. student, Haiyao "Cassie" Huang, one of their recipients.

"Cassie is a student that is quick to learn, inquisitive, and proactive regarding her education and goals. Her ability to set and carry out her own research agenda sets her apart from average graduate students," said her advisor, Assistant Professor Douglas Densmore (ECE). "It comes as no surprise that she was a finalist for this award and I expect this to be the first of many accolades to come."

As a finalist, Huang will receive a $1000 scholarship and is invited to attend the annual Google Scholars' Retreat this summer in New York City. The event provides an opportunity to network with other recipients and participate in developmental activities.

At BU, Huang has been working closely with Densmore, developing computer-aided design (CAD) tools for synthetic biology. Specifically, she is focusing on how to integrate synthetic biology and microfluidics.

"I've really enjoyed my time in Professor Densmore's lab so far," said Huang. "I like the interactions and collaborations with my lab-mates and the intellectually challenging work."

-Rachel Harrington

Uncovering Answers in the Rainforest

Speaking up about research interests during freshman year might make students a little nervous, but doing so could also take them deep into a Puerto Rican rainforest and provide additional opportunities throughout their undergraduate career.

This was and is the case for Kangping Hu (ECE '13), who presented his Undergraduate Research Opportunities Program (UROP) poster paper, "Mode Conversion of NAU Launched Whistler Wave Over Arecibo, Puerto Rico," in October at Boston University's George Sherman Union (GSU). His research took first place out of 219 participants at the 15th Annual Undergraduate Research Symposium.

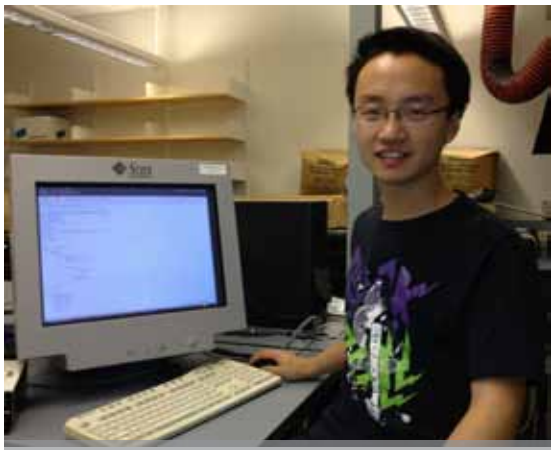
Hu's work explores the effects of wave-particle interactions in the ionosphere. The ionosphere has become increasingly important as the use of wireless communications rises, because certain ionospheres' density irregularities can result in signal distortion.

By studying this, Hu says he hopes to "investigate the spectral broadening effects in the ionosphere for communications and remote sensing purposes."

Hu took advantage of having Professor Min-Chang Lee (ECE) as his advisor soon after he came to BU. Grants Lee received even funded some of Hu's research with him over the last three summers.

"I have been tutoring Kangping in his research over the past three years, beginning his freshman year in 2009, with my other undergraduate and graduate students," said Lee. "He is both intelligent and a hard worker."

Over his last winter and summer breaks, Hu flew to Puerto Rico to conduct research in the rainforest at the Arecibo Observatory, home of the world's largest radio telescope.



Kangping Hu (ECE '13)

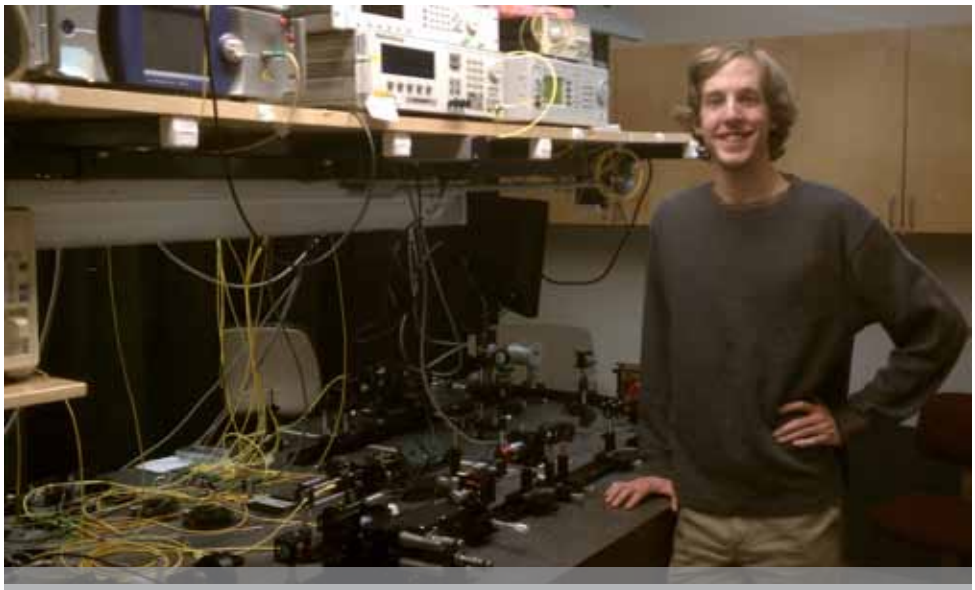
"We did the research in the observatory using a dish that was in the heart of the jungle," said Hu. "We spent a week there setting up experiments in the middle of the night from 8 p.m. 'til 5 a.m. in order to remove the sun as a variable."

His work didn't end after the information was collected. Last summer, Hu analyzed the data during the UROP summer research session. "With this analysis, we made more developments for the presentation," he explained.

He is currently applying his accumulated research to write his Senior Honors thesis. After graduation, Hu plans to continue his academic career and get a graduate degree in electrical engineering.

-Sneha Dasgupta (COM '13)

Three ENG Students Receive NSF Graduate Research Fellowships



Patrick Gregg (ECE) was one of three College of Engineering PhD students to receive an NSF Graduate Research Fellowship.

College of Engineering Ph.D. students Patrick Gregg (ECE), Daniel Reynolds (BME) and Benjamin Weinberg (BME) have received National Science Foundation Graduate Research Fellowships. The prestigious award provides a $30,000 annual stipend and $12,000 cost-of-education allowance for up to three years to outstanding full-time U.S. graduate students deemed likely to contribute significantly to the advancement of science and engineering in the U.S.

The nation's oldest fellowship program directly supporting graduate students in science, technology, engineering and mathematics fields, the NSF Graduate Research Fellowship Program (GRFP) is highly competitive: this year only 2,000 fellowships were awarded out of more than 13,000 applicants. Since the GRFP's inception 60 years ago, it has funded several graduate students who went on to become Nobel Prize winners and industry and government leaders.

"The success of our graduate students in the NSF Fellowship competition is further evidence of the quality of our doctoral programs and the recognition our research efforts are receiving," said Professor M. Selim Ünlü (ECE, BME, MSE), Associate Dean for Research and Graduate Programs. "I congratulate our students for capturing these prestigious and highly competitive grants."

Gregg, a second-year graduate student, is working with Associate Professor Siddharth Ramachandran (ECE, MSE) on a new method to modify current optical communications systems to provide increased bandwidth, so more information can be transmitted over the same volume of optical fiber.

"One of the current problems with optical communications systems today is the so-called 'capacity crunch,' which is dictated by the projected increasing demand for bandwidth and the limitations of current technology," said Gregg, who with Ramachandran is advancing a potential solution in which light beams that twist forward like a spiral are simultaneously transmitted through an optical fiber.

Reynolds, a first-year graduate student focused on biomaterials research, is considering a project to grow cancer cells on biomaterial scaffolds as a way to simulate the tumor environment in the laboratory setting.

"These engineered tumor constructs provide an advantageous platform on which to investigate basic cancer biology as well as to test anticancer drug efficacy," explained Reynolds, who is also interested in using biomaterials to improve the delivery of such drugs to tumor cells.

Weinberg, a first-year graduate student, aims to answer major scientific questions and create new therapeutic strategies through genetic reprogramming of mammalian organisms using synthetic biology tools.

"With the fellowship, I plan to engineer novel synthetic genetic circuits in mammalian brains for precise optical control of neural activity," he said. "This method can be utilized to systematically analyze the causal role of each cell type in neural circuit computation, cognition and pathology, and develop gene therapy-based treatments for neurological and psychiatric disorders."

-Mark Dwortzan

BU iGEM Team Takes Gold at Regional Jamboree

Mark Twain once said, "It's not the size of the dog in the fight, it's the size of the fight in the dog."

The same can be said of teams at the International Genetically Engineered Machine (iGEM) Americas East competition.

Boston University may have only had two members, Monique De Freitas (MET '13) and Shawn Jin (SAR '15), but that didn't keep them from winning gold against 40 teams in Pittsburgh, Pa., last year. They even earned a chance to showcase their work at the World Championship Jamboree in Cambridge, Mass.

"It was an amazing experience," said De Freitas. "It was great to have an opportunity to show our work to experts in the field."

The iGEM competition, which is geared toward undergraduates, is dedicated to advancing the field of synthetic biology by developing its community and collaborations.

Since the summer, De Freitas and Jin have been working on designing a standardized method that not only characterizes and tracks genetic circuits but also clones genes with a new method called MoClo. Their project focused on creating a standard protocol that would allow synthetic biologists to share and compare data.

"Shawn and Monique created a way to track the data that will allow us to track more information at once," said Assistant Professor Douglas Densmore (ECE), the team's faculty advisor. "This allows us to work much faster."

Monique De Freitas (MET '13) and Shawn Jin (SAR '15) present during the iGEM competition, which is dedicated to advancing the field of synthetic biology.

Assistant Professor Douglas Densmore (ECE), Monique De Freitas (MET '13), Shawn Jin (SAR '15), and post-doctoral associate, Traci Haddock, pose at the iGEM World Championship Jamboree.

Jin said that they made use of software tools, such as Eugene and Clotho, that Densmore and his research team had previously designed in order to help advance their own project.

At both competitions, De Freitas and Jin received great feedback from both the judges and other students.

"We even met with some other teams who were interested in collaborating and working together in the future," said De Freitas.

De Freitas had wanted to join BU's iGEM team even before she started at the university.

"I was interested in biology and thought that getting involved in a competition centered around the subject would be a great opportunity," she said.

Meanwhile, Jin, who also happens to be a Kilachand Honors College student, discovered the team through Sonya Iverson, a biology teaching fellow at BU who encouraged him to sign up.

"I plunged into the world of synthetic biology and it was a fast learning curve," said Jin.

This team is Boston University's second since 2006, though Densmore had competed previously with UC Berkeley in 2008 and 2009.

As part of their research, De Freitas and Jin collaborated with researchers from Wellesley College and Boston University post-doctoral associates and graduate students, including team advisor, Traci Haddock, a post-doctoral associate in the Department of Electrical & Computer Engineering.

"Collaboration was a key component in our students winning the medal," said Haddock.

So was hard work. Haddock said that De Freitas and Jin worked on the project 5-6 days a week during the summer and continued to work on it during the semester, all while maintaining their academic course loads.

Their efforts have paid off. De Freitas said that they've had more than 2,000 people checking out their research website and even heard from some curious individuals who heard about her work from her home country, Brazil.

"It has truly been an eye opening experience," added Jin. "At no point could I have dreamt of having an opportunity to be in a competition like this as a sophomore. This was my first real taste of college research."

-Rachel Harrington

Alumni

The Verbal Advantage

In 2008, Professor Emeritus Theodore Morse (ECE), who was then the Director of Boston University's Laboratory for Lightwave Technology, suffered a heart attack followed shortly by a stroke.

The experience was scary enough but then it was followed by some alarming side effects Morse wasn't prepared for.

"I couldn't speak a word nor was I able to write, and yet, my perceptions of the world were intact," he said.

While Morse was in the hospital, he couldn't convey even the simplest requests like needing food or worse - that he was in pain.

A new application made to work on iPads may change the experience for patients like Morse in the future. And the best part? It was created by his own students.

Designed by Nick Dougherty (ECE '12), Eric Hsiao (ECE '12), and Gregory Zoeller (ECE '12), the app, Verbal, was Morse's idea for a senior design project in 2011-12. Final research projects are an annual tradition in the Department of Electrical & Computer Engineering (ECE). The experience allows undergraduates to design and prototype a product, electronic device, or software system and present it in front of faculty, staff, students, and engineering professionals at the end of the spring semester.

Morse asked Dougherty, Hsiao, and Zoeller, along with their senior design teammates, Kenneth Zhong (ECE '12) and Kholood Al Tabash (ECE '12), to come up with a design that would allow patients, caregivers, and nurses to communicate with each other even if there are speech or language barriers.

The team took initiative by shadowing nurses at the Massachusetts General Hospital (MGH), speaking with information services and technology professionals, and meeting with stakeholders within the hospital. From their research, they released their first design: iMedix.

The app allowed patients who spoke different languages or suffered from speech disabilities to use features such as picture-based icons to better communicate their needs to nurses. With the click of a button, patients could let their nurses know that they needed water, wanted to use the bathroom or a number of other options.

"We knew from the first semester that we'd eventually want to turn [the iMedix project] into a business," said Dougherty. "We thought of the project outside the context of senior design and treated it in a professional way."

A panel of ECE alumni judges saw the potential of their work and awarded Team iMedix the Entrepreneurial Award. The students went on to take second place in the College of Engineering Societal Impact Capstone Project Awards, given to projects that are likely to have the biggest impact on society.

Dougherty, Hsiao, and Zoeller saw the potential of continuing their work, as did Zoeller's mother, a nurse who said they'd be crazy not to keep pursuing the product. Now under the name Red Electric Consulting, they are working with Morse to bring their platform to market.

The task is not easy. By day, Dougherty and Zoeller work as web developers at Homesite, and Hsiao is a software engineer at Hubspot. If that isn't enough, Dougherty also heads the non-profit, Project Mailbox. At night and on weekends though, their focus turns to Verbal.

"It helps that we're all in Boston and have each other to bounce ideas off of," said Hsiao.

"That was something that stemmed from senior design," added Zoeller. "We definitely had late nights in college where we were collaborating and doing just that."

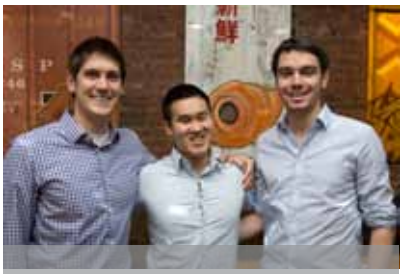
In the meantime, familiar faces in ECE like senior design project advisor, Associate Professor of the Practice Alan Pisano (ECE), and Morse have offered their help and guidance.

Morse is assisting in the grant application process which could help make Verbal a commercially viable product. He will serve as Principal Investigator on Red Electric's National Institute of Health Small Business Innovative Research grant that includes the Massachusetts General Hospital as a partner. Morse and Red Electric have even obtained a letter of support for the grant and product from Secretary of State John Kerry. With his support, the Verbal team is working toward a partnership with the Department of Defense and the Department of Veterans Affairs to establish communications solutions for veterans suffering from brain injuries or speech impediments.

Along with Dougherty, Morse also plans to present the project to Lifespan, a healthcare company in Rhode Island.

"Professor Morse has been such a strong supporter of this project," said Dougherty. "He takes notes and observes at the hospital, finds great sources for us to speak with and has served as a mentor."

Five years since his own hospital stay, Morse's speech has improved thanks to two years of therapy and fortunately, the stroke didn't affect his mobility. Still, he remembers his experience vividly and is excited to see his students creating an app that would prevent others from going through what he had to.



Pictured from left to right are Nick Dougherty, Eric Hsiao, and Gregory Zoeller (all ECE '12) who designed the app, Verbal.

"I am pleased beyond belief with the work these alumni are doing," he said. "This app would have been superbly helpful if it existed when I was in the hospital."

Right now, the application is being used at Massachusetts General Hospital and specifically, in their Respiratory Acute Care Unit where patients are sometimes unable to speak.

"Eventually we would like to test this out in other hospitals, too, but we think proving its effectiveness at MGH holds a lot of weight," said Zoeller.

"Nurses and patients have really been our greatest advocates so far," added Dougherty. "It helps us to know that what we've designed is really meaningful."

Since graduating, Dougherty, Hsiao and Zoeller have worked to design a product that reflects what hospitals really need and are building upon the customizability of their app. Patients can now write specific requests while nurses can add new input fields. The app also has the ability to prioritize the requests of patients based upon their needs and urgency.

"We've been able to use much of this feedback to really refine the user experience," said Hsiao.

Eventually, the alumni would like to see their app used not only in hospitals but also in homes and senior centers.

"Our ultimate goal is to improve patient care," said Dougherty. "By improving nurse efficiency and cutting back on hospital costs, we hope our app can provide the means to do just that."

Based on the positive responses so far from patients, nurses, doctors, administrators, and even a U.S. senator, it looks like Verbal is headed in the right direction.

-Rachel Harrington

No Longer Lost in Translation

Just two years ago, American Ryan Rogowski found himself living and working in China building mobile games. He had never spoken Chinese before and learning the language proved to be quite difficult.

If only a tool existed that allowed you to look up characters on a phone simply by pointing your camera at the text, Rogowski thought.

Enter Huan-Yu Wu (MS '10) who is helping make that dream a reality.

Rogowski met Wu shortly after he returned to the U.S. He encouraged Wu to help with his idea by joining Translate Abroad, a small startup company.

"I had a passion for image processing, and he was looking for teammates to build the app," said Wu. "We soon realized the potential of our project, too."

Today the free app is better known as Waygo, a name chosen because of a similarly pronounced Chinese word that means foreign country. Wu has been instrumental in the development of the app's image capture and analysis features.

Waygo is able to instantly translate Chinese to English via an iPhone, but other languages like Japanese and Korean, as well as English to Chinese translations, are in the works.

"We decided to first focus on China and the East Asian market because that's where our team had the most experience," said Wu. "These countries also use some of the more difficult languages to translate but we're up for the challenge."

Wu's familiar with tackling new research. At Boston University, he studied under Professor Janusz Konrad (ECE) and Associate Professor Prakash Ishwar (ECE) in the Department of Electrical & Computer Engineering. Both professors pushed him to learn more about image processing during his small classes and master's project.

As a student at Boston University, Huan-Yu Wu (MS '10) gained a greater understanding of image processing by working with Professor Janusz Konrad (ECE) and Associate Professor Prakash Ishwar (ECE).

At the Global Mobile Internet Conference, Waygo took top honors in the appAttack contest. Pictured from left are Huan-Yu Wu, Robert Sanchez, Alejandro Campos Carlés of StartMeApp, and Ryan Rogowski at the award ceremony.

"It was easy to interact with my professors so I was able to get the most out of studying here," said Wu. "Also, Boston's easy access to resources makes it one of my favorite cities."

Ishwar, who with Konrad was one of Wu's co-advisors, recalls that his former student was difficult to read initially thanks to his soft-spoken nature.

"In your first meeting with Huan-Yu, you may not grasp his steely determination to succeed, hard work, perseverance, and sharp intellect lurking under his quiet and unassuming nature," said Ishwar, "but if you give him a chance and wait to see the quality and quantity of his work output, you will be pleasantly surprised to find out how wrong you were."

Wu decided to attend BU after browsing through some websites and discovering the ECE Department's strong group in signal processing.

"This was what I had wanted to learn, and after I came here to study, I was really glad I made the right choice," said Wu.

By working with Ishwar and Konrad, Wu gained a greater understanding of image processing – information he uses every day at Translate Abroad where he works on the algorithms and back end of the app. His counterparts – Rogowski, the CEO, and Kevin Clark, who works on the mobile and front-end aspects of the product – also possess backgrounds in image processing research.

"To be more productive, we divided our work and supported each other on our assignments," said Wu. "Ryan focuses on the business side, Kevin designs mobile interface, and I develop the recognition and translation algorithm."

More recently, Waygo added a fourth member, Robert Sanchez, who helps in marketing and business operations. All four are working from Providence, R.I., though the company now additionally has ties to Mountain View, Calif., after joining the startup accelerator program, 500 Startups.

Their company may be in its early stages still but it's already received praise for Waygo at the Global Mobile Internet Conference - Silicon Valley last year. The app, then known as Waigo Translate, took home top honors and beat over 200 competitors in the event's appAttack contest. For their design, the Waygo team was awarded $5,000.

"The conference turned out to be a wonderful platform for keeping up-to-date with new technologies and connecting with great people," said Wu. "There were a number of people present who travel back and forth between the U.S. and China, so it was a good opportunity to build traction with our app," said Wu.

Whether you're traveling to China soon or simply want to have a better understanding of the menu the next time you're at a Chinese restaurant, Waygo is worth trying out.

-Rachel Harrington

BU Alumni Target Advertising, Journalism With Visual Recognition Technology

Tagging your friends on Facebook became a lot easier when face recognition technology came into play and identified familiar faces from your previous photos.

Orbeus, a joint BU-MIT alumni startup, saw the potential of using visual recognition in other fields and decided to target new audiences by molding their services for advertising agencies, social media networking sites, and journalists. The technology they're developing can identify brands, logos, and other information that can be helpful for advertisers to find the right target audience.

"Visual recognition is in demand and people in surveillance, e-commerce, and advertising are already interested," said Xing Meng, one of the company's co-founders. Meng Wang (MS '12) and Tianqiang Liu (MS '11) also make up the company's founding entrepreneurs.

The idea for Orbeus first developed in Boston, where Meng was a student at MIT and Wang and Liu were studying at BU.

"I had been studying lots of topics such as anomaly detection, image saliency, and 3D reconstruction," explained Wang. "From that, I knew that I wanted to help develop a unifying data-driven framework that could tackle a lot of computer vision problems, which later on became the technology foundation of Orbeus."

At BU, Wang said he enjoyed freedom in his research and the academically dynamic community.

"I love to play with different ideas and patterns, but it was only through in-depth discussions with my MS professors that those ideas eventually transformed into concrete algorithms that are grounded in sound theory," said Wang.

Professor Janusz Konrad (ECE) was one of the professors who helped shape Wang's ideas.

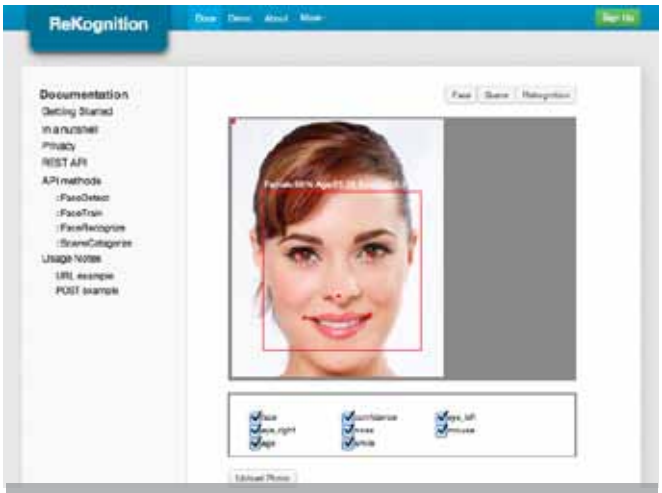
"In his research projects at BU, Meng [Wang] showed an exceptional ability to solve practical image processing problems with great algorithmic efficiency," said Konrad. "This often required integration of several algorithms into a complete working system, so it comes as no surprise to me that he translated these skills into a successful startup."

Wang's creativity and hard work came to fruition at the MIT $100k Entrepreneurship Competition, where team Orbeus was a semi-finalist. From that contest, Orbeus gained more than a formal mentorship, an expense account, and the opportunity to pitch to a group of judges in a simulated funding meeting. The mandatory demo presentations and business plan write-ups forced the members of Orbeus to make concrete decisions.

"By asking us to present demos, the competition made us shift our focus from technology-development to product-building," said Meng. "It forced us to sit down as a team and decide where we wanted to take Orbeus as a company."

Professor Prakash Ishwar (ECE) wasn't surprised to hear about the success Orbeus found at the MIT competition. Like Konrad, he also had the chance to work with Wang at BU.

"Meng Wang is an ambitious, fearless, and gifted hacker who has boundless creative enthusiasm for tackling real-world visual information processing problems," said Ishwar.



On their website, ReKognition.com, Orbeus offers visual recognition technology that identifies facial expressions.

Ishwar added that his former student showed potential even before joining BU. As an undergraduate, Wang launched GoGoStudio, a blogspot that documents his handiwork in machine vision.

Like any new tech startup, Orbeus has faced its share of challenges. After initially developing an infrastructure without picking any direction, the group's many mentors began pulling them down different paths.

"With at least six meetings a day, our team had to sit together and evaluate what we needed to do from a technology perspective," said Meng.

After sorting through their different options, they decided on one clear direction for marketing in terms of the right target audience and are working on developing their product with that in mind.

The second challenge was funding. Paying for experienced developers, hosting, software, and hardware added up when the company expanded. Luckily, members of Orbeus were able to secure additional funding when they were introduced to others who needed the technology their company was offering.

In May 2012, the company moved to Excelerate Labs. The Chicago-based incubator gives the team mentorship, products, business, marketing and a platform to pitch and showcase their product in front of 400 to 500 people during a demo day. Meng believes this could potentially help them secure their second round of funding.

Moving to Chicago also gave the team the opportunity to find more advertisers that were interested in the product. In the past couple of months new opportunities have opened up. In June 2012, Facebook acquired Face.com, a leading face recognition service company with a third of the visual recognition marketplace, opening up a huge hole for other startups like Orbeus to fill.

The technology has the potential to benefit journalists as well. Current stock image websites limit searches to generic pictures, but with visual recognition, it will be possible to search for specific attributes of images such as negative emotions in facial expressions.

With new opportunities arising, the company has big goals for the future. Last August, they released a new Application Programming Interface (API) allowing developers to test and sign up for an API key to try the platform on their website, ReKognition.com.

Two weeks later with 200 developer sign ups, they launched their first site for consumer search images which will allow customers to find photos with themselves and their friends in an easy-to-use platform.

Alongside these new projects, the team hopes to increase user adoption and find more developers in the months to come.

-Sneha Dasgupta (COM '13)

Parking Perfected

Fenway Park is one of New England's most popular destinations, especially in the summer. Unfortunately, many ticketholders that drive into Boston to see their beloved Red Sox have to contend with traffic and finding a place to park.

These aggravations are just some of the annoyances fans put up with to see baseball in Beantown, but there's a company that can help with at least one of those problems.

ParkWhiz, founded by Aashish Dalal and Jon Thornton (ECE '06) as a result of their own ballpark experiences, allows users to find available parking and reserve a space before they reach their destination. The technology even allows drivers to compare prices, location and amenities of the spaces.

"It's incredibly gratifying to work on something that hundreds of thousands of people use to make their lives easier," said Thornton. "Trying to build software that makes all of our customers happy can be a challenge, but it's never boring, and that's the best part about my job."

In a way, ParkWhiz actually stemmed from Thornton's senior design project at Boston University. He and his research team worked with Professor Thomas Little (ECE) who had written a research paper about designing a parking system based on sensor networks. The students' job was to implement a design that would allow drivers to locate a parking space in a garage or at a meter and make a reservation.

Jon Thornton (ECE '06)

"Jon had a key role in developing software to essentially move sensor data into the cloud by enabling parking spot vacancy sensors to communicate occupancy data to wireless gateways that collected information on parking availability," Little recalled.

In the meantime, Dalal, who had been working on a business plan for a parking technology company, had come across Little's research paper. Dalal reached out to the professor who then introduced Thornton to his future business partner. Thornton was prepared to start at New York University's Interactive Telecommunications Program in Fall 2006 but decided to work on ParkWhiz over the summer.

"Once NYU sent the first tuition bill in September, I decided I could get a much cheaper education by seeing where ParkWhiz went," said Thornton.

The company grew slowly at first. For the first five years, the company was just Dalal and Thornton, who both took other jobs to support themselves. By their third year working on ParkWhiz, they were able to pay themselves a small salary and by the fourth year, the company really took off, and Dalal and Thornton were able to hire their first employee.

"Since then, we've hired 16 more in a little over a year," said Thornton.

Today ParkWhiz, which is based in Chicago, can support parking requests near Madison Square Garden, Wrigley Field, and LAX Airport, to name a few. They have been the catalyst behind more than $10 million in parking revenue, have access to over three million parking spaces, and secured partnerships with StubHub, the Indianapolis Colts, and US Airways Center. The company also recently received $2 million in funding from Hyde Park Venture Partners, which will allow it to expand its team and accelerate its growth.

"This financing allows us to realize our next stage of growth, beginning with the hiring of 20 additional employees," Dalal said in a press release.

As Parkwhiz continues to grow, Thornton continues to be grateful for his alma mater, not just because BU was where he met his cofounder but also because of the education he received. Professors Little and Min-Chang Lee were among those who pushed him to become a better student and excel in more difficult subjects, like Introduction to Electronics and Electrodynamics.

"What impressed me was not only his intelligence and diligence but also his attitude toward his studies," said Lee. "He was very enthusiastic about learning these courses."

Thornton said that his education at BU prepared him for both the research and business sides of his work.

"BU gave me exposure to people who were studying all sorts of different things - not just engineering," said Thornton. "This helped prepare me for the business world where things don't fit into neat buckets and gave me a large network to call on when I needed help."

It's safe to say that Thornton will continue to apply both his education and business know-how as ParkWhiz grows in the years to come.

-Rachel Harrington

PhD Dissertations

Student Name	Dissertation Advisor	Dissertation Title
Ronen Adato	Hatice Altug	Mid-Infrared Plasmonics for Ultra-Sensitive Spectroscopy of Biomolecular Interactions
Alp Artar	Hatice Altug	Engineering of Electromagnetic Interactions in Three-Dimensional Plasmonic Metamaterials
Khan Ashfaquzzaman	Martin Herbordt	Scalable Molecular Dynamics Simulation Using FPGAs and Multicore Processors
Ajay Kumar Bangla	David Castañón	Auction Algorithms for Generalized Nonlinear Network Flow Problems
Nenad Bozinovic	Siddharth Ramachandran	Orbital Angular Momentum in Optical Fibers
Thomas Butler	Joshua Semeter	Spatial Statistics and Analysis of Earth's Ionosphere
Cassandra Browning	Mark Horenstein	Transdermal Delivery of Drug-Infused Nanoparticules Using Electrostatic Pulse
Yushan Chen	Calin Belta	Formal Synthesis of Control and Communication Schemes
Min Huang	Hatice Altug	Optogluidic Plasmonic Nanosensor Arrays for Biodetection
Atabak Mahram	Martin Herbordt	FIPGA Acceleration of Sequence Analysis Tools in Bioinformatics
Faisal Sudradjat	Roberto Paiella	Terrahertz Optoelectronic Devices Based on Intersubband Transitions in II-Nitride Semiconductors
Gary Walsh	Luca Dal Negro	Engineering Optical Nonlinearities in Metal Nanoparticle Arrays
Lu Wang	Ronald Knepper Selim Ünlü	A 256-Input Micro-Electrode Array With Integrated CMOS Amplifiers for Neural Signal Recording

Additional PhD Dissertations with ECE Advisors

Student Name	Dissertation Advisor	Dissertation Title
Sunmin Ahn (BME)	Selim Ünlü	Performance Improvement of Label-Free Biosensors and Their Applications in DNA and Protein Microarrays
Serap Aksu (SE)	Hatice Altug	Development of Nanostencil Lithography and Its Applications for Plasmonics and Vibrational Biospectroscopy
George Daaboul (BME)	Selim Ünlü	Nanoparticle Sensing Platform for Pathogen Detection and Identification
Yanfeng Geng (SE)	Christos Cassandras	Optimization Methods For Intelligent Transportation Systems in Urban Settings
Fuzhuo Huang (SE)	Ioannis Paschalidis	On the Maximum Weighted Independent Set Problem With Applications in Wireless Sensor Networks
Yuk Kwan Sylvanus Lee (ME)	Luca Dal Negro	Engineering Aperiodic Nanostructured Surfaces for Scattering-Based Optical Devices
Margo Monroe (BME)	Selim Ünlü	Highly Sensitive and Multiplexed Platforms for Allergy Diagnostics
Tao Wang (SE)	Christos Cassandras	Control and Optimization Approaches for Power Management in Energy-Aware Battery-Powered Systems

Ph.D. student, Hassan Akbari (ECE), installs a low-light imaging system in an observing dome at the Poker Flat Research Range near Fairbanks, Alaska. The camera system is used to study fine-scale structure in the aurora borealis and its relationship with plasma turbulence in the ionosphere.

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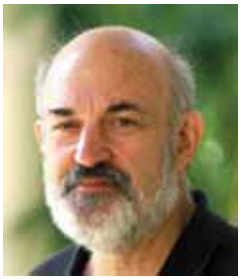

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Malay Mazumder
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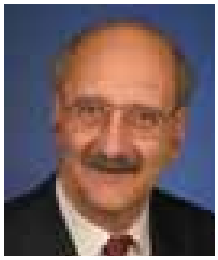

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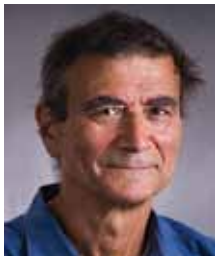

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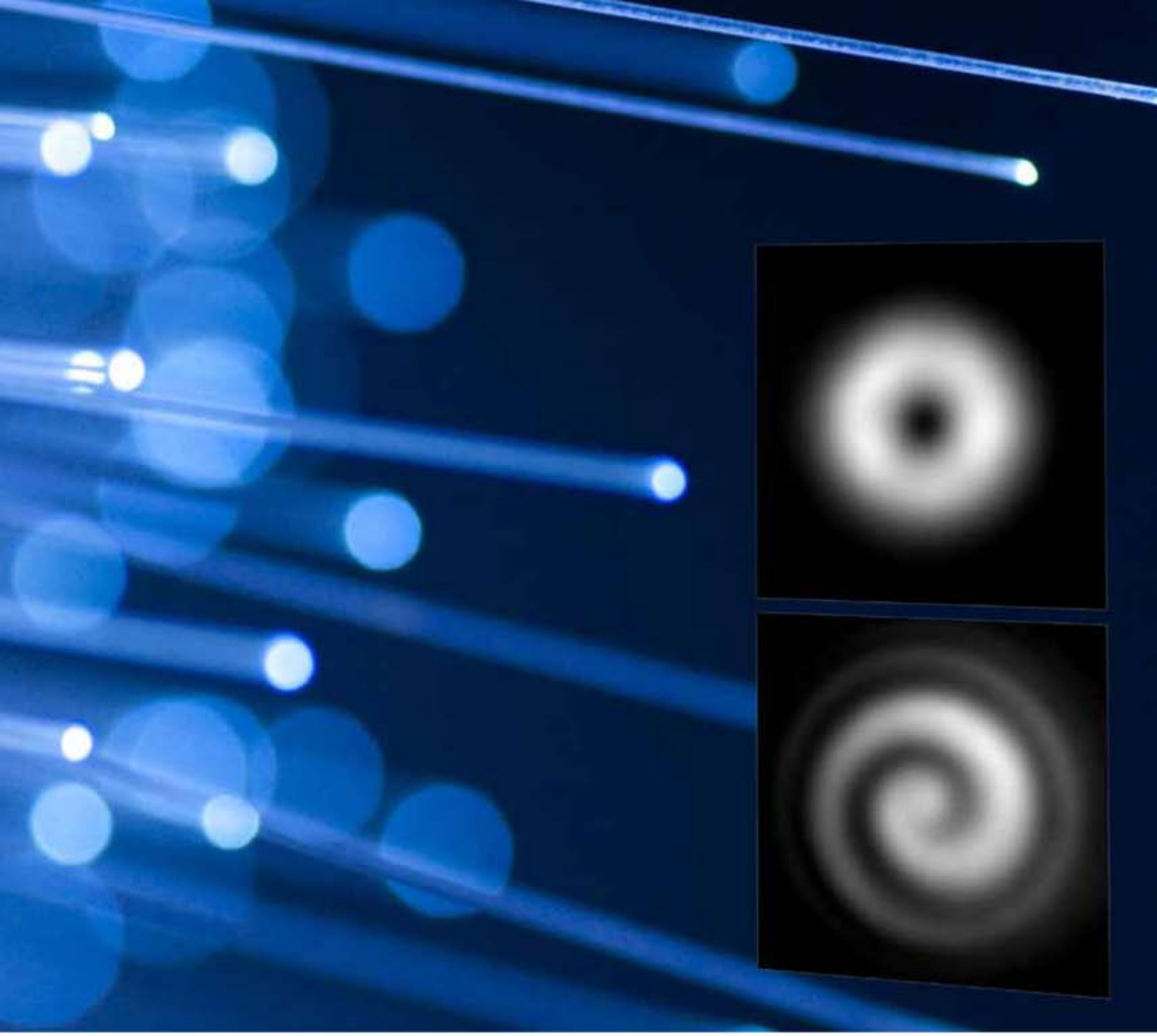

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