

COLUMBIA | ENGINEERING

ENGINEERING NANOSCIENCE

SMALL SCALE,
HUGE POTENTIAL

A CAMERA THAT
POWERS ITSELF

INTERNET OF
THINGS: NEXT STEPS

KY HARLIN BS'08:
DATA + GROWTH
AT CONDÉ NAST



Seniors from all nine Engineering departments showcased their innovative capstone projects at the School's Senior Design Expo last spring. (Photo by Timothy Lee Photographers)





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Opposite page:
Dean Mary C. Boyce
(Photo by Jeffrey Schifman)

Cover: Assistant Professor Nanfang Yu's research expertise is in nanophotonics and optoelectronic devices. In a collaborative project with Professor Michael Weinstein, he is exploring a planar device for robust transport of guided optical waves. Illustrated in this research image is the intensity of light reflected from a nanostructured silicon membrane that supports two closely spaced optical resonances. (Image courtesy of Adam Overvig)



The first day of the fall semester marks a new beginning for students and faculty alike, and, at Columbia Engineering, many exciting changes have taken place over the past year, paving the way for great advancements in research, education, and innovation.

Last year we initiated a series of faculty discussion forums focused around highly interdisciplinary research themes that cut across our School, many of which also leverage incredible collaborations with our sister schools. We have discussed research initiatives that address society's grand challenges and those that push disciplinary frontiers. Not surprisingly, these fields intersect and all spur discovery of novel areas of research.

Our faculty and students are concentrating on global challenges including water, energy, climate, mobility, human health, and communications, and, on the frontiers of sensing and imaging, data science, computation-based engineering science, and advanced materials and devices. These research endeavors advance fundamental knowledge that will impact society at all levels—truly *transcending disciplines and transforming lives*.

The research focus of this issue, starting on page 6, showcases our work in nanoscience and nanoengineering—a field of advanced materials and devices where the line between a material and a device is often absent. Columbia is recognized worldwide as one of the leaders in the development of nanoscience. Manipulating materials at the atomic and molecular levels will provide new ways to fabricate macroscale products with innovative applications that will impact medicine, energy, water, computing, and much more.

To support the research endeavors of our faculty, including 15 new faculty (page 40) and four more joining in January, we have committed significant resources to outfitting new laboratories, renovating current laboratories, expanding and renovating

clean rooms, and creating an electron microscopy lab with a new transmission electron microscope as part of a set of shared facilities with Arts and Sciences.

In addition to renovated spaces for research, transformations to education and common spaces have also been a priority. Students were greeted by a fresh, sleek campus-level entry to Mudd, and a modern, inviting student space, Carleton Commons, with areas for quiet study, tables to work or eat together, and comfortable seating for relaxing between classes or activities. Carleton Commons is open 24 hours a day and is well used, both day and night! See details of all our new renovations on page 48.

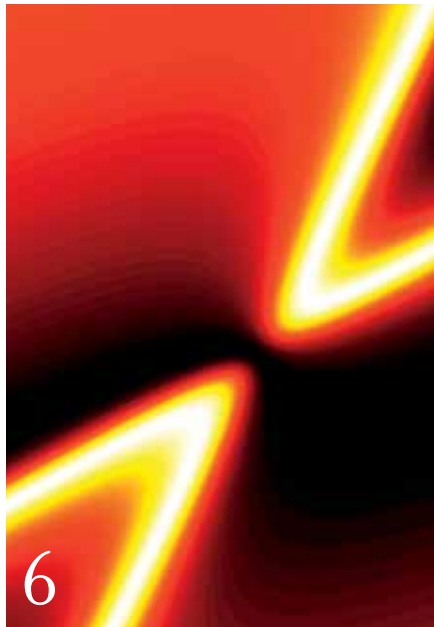
Also in this issue you'll get to know some of the many innovations coming from our faculty, students, and alumni. Shree K. Nayar, T. C. Chang Professor of Computer Science, a serial inventor, has developed a self-powered video camera (page 24). Alums Ky Harlin of Condé Nast and Shahram Ebadollahi of IBM Watson Health both use big data to achieve their different business objectives (pages 36–38); and students like Jason Kang (page 26), Ritish Patnaik, Riley Spahn, and Jessica Valarezo (pages 32–35) epitomize the spirit and inventiveness of today's Columbia Engineering students.

We are proud to share these stories with you so that you can see for yourself the remarkable institution that is Columbia Engineering today.

Mary C. Boyce

Mary Cunningham Boyce
Dean of Engineering
Morris A. and Alma Schapiro Professor

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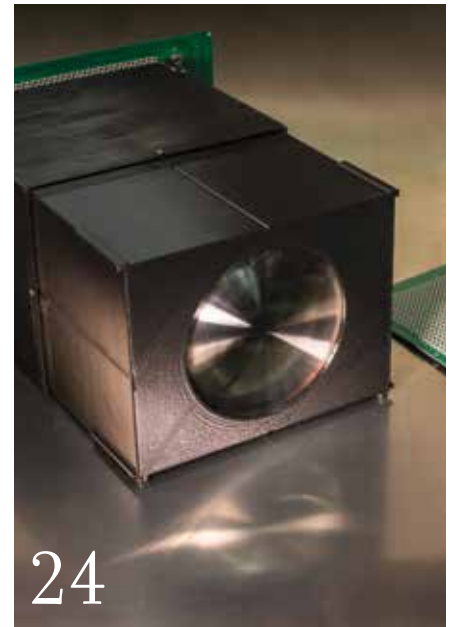
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RESEARCH

The background of the page is an abstract, dynamic composition of flowing, curved lines. The color palette is dominated by bright yellow and vibrant red, with some darker, almost black, areas that create a sense of depth and movement. The lines appear to be layered and overlapping, giving the impression of a complex, organic structure or perhaps a stylized representation of energy or data flow.



ENGINEERING FACULTY LEAD NANOSCIENCE DISCOVERIES

Columbia has been at the forefront of nanoscience research for more than 15 years, and, with the University's launch of the Columbia Nano Initiative (CNI), activity on this front is accelerating. As James T. Yardley, CNI's acting executive director, puts it, "When I came here in 2000 and walked up and down the hallways, you'd hardly see anybody. But now when you walk up and down the halls, you see people arguing with each other, holding samples, animated in discussion."

Working with colleagues Keren Bergman, James Hone, Colin Nuckolls, Ken Shepard, Latha Venkataraman, and many others, Yardley has been instrumental in leading nanoscience at Columbia, and he sees this burgeoning field bringing together investigators in an exciting new way.

"At Columbia, we've really pioneered the concept of interdisciplinary research, of getting more than the sum of the parts by bringing together physicists, engineers, and chemists to do collaborative research," he says. "We've revolutionized the fundamental understanding of how electrons

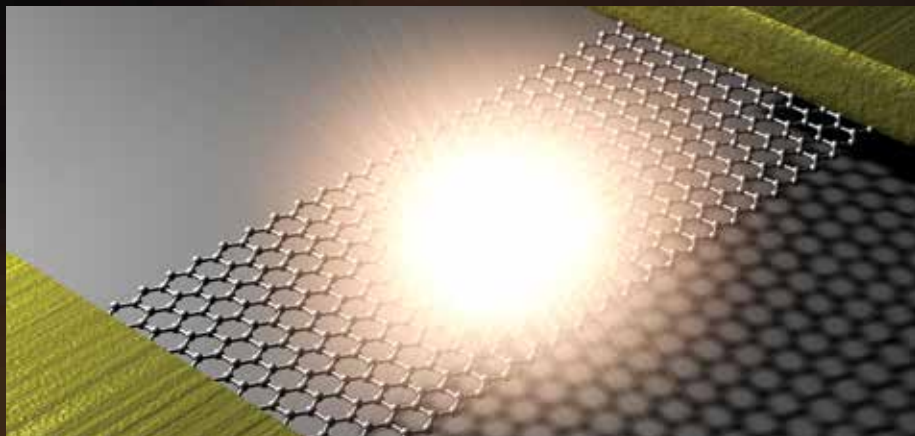
move through molecules; of what graphene, a material we pioneered here, is and how it works; and established basic knowledge about carbon nanotubes. Our discoveries have fostered important research around the world, and that's really come about because of the collaborative environment we've created here at Columbia."

The complexities of nanoscience, manipulating individual atoms and molecules, make for a perfect intersection of disciplines. The rules change at the nanoscale; materials, electrons, chemicals—all behave differently. Shared equipment, such as the state-of-the-art transmission electron microscope, and expanded facilities like the Nanofabrication Clean Room, which is almost doubling in size, are reinforcing partnerships, as is Columbia's new \$15 million, multiyear NSF Materials Research Science and Engineering Center (MRSEC).

Here, *Columbia Engineering* spotlights just a few of our professors whose work is advancing the field of nanoscience and, in many ways, pushing boundaries far beyond the nanoscale.

JAMES HONE + COLIN NUCKOLLS

**COLLABORATING TO CREATE NOVEL
MATERIALS ON THE NANOSCALE**



Led by Young Duck Kim, a postdoc in the Hone Lab, a team of scientists from Columbia, Seoul National University, and Korea Research Institute of Standards and Science have recently demonstrated—for the first time—an on-chip visible light source using graphene. They attached small strips of graphene to metal electrodes, suspended the strips above the substrate, and passed a current through the filaments to cause them to heat up, essentially creating the world's thinnest light bulb. (Image provided by Young Duck Kim)

If someone wagers there is nothing new under the sun, it would be best to first consult with James Hone and Colin Nuckolls before taking the bet. After all, their combined focus is to create new materials on the nanoscale that have the potential to solve some of the world's most persistent problems.

Hone, Wang Fong-Jen Professor of Mechanical Engineering, and Nuckolls,

Higgins Professor of Chemistry, are director and associate director, respectively, of Columbia University's new Materials Research Science and Engineering Center (MRSEC), supported by a \$15 million, six-year grant from the National Science Foundation. Their goal is to learn about the properties of atoms and molecules and then determine how to assemble these nanoscale building blocks into materials and structures that will define the next generation of medicine, electronics, energy production, and consumer products.

"Nanoscience is a special area in which many disciplines meet because of the complexity of the science," says Nuckolls, who concentrates his research on creating new materials using chemically designed superatoms. These highly complex designer elements are expected to have unprecedented levels of functionality. "Our MRSEC has preliminary results that are already quite exciting, which demonstrate that these elements have the potential for interplay between thermal, magnetic, and electrical conductivity," he says.

“Much of our work in nanoscience is like Darwin stepping onto the Galapagos Islands. There is something new, something never before seen, happening all the time.”

—James Hone, Wang Fong-Jen Professor of Mechanical Engineering

Graphene incorporated into nanomechanical device via nanofabrication by the Hone Research Group. (Photo by Jeffrey Schiffman)

While Nuckolls works on designing new superatoms, Hone focuses on thinning known materials to the ultimate limit—like graphene, an atomically thin form of graphite that is a single atomic layer of carbon atoms. This two-dimensional material is stronger than a diamond and better able to conduct electricity and heat than any known material. In the MRSEC, Hone and colleagues are stacking it and other 2D materials to create heterostructures, which helps him learn how to control the properties of these nanomaterials to create interfaces that exhibit entirely new electronic phenomena.

“Our work in the MRSEC is examining material in an atomically thin layer, which exposes new properties we have never seen before. Much of our work in nanoscience is like Darwin stepping onto the Galapagos Islands,” says Hone. “There is something new, something never before seen, happening all the time.”

Collaboration between Hone and Nuckolls has resulted in some interesting science that not only helps further insight into the chemistry of graphene, but also

helps illustrate the potential for the material as part of next-generation circuitry.

“Colin and I worked together to couple carbon nanotubes and DNA and made circuits,” says Hone. That work forged both literal and figurative connections between chemistry, physics, materials science, and biology, which holds promise for a new generation of integrated multifunctional sensors and devices.

That potential for discovery—and Columbia Engineering’s reputation as a collaborative environment—attracts interest from outside the University.

“If you want to tackle big questions—and nanoscience is full of big questions, then you need to work in groups across disciplines,” says Hone. “Here, we welcome collaboration.”

Researchers from a number of institutions of higher education, including City College of New York, Harvard University, Barnard College, Stanford University, and the University of the Virgin Islands, are part of the MRSEC investigations. So too are the Brookhaven National Laboratory, IBM, and DuPont.



James Hone (left) and Colin Nuckolls, pictured in the Hone Lab. (Photo by Eileen Barroso)

“At Columbia, there is a watercooler effect in which we all talk to each other about problems we are working on,” explains Nuckolls. “That give-and-take results in important insight and better understanding among all of us about these new materials.”

By Amy Biemiller

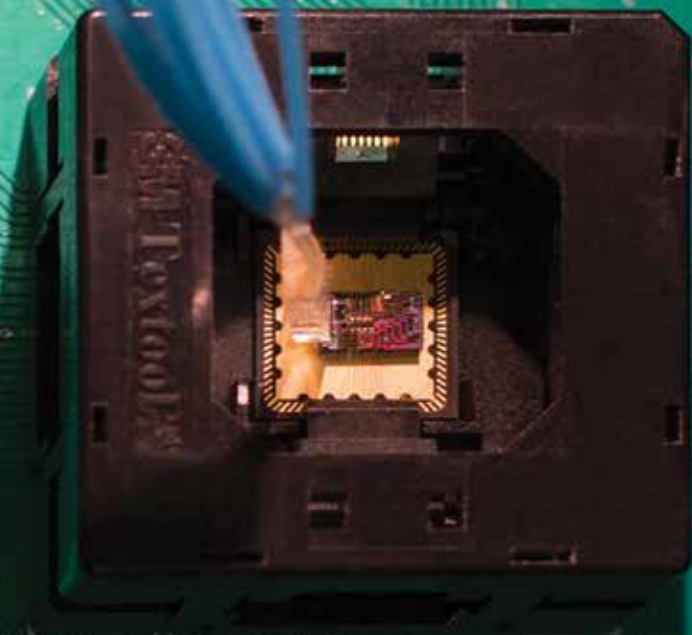
RESEARCH

BERGMAN + LIPSON + GAETA
engineering.columbia.edu/web/newsletter/photonics



Nanophotonic switch demonstrated in a high-performance embedded computing system. (Photo by Jeffrey Schifman)

Opposite page, bottom: A chip being examined with several fabricated nanophotonic comb lasers. (Photo by Jeffrey Schifman)



KEREN BERGMAN + MICHAL LIPSON + ALEX GAETA

COMBING THROUGH STREAMS OF LIGHT

After almost a decade of long-distance collaborations, Keren Bergman, Michal Lipson, and Alex Gaeta are working together in one place, here at Columbia Engineering. Lipson and Gaeta joined the School this summer as the Eugene Higgins Professor in Electrical Engineering (EE) and the David M. Rickey Professor of Applied Physics and of Materials Science, respectively. And now, together with Bergman, who is the Charles Batchelor



to high bandwidth communications that connect data centers and their thousands of servers at very high speeds.

“Measuring time is essential to almost everything in our lives,” says Gaeta, a pioneer of laser physics, the field that underlies nanophotonics. “We can use these combs to precisely measure frequency and thus measure time extraordinarily accurately. And if you can measure time accurately, you can measure distance with very high precision.”

Frequency combs are expected to generate all kinds of critical real-world applications, from vastly improved GPS positioning to predicting earthquakes and volcanoes, from sensing chemical agents to detecting oil and gas underground. Gaeta and Lipson have been able to control the dimensions of their devices, “controlling them exquisitely well—to a nanometer precision—so that these optical processes can occur really efficiently,” Gaeta adds. Bergman brings her expertise in large-scale optical network systems.

And it’s only the beginning.

“Only 15 years ago, the optical components we were making, whether they were clocks or sensors, were all really big,” says Bergman.

Lipson adds, “And now, with nanotechnology, we can fit the optics onto a chip.”

“It’s really cool that these innovations at the nanoscale enable you to do things for real life that were never possible before at the macroscopic scale,” Bergman concludes. “We’re very lucky to be working in such a transformative field at the right time—and now we can do it together.”

By Holly Evarts

Pictured above, from left to right: Keren Bergman, Michal Lipson, and Alex Gaeta. (Photos by Eileen Barroso)

“The emerging field of nanophotonics is revolutionizing telecommunications, computation, and sensing.”

—Keren Bergman,
Charles Batchelor Professor
of Electrical Engineering

Professor and EE chair, the trio is set to break new ground in nanophotonics, or, as Lipson, a preeminent leader in nanophotonic fabrication, puts it, “optics on a very, very small scale.”

“The emerging field of nanophotonics is revolutionizing telecommunications, computation, and sensing,” notes Bergman, who specializes in optical interconnection networks for advanced computing systems. “This is a very strong area at SEAS, and the arrival of Michal and Alex will greatly broaden our research impact—I’m really excited that their labs are practically next door to mine and our students can work together.”

One of their primary foci is on developing frequency combs, light sources that generate multiple colors—or frequencies—that are spaced to extraordinary precision and can be visualized like the teeth of a comb. Frequency combs can be used to measure light colors to very high precision over a broad frequency range, over an octave of spectrum, which enables a direct link from microwave to optical frequencies; their “teeth” are used to perform ultraprecision measurements in time or frequency in a similar fashion to atomic clocks. The combs can also be used in sensing devices that can, for instance, rapidly detect explosives or drugs from 30 meters away or be applied



Nanfang Yu (left) and Michael Weinstein in Yu's optics lab. (Photo by Jeffrey Schifman)

MICHAEL WEINSTEIN + NANFANG YU

SMOOTH SURFING OF OPTICAL WAVES

Solitary ocean waves ridden by surfers eventually break, but there are optical waves that travel along interfaces and are able to glide smoothly around and through rough environments without distortion.

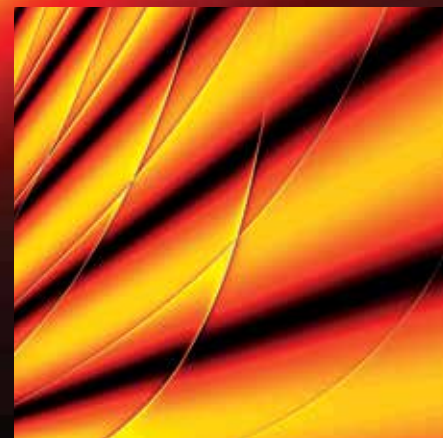
This unusual class of optical waves is the focus of an ongoing collaboration between Michael Weinstein, professor of applied mathematics, and Nanfang Yu, assistant professor of applied physics.

Weinstein, who has a joint appointment as a professor of mathematics in the Department of Mathematics, and James Lee-Thorp, his student, recently obtained mathematical results on the existence and properties



Illustrated here is the intensity of light reflected from a nanostructured silicon membrane that supports two closely spaced optical resonances. (Research images courtesy of Adam Overvig)

Reflection spectra of bonding and antibonding perturbation resonances in a symmetry broken periodic silicon nanostructure with varying height.



of “topologically protected edge states” in structures whose material spatial variations have special symmetries. According to Weinstein, “An edge state manifests itself as a surface wave propagating along a structured surface between two distinct media. What is remarkable is that these guided waves do not spread out or decay in amplitude, even in the presence of strong perturbations.”

Yu pointed out that “this robustness is a highly desirable feature for information transfer in ‘optical integrated circuits,’ and it is very compelling for us as device physicists to investigate physical realizations of these robust edge states.”

Telecommunication relies on reliable transfer of light from one location to another. On a chip, this is impeded by factors such as inaccuracy of device geometry due to fabrication errors, varying operation conditions of the chip, and defects introduced to the chip while it is in use. Yu and Weinstein remark that the optical edge states they are studying promise to have fewer issues of this sort, and therefore offer an improved platform and can serve as a fundamental building block with which to create robust on-chip photonic devices.

“This is an exciting collaboration between mathematical theory and experiment,” said Weinstein. “Mathematicians and physicists naturally come at questions from different angles, so one is always learning and also being challenged to communicate one’s own perspective.”

Added Yu, “Weinstein’s group predicted the existence of a robust guided optical wave in a nonobvious structure, which physicists and engineers in the photonics community would be very unlikely to invent or study otherwise.”

“Nanfang Yu and his student Adam Overvig are outstanding device physicists and experimentalists in photonics. They have the expertise to design and realize novel device functionalities by choosing the right materials systems, and a device architecture that is feasible for nanofabrication,” said Weinstein. Together, the two research groups have a very broad toolset to demonstrate and explore modes of robust energy transport, and to develop mathematical and experimental approaches that can be used well beyond the current problems.

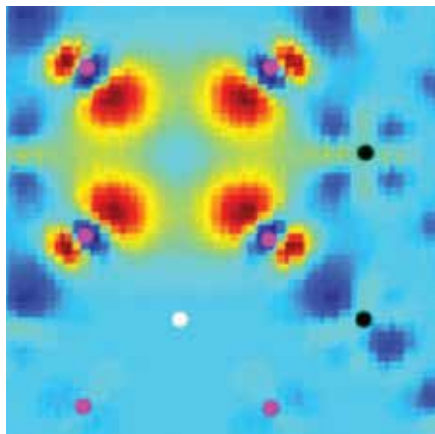
Weinstein and Yu’s research on optical “topologically protected” edge states

“This is an exciting collaboration between mathematical theory and experiment. Mathematicians and physicists naturally come at questions from different angles, so one is always learning and also being challenged to communicate one’s own perspective.”

—Michael Weinstein,
Professor of Applied Mathematics
and Professor of Mathematics

is closely related to “topological insulators,” a field of intense fundamental and applied scientific activity. Their collaborative effort is supported by the National Science Foundation, the Air Force Office of Scientific Research, and the Simons Foundation.

RESEARCH



Research images provided by Chris Marianetti; *Top right:* Chris Marianetti (Photo by Eileen Barroso)

The first-principles theory of materials science continues a great tradition that emerged in the aftermath of the quantum revolution nearly 90 years ago. In 1929, Nobel Laureate Paul Dirac keenly noted, in essence, that the mathematical laws of physics necessary to describe all of materials science were completely known, but the solution of these equations was impossibly difficult.

Applying physics and mathematics to solve difficult equations is what brought electronics to our landscape. Much of today's commonly used technology was developed based on preliminary understanding of how electrons move through various materials under different conditions. That theoretical science combined with heroic experimental efforts made it possible, by the mid-20th century, to harness the behavior of electrons in materials to create the modern computer.

In the realm of nanotechnology, theorists like Chris Marianetti, associate professor of materials science and applied physics and applied mathematics, are particularly important in helping understand how the subatomic world works in complex scenarios. To better understand and explain what happens on the nanoscale, theorists use quantum mechanics, the mathematical description of the motion and interaction of

subatomic particles. The core equation in quantum mechanics is the Schrödinger equation.

"In terms of materials science and chemistry, the Schrödinger equation holds all the information that we need, but the secrets are locked away inside. We work to apply sophisticated mathematical formalisms, which are amenable to reasonable approximations, and work to develop new approaches when our existing methodologies break down," explains Marianetti.

It is these computational approaches that allow researchers to model outcomes of experiments with atomic particles—a job that would be prohibitive if one solely relied on experimental trial and error. These mathematical descriptions help researchers understand how to control the structure of matter and evaluate hundreds of possible material combinations to find the most promising.

"We can now predict many aspects of materials properties for systems spanning the entire periodic table," says Marianetti.

One such material is graphene—a single layer of bonded carbon atoms one million times thinner than paper, which could replace silicon. Marianetti and his group used quantum mechanics to demonstrate that straining this material should induce a novel phase transition, which would cause graphene to mechanically break. Strain is a way to engineer the properties of graphene, so understanding its limits is very practical.

"We can now predict many aspects of materials properties for systems spanning the entire periodic table."



CHRIS MARIANETTI

THEORY UNLOCKS THE SECRETS AT THE NANOSCALE

“This phase transition has not yet been observed, so it is still a bit of a mystery. Several colleagues not connected to our original work have proposed hypotheses on the absence of this transition, and five years out we are still searching for what we believe is the dominant reason. We believe we are close to unraveling this mystery, and ultimately experiment will prove us right or wrong; that is part of what makes this game so fun. I like to say that physics is an art, with a sense of right and wrong.”

Marianetti’s research has also enhanced understanding about the solid-state properties of plutonium, the radioactive element which is used in radioisotope thermoelectric generators, fuels in some types of nuclear reactors, and was used in creating many existing weapons in the world’s nuclear stockpile. He was the first to predict the temperature dependence of the magnetic properties of the material, which is relevant to safe storage of weapons and ensuring the Nuclear Test Ban Treaty far into the future. Research underway in his lab also focuses on

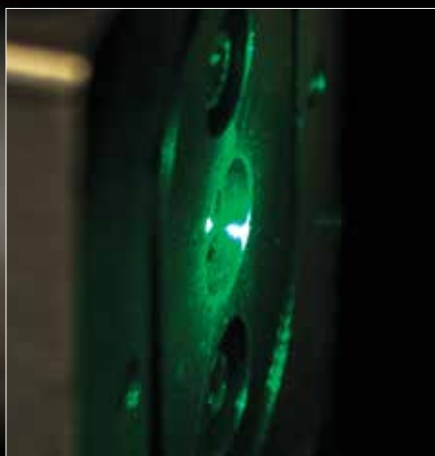
understanding the behavior of nonconventional material and nanostructures of multifunction oxides, metals, and semiconductors to accelerate innovations in analog, logic, and memory devices.

Theory, as exploratory engineering, bookends the science of nanotechnology. Theorists help other scientists and engineers predict new possible combinations of atoms and molecules and, once combinations have been made, test those new materials to explain what is happening on the nanoscale. Theory magnifies experimental capability, and researchers like Marianetti are learning to create functional materials and devices via assembly and manipulation at the nanoscale.

“Theoretical and computational developments help us understand how materials behave under all sorts of conditions,” he says. “This understanding will enable us to design new materials at the atomic scale and work with experimentalists to realize novel phenomena and functionality.”

By Amy Biemiller

RESEARCH



Above: The nanoparticles comprising novel gas separation membranes are characterized by laser light scattering.

Pictured top right: Christopher Durning (left) and Sanat Kumar (Photos by Jeffrey Schifman)

Gas mixtures mimicking contaminated natural gas are prepared reproducibly in order to assess membrane performance.



Sometimes separating things, instead of mixing them, is the goal in chemical engineering. But some systems prove difficult to separate, as is the case when trying to remove salt from water, or contaminants from natural gas (such as CO₂ or other flammable impurities). Membranes are an effective way to remove contaminants from liquids or gases. They can act like filters to “screen” the objectionable component out, and provide a purified fluid. But it is a challenge to produce an effective membrane for a given application. In some cases the substance to be extracted is molecularly too small and easily passes through, or perhaps it is chemically too harsh and degrades the membrane. What is needed is a system that can be highly selective in separating components; tough enough to withstand extreme pH, oxidation, or elevated temperatures; and still “porous” enough to allow the gas or liquid product to come through fast enough.

About a year ago, a single conversation between two chemical engineering researchers about the problems designing such a system for a very important application resulted in an idea proving to be a viable solution. Sanat K. Kumar,

SANAT KUMAR + CHRISTOPHER DURNING

PARTNERING TO DEVELOP HIGHLY SELECTIVE MEMBRANE TECHNOLOGY

professor and chair of the Department of Chemical Engineering, and Christopher J. Durning, professor of chemical engineering, are creating “designer” nanoparticle membranes that can screen out very specific components of a gas mixture.

“I have been working on polymer and nanoparticle design, and Chris has been working on membranes for gas and water purification, for a long time,” explains Kumar. “It was the case of the right people talking to each other at the right time about a shared challenge. That conversation resulted in us being able to take some fundamental science and platform technology and adapt it to a specific application.”

What Kumar and Durning have been able to do is control the structure and dynamics of nanoparticle-polymer assemblies by combining the two in a very specific way, and add the understanding emerging from this work to a growing knowledge of how gas separation membranes work. This combination has resulted in a new class of gas separation membranes that can potentially overcome the performance limitations of the best current membrane systems.

“The designer nanoparticle membranes let certain chemical species pass through

faster than the native polymer membrane,” explains Durning. “It’s as if the presence of the nanoparticles that are decorated with chemically attached polymers open pathways for transport of certain chemicals.”

The duo’s research has great potential for well-gas purification, an important technology that can meet the increased global demand for high-purity natural gas.

“Well gas must be purified to remove dangerous contaminants, such as explosive condensable hydrocarbons, water, and corrosive sulfurous compounds,” explains Durning. “Advanced membranes have been identified as a strategic new technology that can enable more effective gas purification than current methods.”

The researchers have filed for a patent and are talking to others in the technology field about commercializing their solution.

“This underscores what scientific investigation is all about,” says Kumar. “You adapt an idea to a new application, and new physics emerge,” he says. “But I would never have thought to apply this to membranes, until I had that conversation with Chris.”

By Amy Biemiller

Below: Sensitive photon detector on laser light scattering unit used to characterize the key building blocks of novel gas separation membranes.



The duo’s research has great potential for well-gas purification, an important technology that can meet the increased global demand for high-purity natural gas.

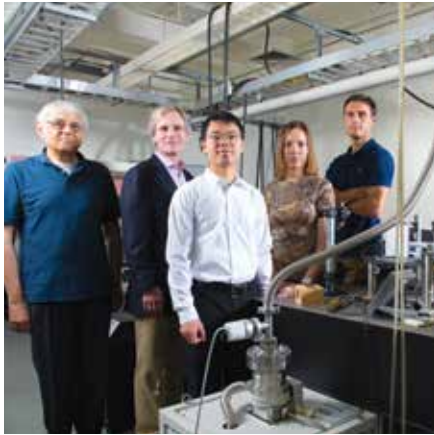
ARON PINCZUK + SHALOM WIND

*ARTIFICIAL GRAPHENE—BETTER
THAN THE REAL THING?*



PhD candidate Diego Scarabelli handles samples in the ultraclean laboratory housing the Nanobeam nB4. A glimpse of the artificial graphene pattern can be seen on the screen at right. (Photos by Jeffrey Schifman)

Working at the cutting edge of physics at the nanoscale, Aron Pinczuk and Shalom Wind are developing new ways to access quantum mechanical phenomena by manipulating matter at nanoscale dimensions. One of the areas they are especially interested in is artificial graphene, a material that is now attracting more and more attention because researchers believe it will have more versatile properties than the real thing.



Above, from right to left: The Artificial Graphene team: Diego Scarabelli, Yuliya Kuznetsova, Sheng Wang, Shalom Wind, and Aron Pinczuk.

Above, right: The Nanobeam nB4 electron beam lithography system, shown here, uses a finely focused beam of electrons to "write" nanoscale patterns that define the artificial graphene lattice. The nB4 is one of the critical tools within the Columbia Nano Initiative that enable leading-edge nanoscience research.

"This is a rapidly expanding area of research," says Wind, adjunct professor and senior research scientist in the Department of Applied Physics and Applied Mathematics. "We are uncovering new phenomena that couldn't be accessed before. As we explore novel device concepts by engineering the artificial graphene in different ways, we can unlock the potential to expand frontiers in quantum mechanics, with potential applications in advanced optoelectronics and data processing."



Graphene has highly unusual electronic properties: its electrons can travel great distances before they are scattered, making the material an outstanding conductor. In addition, the way atoms are arranged in graphene causes them to behave as if they are relativistic particles that have zero mass and can move close to the speed of light, fueling hopes for hyperfast electronics and more.

"These properties are very exciting because they can lead to the observation of exotic quantum mechanical states," says Pinczuk, professor of applied physics and physics, who uses optical methods to examine nanostructures. "But accessing these states in natural graphene is challenging, because handling single atomic layers entails extremely complex operations."

While researchers have been trying to create artificial graphene in semiconductors, until now they have been unable to reach the small dimensions required to create an interconnected electronic lattice. The Columbia Engineering team's latest breakthrough has been to recreate, for the first time, the electronic structure of graphene in an engineered semiconductor. Using the tools of conventional chip technology, they made quantum dots—instead of carbon atoms—in a gallium arsenide-based semiconductor

and organized them in a honeycomb lattice, mimicking the graphene crystal structure. Once the quantum dots were placed close enough to each other that they could share electrons, they displayed the electronic signature of graphene.

This artificial graphene has several advantages over natural graphene; for instance, researchers can design variations into the honeycomb lattice to modulate electronic behavior. And because the spacing between the quantum dots is much larger than the interatomic spacing in natural graphene, researchers will be able to observe even more surprising quantum phenomena with the application of a magnetic field.

"It will be easier to make observations with the artificial graphene we've developed," Pinczuk notes. "Potential applications include new types of electronic switches, novel photodetectors and transistors with superior properties, and even perhaps new ways of storing information based on novel quantum mechanical states. And we've created a new materials base to explore intriguing quantum physics."

He and Wind are now working on the next generation of artificial graphene devices, which will have more closely spaced lattices, making it easier to observe electronic states. They will use the devices for experiments at high magnetic fields as well as transport experiments, where they measure current through the artificial graphene lattice.

"This is an exciting time for those of us working in nanoscience," Wind adds. "As our ability to structure matter at increasingly small dimensions continues to improve, we'll be able to observe newer and more exotic phenomena and create materials, like artificial graphene, that we've only been able to dream about."

By Holly Evarts

RESEARCH

Barmak stands in the newly constructed Electron Microscopy (EM) Laboratory located on the first floor of Havemeyer Hall. (Photo by Jeffrey Schifman)



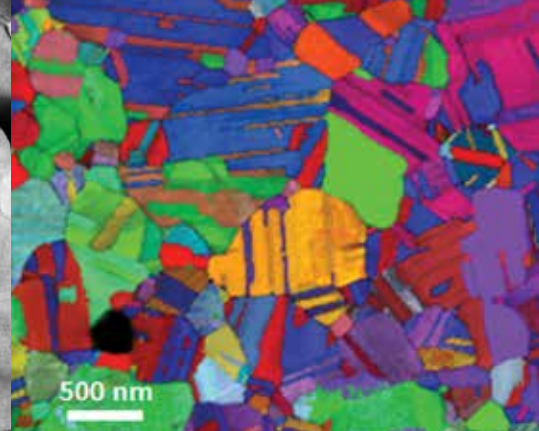
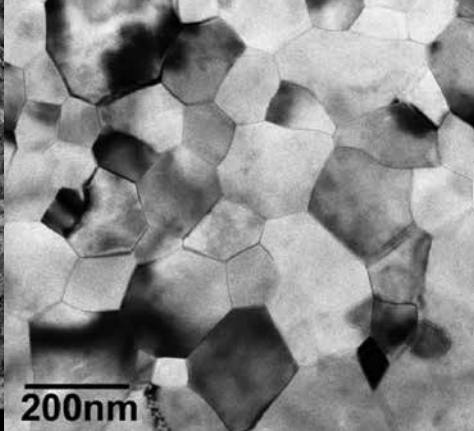
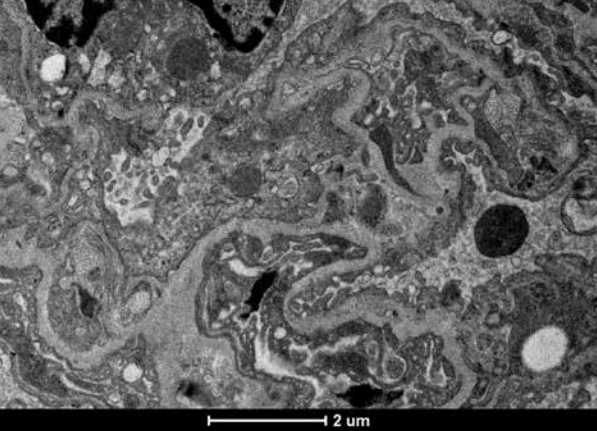
q&a **KATAYUN BARMAK**

Katayun Barmak is aiming to define structure-property relationships of metals in engineered high-tech systems like data storage, integrated circuits, and advanced permanent magnets. As an experimental materials scientist, Barmak spends the majority of her time in the lab, peering into electron microscopes to study the very minute, nanometric-scale structure of materials, with the hope of finding the link between their structure—for example, the three-dimensional arrangement of the nanocrystals—and their properties, whether it's electrical conductivity or magnetic hardness.

"I'm very interested in basic studies that explore the relations between how you make a material, what its structure is, and then, how it behaves. Is it a good or poor conductor of electricity, and so on," explains Barmak, the Philips Electronics Professor in Applied Mathematics and Applied Physics. "I find it very exciting because I like to work on that edge of science where I can see the application. I want to know that the science will be used; I'm interested in the underlying science of the material that goes into building even just a small part of an engineered system."

Before joining Columbia Engineering in 2011, Barmak was on the faculty at Carnegie Mellon University, where she rose to full professor in just three years. She was one of the first materials scientists ever to successfully map the crystallographic orientation of polycrystalline structures on the nanoscale for statistically significant populations. An exciting research feat at the time—four years ago—when high throughput crystal orientation mapping methods at the nanoscale were not available. But now the technique is readily available, making it possible, for example, to see how metallic elements like copper can be tailored to be even better nanoscale electrical conductors.

Shortly after the fourth of July holiday, Barmak talked to *Columbia Engineering*



magazine about her ongoing work in metals on the nanoscale, setting up the School's new electron microscopy lab, and her previous life in the performing arts.

HOW DID YOU GET YOUR START IN METALLURGY?

I went to Cambridge as an undergraduate and started in natural sciences to give me some flexibility in the choice of classes. I had to pick a last class. I had only been in England for two years. To me, English was still a second language, although I spoke it very well, so I was trying to avoid any classes where essay assignments were involved. Ironically, all I do now is write, and I was trying to avoid writing. There was only one class without essays and it was Crystals. We started to do a lot of visible light microscopy of crystals, and the images were beautiful. What you can see in the microscope, those images, just grabbed me. I spent a lot of my time collecting images, analyzing images, extracting information from images. And, I love art. I love the visual arts, the performing arts, and painting. For me, the images were beautiful, appealing in their own right; but also what kept my interest was the information content extracted from those images. The images led to the science.

THE PERFORMING ARTS WERE ACTUALLY A BIG PART OF YOUR LIFE AT ONE POINT.

I wanted to be a ballet dancer. I started at age 8. In the end, I did ballet on and off for 25 years. I danced in graduate school and afterwards. I danced with chamber ballet companies. In a dance class, your

mind is completely engaged in trying to learn the steps, keep to the music, keep to the time. It's physically and mentally so fully engrossing that you come out of class exhausted but also refreshed. I miss it terribly. It was the best thing. So initially I wanted to become a ballet dancer. Now, I look back on the insanity of that. I grew up in Iran, but at the time of rapid growth and modernization. The country had a ballet company that I could join. And we had dancers and teachers from all over the world. It was just this phenomenal pocket of time where we thought we were dancing on the world stage . . . but then my parents thought this was absolutely not the career for me. [Laughs] And in retrospect, it was a very lucky thing I didn't do it.

YOU'RE CURRENTLY DOING A LOT OF RESEARCH ON THE NANOSCALE. WHAT IS THE MATERIALS SCIENCE FIELD LIKE NOW?

It's an exciting time. It's exciting because now our instrumentation and our computing power are beginning to match our desires. The computing power that wraps around every instrument is making things so much better and enabling new science. In materials, for me, it's a very exciting time because we do not yet have the full predictive theories in materials that will allow us to design a material for an engineered system in a computer, then go and make it and have it behave the way we wanted. But we're getting there. Some of what [Associate Professor] Chris Marianetti and others do—computing materials from the principles of quantum mechanics—and some of the materials and properties predicted we're now able

to measure and verify. We're beginning to get glimpses of what we can do.

WHAT IS THE END GOAL?

To find new or better materials—there's always newer and better defined by some figure of merit. Hopefully, the new is better. [Laughs]

THIS ACADEMIC YEAR, FACULTY, STUDENTS, AND RESEARCHERS ACROSS COLUMBIA WILL HAVE ACCESS TO THE SCHOOL'S NEW ELECTRON MICROSCOPY (EM) LAB IN HAVEMEYER. THIS IS SIGNIFICANT.

It has been exciting (and, at times, exasperating) constructing this new central facility for not only our faculty and students, but for other Columbia members and alumni. I am looking forward to the creativity we're going to get out of its use, the world-class science that will come out of it from researchers using the instrument and who are doing exciting work here. I think we'll be blown away!

By Melanie A. Farmer

Pictured above, from left to right: Bright-field transmission electron micrograph of stained mouse lung tissue; bright-field transmission electron micrograph of an aluminum film; crystal orientation map of a copper film. (Images courtesy of Katayun Barmak)

VENTURE COMPETITION WINNERS MOVING AHEAD



Top, from left to right: Teresa Cauvel, Sona Shah, and Rebecca Peyser; Bottom: Chris Cleveland

Opposite page: Neovel rendering; Adam Hurst (left) and Nick Petrone

Three emerging startups born at Columbia Engineering are taking their business to the next level thanks to wins at the annual Columbia Venture Competition. Held at the School last April, the event brought together students and alumni from SEAS and other schools to vie for \$250,000 in seed funding—among one of the largest and most competitive university-based startup competitions in the United States. This year, teams participated in specific, topic-related tracks, two of which were sponsored by the Engineering School: Technology Challenge, focusing on software and hardware startups in multiple sectors; and Global Technology Challenge, aimed at health, environmental, and disaster relief ventures with a global sustainability component.

Neopenda, a health technology startup founded by Teresa Cauvel, Rebecca Peyser, and Sona Shah, took third place in the Global Technology Challenge track. The three biomedical engineering graduate students took home \$10,000 for their concept: a hat or headband containing a small circuit that measures heart rate, respiratory rate, temperature, and blood oxygen saturation in critically ill infants and sends the data to a centralized monitoring device. Their winnings will fund a trip, possibly to Uganda, to put early prototypes of their design in the hands of doctors and nurses to gather feedback and help refine the product for optimum use in low-resource medical settings.

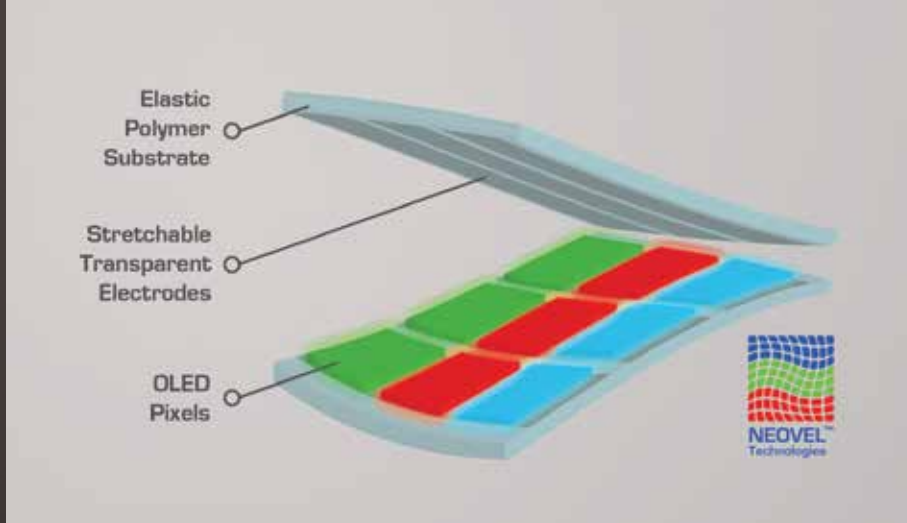
“In many places where there’s a really horrible nurse-to-baby ratio, where there might be 30 or 60 babies for each nurse, a lot of babies die because the nurses don’t recognize when something is going wrong,” Shah said. “And we want to try to prevent that from happening.”

Going through the Venture Competition at such an early stage for Neopenda—the idea was born in early January during a biomedical design class—has helped shape the company from the start, Shah said. “It was an awesome experience to learn about the business side,” Shah remarked. Since the competition, the team has added Columbia MBA student Jonathan Lichtinger to flesh out the logistics. “Apart from having an idea, we’re learning that having a solid business plan is just as important.”

Nick Petrone PhD’14 and Adam Hurst PhD’15 won first place in the Technology Challenge track, as well as \$25,000, for their company, Neovel. This venture, which grew out of Petrone’s work with graphene at Columbia, is developing flexible, wearable display screens made out of the 2D material. (Neovel also won a \$25,000 cFUND Ignition Grant in 2014; Petrone and Hurst deferred it until January of this year in order to complete their PhDs.)

“Initially we’ll probably focus on active camouflage for soldiers in the field for the military, as well as heads-up displays on vehicle windshields,” Hurst said. “We’d also like to transition the technology to wearables, where there are a number of ways we could really transform the user experience.”

Two-year-old Pixm, founded by computer science MS student Chris Cleveland, won third place and \$10,000 in the Technology Challenge track for its work in building technology that combats phishing attacks and fake web page attacks.



The School’s annual Columbia Venture Competition brought together students and alumni from SEAS and other schools to vie for \$250,000 in seed funding—among one of the largest and most competitive university-based startup competitions in the United States.

“What we’re trying to do is make software that can detect fraudulent websites by identifying visual elements of the real web pages and cross-check domain addresses,” he said. “And while there are many crappy phishing attacks, there are more and more sophisticated attacks and very compelling pages. It’s a big problem for the private sector, costing more than \$10 billion a year, so timing is on our side.”

Cleveland said he found the Venture Competition invaluable—and not only for the \$10,000 in prize money, which he’s using toward two full-time summer interns as well as computing infrastructure.

“It was a great way to get focused and get feedback. There are three different rounds, and we got very useful feedback in each round,” he remarked. “And it really forces you to focus on marketing. I found it really fun—stressful fun, but really fun.”

And it is paying off. Pixm, which was born out of a computer vision class at Columbia Engineering, has already been contacted by two security firms, as well as a handful of other groups, without having invested anything yet into marketing. “It helped us get our message out into the world,” Cleveland said.

The School’s dedication to incubating startup culture in New York City and in support of its alums doesn’t end there.

Both Neovel and Pixm have won space in Columbia’s year-old Startup Lab, cofounded and cosponsored by the Engineering School, which offers dedicated office space in the WeWork Soho West building on Varick Street. As part of WeWork, which brings startups and entrepreneurs together in a shared office environment, the teams get desks and access to conference rooms, kitchens, and office services, as well as an open work space that encourages collaboration and cross-pollination across the different ventures through get-togethers, guest speakers, and more. They also get a big break on costs, with Columbia paying 75 percent of the normal monthly space fee.

“There are lawyers, venture capitalists; different alumni with different backgrounds spend time talking at the Lab, and it’s very, very useful—you can really leverage the network,” Pixm’s Cleveland said. “And you’re around other Columbia students and alums, and it’s really a great community. You’re fighting similar battles, and it’s cool to be able to trade war stories.”

And the Neovel team, which also uses space at the School’s clean room to manufacture, agrees. “I have to be honest, as a hardware company, we have some different needs [from other startups], but being able to work out of Columbia’s clean room provides that, so it’s been great working out of the Startup Lab along with people from the business school and the law school,” Petrone said. “For the daily operation of the business, it’s been a huge support to be in that diverse environment.”

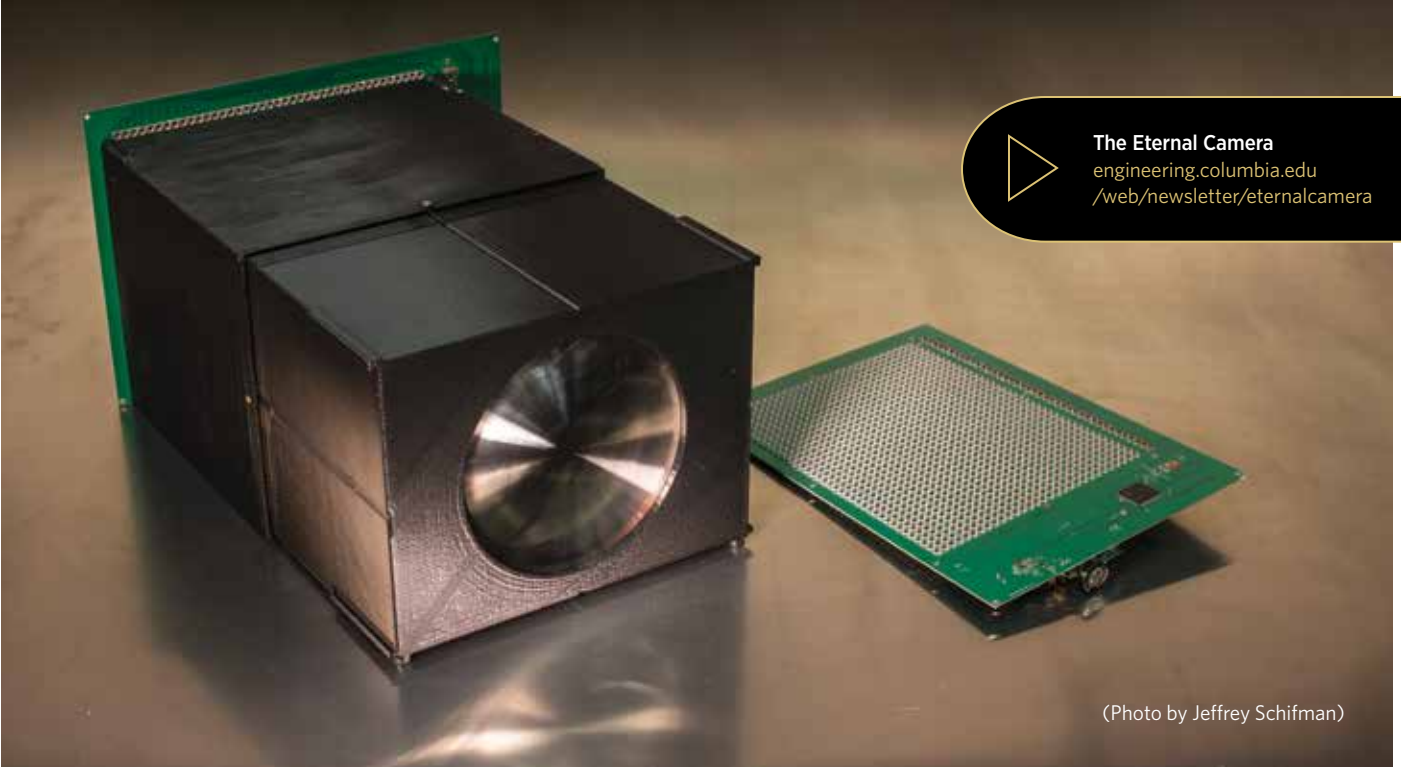
By Jennifer Ernst Beaudry

INNOVATION



— THE —
ETERNAL
CAMERA

(Photo by Jeffrey
Schifman)



(Photo by Jeffrey Schifman)

According to computer scientist Shree K. Nayar, “we are in the middle of a digital imaging revolution.” And, his latest innovation—a self-powering camera—is a driving force. A research team led by Nayar has invented a prototype video camera that is the first to be fully self-powered—it can produce an image each second, indefinitely, of a well-lit indoor scene. They designed a pixel that can not only measure incident light but also convert the incident light into electric power.

Nayar, who directs the Computer Vision Laboratory at Columbia Engineering, notes that in the last year alone, approximately two billion cameras of various types were sold worldwide. “I think we have just seen the tip of the iceberg. Digital imaging is expected to enable many emerging fields including wearable devices, sensor networks, smart environments, personalized medicine, and the Internet of Things. A camera that can function as an untethered device forever, without any external power supply, would be incredibly useful.”

A leader in computational imaging, Nayar realized that although digital cameras and solar panels have different purposes—one measures light while the other converts light to power—both are constructed from essentially the

same components. At the heart of any digital camera is an image sensor, a chip with millions of pixels. The key enabling device in a pixel is the photodiode, which produces an electric current when exposed to light. This mechanism enables each pixel to measure the intensity of light falling on it. The same photodiode is also used in solar panels to convert incident light to electric power. The photodiode in a camera pixel is used in the photoconductive mode, while in a solar cell it is used in the photovoltaic mode.

Nayar, working with research engineer Daniel Sims BS’14 and consultant Mikhail Fridberg of ADSP Consulting, used off-the-shelf components to fabricate an image sensor with 30x40 pixels. In his prototype camera, which is housed in a 3D printed body, each pixel’s photodiode is always operated in the photovoltaic mode.

The pixel design is very simple and uses just two transistors. During each image capture cycle, the pixels are used first to record and read out the image and then to harvest energy and charge the sensor’s power supply—the image sensor continuously toggles between image capture and power harvesting modes. When the camera is not used to capture images, it can be used to generate power for other devices, such as a phone or a watch.

Shree Nayar and his team have invented a prototype video camera that is the first to be fully self-powered.

Nayar notes that the image sensor could use a rechargeable battery and charge it via its harvesting capability, “but we took an extreme approach to demonstrate that the sensor is indeed truly self-powered and used just a capacitor to store the harvested energy.”

“A few different designs for image sensors that can harvest energy have been proposed in the past. However, our prototype is the first demonstration of a fully self-powered video camera,” he continues. “And, even though we’ve used off-the-shelf components to demonstrate our design, our sensor architecture easily lends itself to a compact solid-state imaging chip. We believe our results are a significant step forward in developing an entirely new generation of cameras that can function for a very long duration—ideally, forever—without being externally powered.” The research was funded by Office of Naval Research.

By Holly Evarts

A CULTURE OF REAL-WORLD RESEARCH

Last year, Jason Kang, a biomedical engineering junior, was thoroughly distracted from his studies—in a good way. He and two classmates undertook a research design challenge at the School to develop low-cost, technology-driven solutions for issues related to the Ebola crisis. While the pressure to balance his classes, homework, and tests with research was intense, Kang never doubted the benefit: he was in the midst of an important investigation to better protect health care workers at high risk of infection.

“The ability to apply theory to practice is an incredibly important learning tool,” says Leora Brovman, associate dean for Undergraduate Student Affairs. “Columbia Engineering students have always had opportunities to work with faculty and graduate students on research—during the school year and over the summer—which prepares them to engage effectively in professional environments postgraduation.”

Research opportunities for undergraduate engineering students are expected in academia. Lab experiences with faculty research mentors and project teams offer students a peek into the culture of research and a real-world look at engineering careers. They can also inspire a deeper connection to engineering as a way to solve problems that affect people.

Two years ago, the School made a commitment to support even more hands-on research opportunities for

Katherine Jin '16CC and Jason Kang '16SEAS hard at work in Carleton Lab, testing their product, Highlight, a colored powdered additive that, combined with bleach, allows health workers to see that a surface has been fully decontaminated of infectious diseases. (Photo by Jeffrey Schifman)



EDUCATION

Over the last year, BME Senior Lecturer Aaron Kyle and his students have begun working closely with the Uganda Industrial Research Institute (UIRI) to create innovative devices that align well with the Ugandan infrastructure—ensuring they can be manufactured and sold sustainably within the country.

undergraduate and graduate students, providing matching funds to departments and principal investigators to hire students for the summer.

The School's new Summer@SEAS research program—a 10-week series of faculty research seminars, lab visits, scientific workshops, student exchanges, and cultural outings—provided students with opportunities to learn about others' rich and diverse research experiences.

"Summer opportunities are as extensive and diverse as our faculty's research," says Brovman. "There are projects in every department, in various institutes, and in cross-disciplinary areas."

Approximately 150 students were engaged in research at SEAS over the summer. "Doing research over a concentrated period of time, without interruption from other responsibilities, allows students to really have an immersive experience," notes Brovman.

SCIENTISTS WITH A SOCIAL CONSCIENCE

Kang, now a senior, stayed local this summer to continue the research he began during the School's Ebola Design Challenge last fall.

His team—which includes Katherine Jin '16CC and Kevin Tyan '16CC—developed an innovative solution to the problem of ineffective decontamination processes threatening health care workers' lives. The team strives to perfect Highlight, a colored powdered additive that, combined with bleach, allows workers to see that a surface has been fully decontaminated.

"We were vetted and supported by professors, infectious diseases experts, first responders, and field workers during the challenge," Kang explains. "We spent a lot of time testing different formulations to achieve our current formula. Now, we're conducting research to validate Highlight against a variety of environmental factors and field-testing to assess its ease-of-use and efficacy."

From the time he started at Columbia, Kang had a strong interest in developing technologies that could improve global health. He also serves as the vice president of engineering at Jibon Health Technologies, a Columbia Engineering graduate-founded company that makes a device to manage postpartum hemorrhage.

"Hands-on training is extremely important because it allows you to better understand the material you're working with, what you should be looking for, and what needs to be done next," says Kang. "Columbia has been immensely helpful in helping us promote our project and connecting us with partner organizations. It is one of the best places to pursue entrepreneurship with a social impact."

The Fire Department of the City of New York has incorporated Highlight into their decontamination protocol. (Photo courtesy of FDNY)



Aaron Kyle, senior lecturer in biomedical engineering and Kang’s adviser for Highlight, knows firsthand the value of getting students involved in research. His two-semester biomedical senior design course emphasizes socially conscious research.

For the last few years, the class has worked with Mulago Hospital in Uganda and the Columbia Medical Center to develop low-cost neonatal care devices that satisfy the specific needs and constraints of the country. Through this partnership, Kyle’s students have developed neonatal transport units that stabilize babies and help maintain their body temperature on the way to the hospital; portable, low-cost phototherapy units that can be placed over the crib or under the bodies of jaundiced infants to treat excess bilirubin before it progresses to dangerous hyperbilirubinemia; and vital-sign-monitoring mats that can measure babies’ breathing, heart rate, and temperature without the need for expensive equipment.

Over the last year, Kyle and his students have begun working closely with the Uganda Industrial Research Institute (UIRI) to create innovative devices that align well with the Ugandan infrastructure—ensuring they can be manufactured and sold sustainably within the country. Neonatal care will continue to be the focus, and Kyle recently secured funding from VentureWell—a nonprofit education network—that will allow him and his students to travel to Uganda next June to see the country’s needs and test their devices firsthand.

As of July, Kyle already had 50 students enrolled in his fall senior design course, and some already had jump-started their projects with calls and Skype sessions with Ugandan partners.

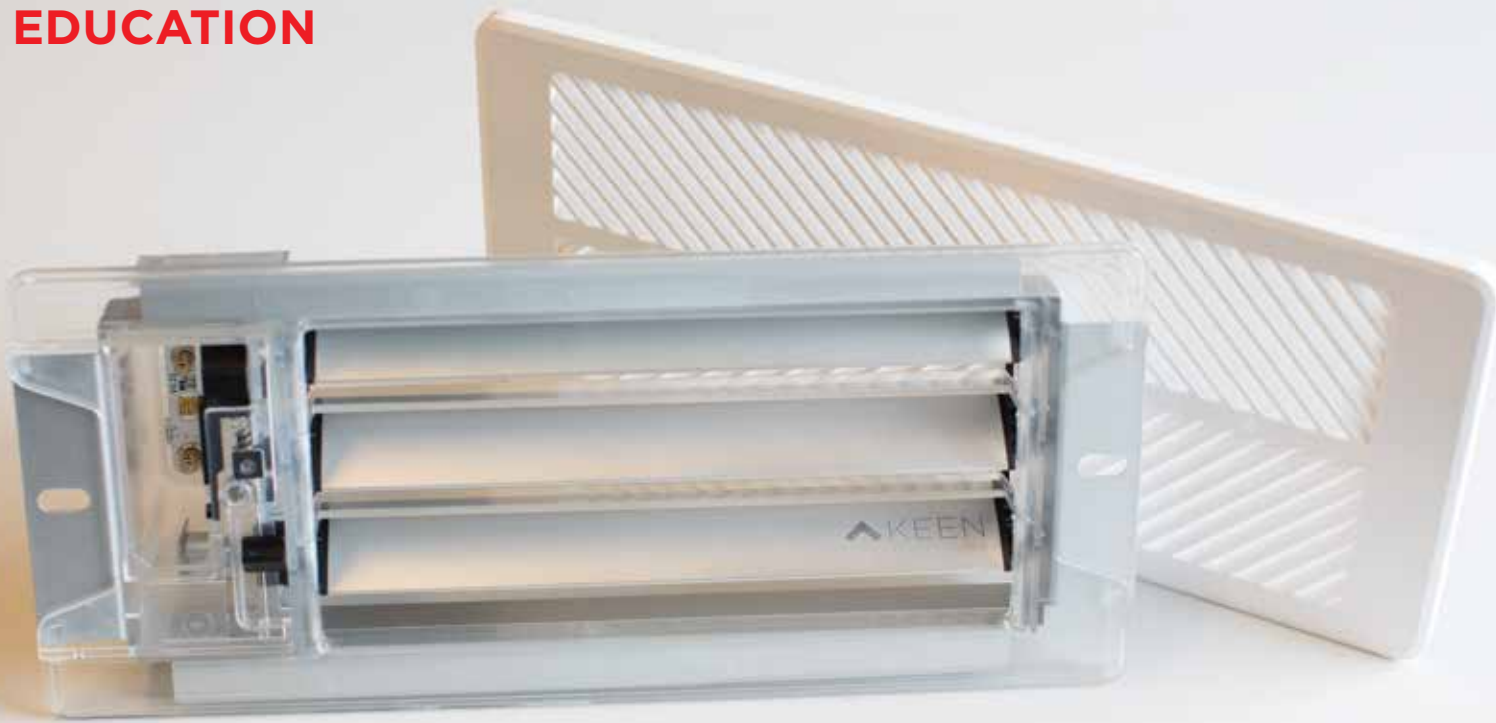
“If we help save or improve the life of even one baby, then we’ve made a huge impact,” says Kyle. “I think our students have an altruistic spirit. They want to use their engineering skills to help people, and they’re excited to do something impactful.”

By Jessica Driscoll

“Hands-on training is extremely important because it allows you to better understand the material you’re working with, what you should be looking for, and what needs to be done next.” —Jason Kang ’16SEAS



Far left: the Special Care Baby Unit at Mulago Hospital in Kampala, Uganda, where Aaron Kyle and his students have traveled to test their low-cost neonatal care devices. Left: a Ugandan mother using a student-designed neonatal transport unit. (Photos courtesy of Aaron Kyle)



A smart vent used in the Internet of Things graduate course. (Photos by Jeffrey Schifman)

TAKING THE NEXT STEP IN

THE INTERNET



Sensor device used in Internet of Things graduate course.

Columbia Engineering is preparing students for the digitally connected world with new classes that give hands-on preparation in the Internet of Things.

For the first time this summer session, the School offered Internet of Things, a graduate course taught by Zoran Kostic, associate professor of professional practice in electrical engineering. And this fall, new faculty member Xiaofan (Fred) Jiang, assistant professor of electrical engineering and a member of Columbia's Data Science Institute, is teaching a graduate and senior-level undergraduate course focused on the same topic.

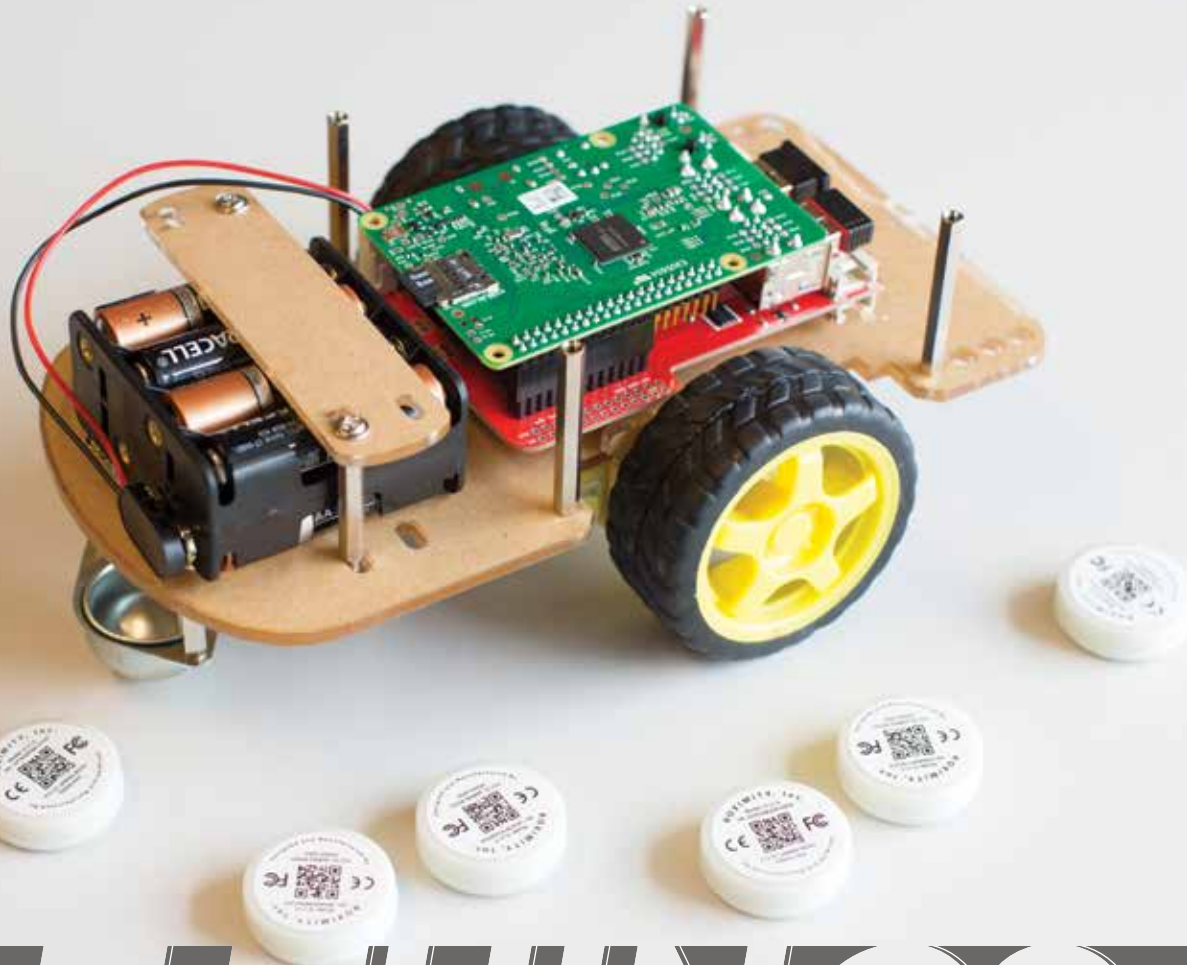
Both professors agree, it's all part of preparing students for a future where Internet

connectivity for devices is a given. "Having this allows us to prepare our students and give them a comprehensive skill set," Jiang said.

The Internet of Things (IoT), we know, is shorthand to describe the network of physical items that can connect to each other, to different networks, and to the cloud. And it covers a huge variety of applications—from consumer devices, like Nest thermostats or sensors in cars that monitor air pressure and engine function, to the ways cities like New York are using mobile air pollution monitors.

The course of the same name trains students in three domains: programming of sensors and sensor data acquisition, processing of sensor data in gateways and hubs, and cloud data analytics and interac-

One student team's Raspberry Pi toy car that can navigate indoors on its own using Bluetooth low energy and artificial neural network.



ET OF THINGS

tion with IoT devices. It is organized to give students the bigger perspective on current and future uses—through lecturers and guest speakers from the field, but also through firsthand experience, as they program their own devices and work with each other and teaching staff to create their own projects using the devices. Students in the class, Kostic said, “are really well prepared to build very sophisticated software.”

Jiang’s class follows a similar format. Students are taught the top-to-bottom process of putting together an IoT system as well as working on independent projects that use the knowledge. “It’s beneficial for students because they’ll gain the skill set to turn an idea

into reality,” he said. “Looking forward to when we have all these things that need to be radically connected to the cloud, we need students who are well equipped to tackle these problems.”

And that represents a sea change for engineering majors, Jiang and Kostic agreed, as they increasingly need to know not only how to create devices, but also how they interact and how they fit into the bigger picture.

“Many of the courses taught at universities are focused on particular, specific things,” Kostic said. “This course is about knowing all of the things together you’d need to build a system and teaching students to be versed in architectural skills. When you go into the job market, even for people who are specialized in

one discipline, it will be useful to be exposed to how it fits into the system.”

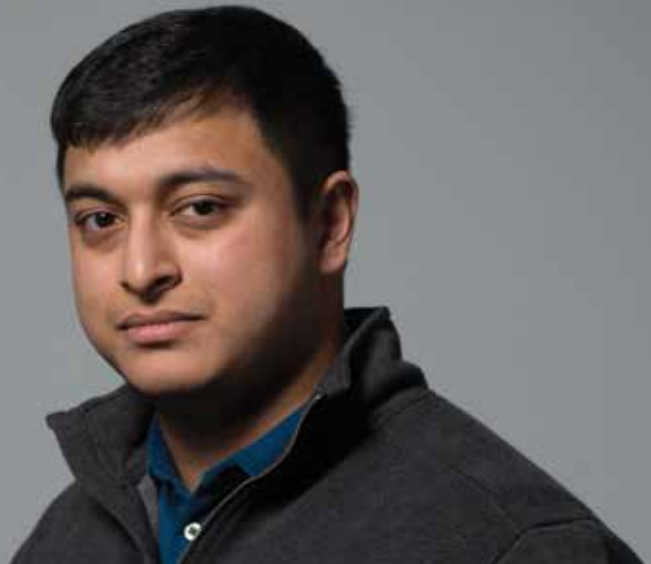
“Before, we’d think of preparing students to enter a big company like Intel or Microsoft, where they’d be a small piece of a larger group,” Jiang said. “We are in the middle of a maker movement—it’s a different mindset, that anyone can prototype a project quickly. With this class, students go a step beyond and learn about the principles behind building a scalable, energy-conscious, and interoperable Internet-scale system. This class has the potential to empower students to think more independently and be confident in creating their own startups.”

By Jennifer Ernst Beaudry

RITISH PATNAIK

BIOMEDICAL ENGINEERING, SENIOR

(Photo by Jeffrey Schifman)



There has been one clear consistency through Ritish Patnaik's goals as they evolve: better the world through science. Initially fascinated with biology, Patnaik identified medical research as a vehicle for affecting change. In high school he pursued his interests with summers in stem cell and cancer research. But he felt something was missing: "I realized that the natural sciences was not the right fit for me because it lacked the creative 'builder's mentality' that I really desire in my career." Patnaik then discovered biomedical engineering as the perfect solution, an obvious conduit to make an impact while enabling him to have a hands-on approach.

Patnaik formulated what he describes as three core professional tenets as an adolescent. He wanted to work on and direct cutting-edge medical technology with the aim of reducing human suffering; to cultivate a younger generation's enthusiasm for science and engineering; and to live a fruitful and well-rounded life. He identified academia as the right path and is studying to eventually become a research professor.

Now a senior, Patnaik is working with Associate Professor Sam Sia. In his research with Professor Sia and MD-PhD student Tiffany Guo, Patnaik designed a point-of-care diagnostic device that provides rapid, low-cost anemia and HIV testing for pregnant women living in low-resource areas. The device's design and preliminary testing results were recently published in the journal *Lab on a Chip*.

In his research with Professor Sam Sia and MD-PhD student Tiffany Guo, Patnaik designed a point-of-care diagnostic device that provides rapid, low-cost anemia and HIV testing for pregnant women living in low-resource areas.

Last fall, Patnaik participated in the Ebola Design Challenge, the student and faculty competition initiated by the deans of Columbia Engineering and the Mailman School of Public Health. It was started in an effort to mobilize the Columbia community to create practical solutions to the Ebola crisis. The dedicated teams worked nonstop to find viable results to help those affected, and the experience only furthered Patnaik's belief in the importance of a nurturing faculty: "One thing that I really appreciated about the Ebola Design Challenge was the cooperation between faculty and student teams. I was delighted to see the support that Dean Boyce, Professor Sia, Professor Massimino, and Professor Kyle provided our team in a moment's notice."

Patnaik understands that the components of his goals—mentoring students and conducting effective research—are very much intertwined. He details with thoughtfulness a future of not only creating additional medical devices for low-resource settings but also embedding a passion for creating health technology in future generations. "By exposing my students to the process of creating medical devices, I hope to inspire them to pursue a career in biomedical engineering and create clinical innovations that change the world," he says.

"Biomedical Engineering professors have the unique opportunity to teach their graduate and undergraduate students about entrepreneurship, intelligent biodesign, and core principles of academic research while being supported by larger biotechs and research agencies through partnerships and funding," Patnaik also notes with characteristic collaborative spirit.

Patnaik is armed with a sense of clarity that is doubtlessly one of his great strengths, allowing him to envision simple, tangible solutions to complex problems and act on their execution. He also possesses an innate altruism. And one senses his future students will not resist his infectious enthusiasm.

By Elaine Rooney



RILEY SPAHN

COMPUTER SCIENCE, PHD STUDENT

Riley Spahn approaches his research in computer science with a key tenet of engineering in mind: the importance of building—namely, creating foundations for future research within his field of study. “It is important to build tools that serve as building blocks so more people can study data and security,” he says. Currently a PhD student, Spahn is focused on the increasingly critical field of privacy.

Spahn obtained his undergraduate degree from Auburn University, where he initially set out to study chemical engineering but quickly changed his mind after one computing class. He was partly drawn to SEAS because of the work of Assistant Professor Roxana Geambasu. “She had a history of doing exciting and novel systems and privacy research,” he remarks.

Spahn joined Columbia with Geambasu as a faculty adviser and has wasted no time in contributing to her exciting research. In his work with her and Professor Gail Kaiser, he builds different transparency tools to help users learn how applications services use their data, as well as tools for programmers to manage data in a transparent, responsible way. Their work couldn’t be timelier, as the fears over digital privacy continue to bubble, an issue of which Spahn is of course cognizant: “With large-scale data collection comes the potential for drastic abuse and

Spahn builds different transparency tools to help users learn how applications services use their data, as well as tools for programmers to manage data in a transparent, responsible way. His work couldn’t be timelier, as the fears over digital privacy continue to bubble.

discrimination. I think that it’s going to be very important for us to develop practical techniques for handling personal data.”

Practicality and responsibility seem to be an innate part of Spahn’s focus and doubtlessly inform his efforts. “I’ve built a modified version of the Android operating system, called Pebbles, that tracks related data and can expose that to users, allowing them to see how applications are managing their data,” he says.

And his efforts have not gone unnoticed. Recently he was one of just fifteen students to receive a North American Google PhD Fellowship for his work. With the bigger picture in mind, Spahn grasps the significance of the honor.

“I’m very happy that my research is receiving recognition, and I think that our research group brings a useful systems point of view to privacy work,” he says. “In addition to my own research, I think that it’s equally important for privacy in general to receive recognition, attention, and funding.”

As for what he’ll ultimately do professionally, Spahn feels a pull into academia but is characteristically practical in pacing his decision, remarking, “I’m far enough out from graduation that I don’t have any solid plans.”

Though he’s open minded about his own career, he possesses a powerful enthusiasm for the future of the field: “I think there are a lot of exciting opportunities to take advantage of data to learn about larger trends within our society, such as in medicine. One example is Google’s effort to track flu trends across the country. We could use such large-scale data to inform policy makers and help direct research direction.”

Spahn is already making important contributions to his field, and it’s obvious that his professional future, whatever it may entail, is bright.

By Elaine Rooney

STUDENTS



Opposite Page: Jessica Valarezo, left, and Lauren O'Connor (Columbia College) (Photos by Jeffrey Schifman)

When senior Jessica Valarezo first encountered Girls Who Code, the national non-profit dedicated to educating young girls about computer science and programming, she thought about the impact it would have had on her in high school. Like many other girls, she felt intimidated by computer science. "I was not interested by a pass/fail computer science class," she admits. "At the time, I was terrified of CS." Fortunately, Valarezo decided to give engineering a chance in college. She benefited from an invigorating summer experience she had at MIT, and an older sister who studied biomedical engineering and shared her love of STEM. And now, Valarezo is paying it forward.

In February, she cofounded Columbia's first-ever Girls Who Code chapter with

"The girls I've taught are getting into their top schools and starting clubs at their own schools—they are in turn becoming advocates for computer science among women, which is spreading incredibly fast."

friend and Columbia College computer science major Lauren O'Connor. In 2014 the pair served as teaching assistants for the Girls Who Code Summer Program and felt enlivened by the young girls who learned so quickly and had so much enthusiasm. When the director mentioned an interest in starting chapters at colleges, Valarezo and O'Connor jumped at the chance.

"We thought, 'why not?' Columbia's beautiful, grand campus would be the ideal location to have a club, combined with Columbia students as teachers who would provide the students with

direct exposure to higher education," Valarezo says.

Valarezo chose Columbia Engineering, like many of her fellow students, because of the invaluable core curriculum. "In high school I wanted to have the liberty of taking political science, ethnic studies, and language courses while in undergrad," she says. And it seems fitting. In seeking a diverse learning environment, Valarezo is able to tune into a social consciousness that has no doubt motivated her to start the Girls Who Code chapter.

The results have been tangible. As O'Connor attests, sometimes all it takes

WOMEN WHO INSPIRE GIRLS WHO CODE

JESSICA VALAREZO

**COMPUTER SCIENCE, SENIOR
GIRLS WHO CODE CHAPTER COFOUNDER**



is exposure. “I think I connect so personally with Girls Who Code because before I took my first computer science class, I never would have considered it as a major,” she says. And the effects are cyclical. “The girls I’ve taught are getting into their top schools and starting clubs at their own schools—they are in turn becoming advocates for computer science among women, which is spreading incredibly fast,” Valarezo adds.

With the headiness of success, including speakers from Google and Goldman Sachs, and a couple of Valarezo’s students from last summer with a final project that went viral, resulting in interviews with *Time* and CNN, Valarezo remains mindful and focused; there is still much to be done. “I believe some of the gender disparity can be attributed to the lack of familiarity with computer science coming into college and facing an intimidating introductory computer science course,”

she says. “Students who have taken a CS class in high school are much more likely to indicate interest in computer science as a major. Because of this barrier, along with the shortage of relatable female role models, women will continue to pursue other career paths.”

Though Valarezo is adept in her assessment, she and O’Connor are taking action and providing solutions, serving as role models to young girls to whom they also provide the exposure they identify as crucial.

As for the future of Girls Who Code at Columbia, it’s as bright as the cofounders’ enthusiasm. The hope is to expand: two classrooms this coming year, new speakers, more events, and one can only imagine exponential growth in the years to come.

By Elaine Rooney

Last spring, two Columbia undergraduates started the University’s first-ever chapter of Girls Who Code—the national nonprofit dedicated to teaching young girls about computer science and programming.

ALUMNI

Ky Harlin BS'08 is using what he learned at Columbia Engineering to bring Condé Nast into the future.

As vice president of growth and data science since March, Harlin is charged with both collecting data about site visitors and analyzing it for trends and insights that can help the venerable publication giant grow its burgeoning digital business. That includes analyzing data to make sure publications are tailoring their posts to channels like Facebook or Twitter where they'll be best received, advising on the kinds of stories that are driving visitors to the site (and the ones that keep them there), and even working with the magazines' online presences to tweak their presentation to maximize each user's experience.

"Condé Nast has all these incredible brands that people know and trust and are authoritative, but their print

publications still drive the majority of their business in terms of revenue," he said. "However, we know that ultimately, people are going to spend the majority of their time consuming content digitally. My function is basically to help us use data to grow that audience."

And to do it, Harlin is relying not only on his years at Internet news media king BuzzFeed—he's putting into practice what he learned as an applied mathematics major at SEAS.

"I think my generation, going into college, was told by people who are four to five years older, 'You don't use anything you learned at school in a real job.' But I feel totally the opposite. What I did at Columbia was perfectly suited to what I do."

Harlin first encountered data science via a guest speaker in the applied mathematics majors' seminar. This led to research in medical imaging at Invicro, a company that provides imaging services

As vice president of growth and data science at Condé Nast, Ky Harlin is charged with both collecting data about site visitors and analyzing it for trends and insights that can help the venerable publication giant grow its burgeoning digital business.

KY HARLIN BS'08

**FROM BUZZFEED TO CONDÉ NAST,
AND ALL THE DATA IN BETWEEN**



to pharmaceutical companies, after graduation. Associate Professor Chris Wiggins—now also the chief data scientist at the *New York Times*—teaches the applied math seminar and later connected Harlin with a consulting opportunity at BuzzFeed.

And working at BuzzFeed gave Harlin a front-row seat to the uses of data science.

“When I started at BuzzFeed, [founder] Jonah Peretti was very visionary. He realized that data was going to be huge in the future,” Harlin said. “Tech companies were doing it, but not many media companies. I was the first guy there doing it, so I learned it through trial and error.”

It’s that hands-on experience that Condé Nast wanted to tap. In his position—the first of its kind at the publisher—Harlin reports to EVP and Chief Digital Officer Fred Santarpia as part of a newly formed digital division that signals the company’s focus on driving their online business.

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“They’re two very different companies. BuzzFeed was born on the web, and, in a sense, that made what I do much simpler, because they were creating content with a digital focus in mind from the beginning,” he said. “But the two companies are ultimately trying to do the same thing. While Condé Nast has built its company and brands through print magazines, we still employ a lot of the same strategies in terms of growing our digital presence.”

And it’s paying off. Harlin said Condé Nast’s Comscore numbers—the industry standard for measurement of web traffic data—have started showing growth: “Good stuff is happening. Three of the first four months since I joined have been our biggest in history.”

By Jennifer Ernst Beaudry

Ky Harlin at the Condé Nast tech campus in Manhattan. (Photo by Timothy Lee Photographers)

ALUMNI

SHAHRAM EBADOLLAHI MS'99, PHD'05

REVOLUTIONIZING HEALTH



Opposite Page, clockwise from top right: Reunion attendees at State 48 for the annual Young Alumni Party; celebrating the Golden Lions at the Russian Tea Room; CEEA Awards Ceremony in Low Rotunda; departmental luncheon held in Casa Italiana (Photos by Timothy Lee Photographers)

The world is looking at a new era in wellness and health care, according to Shahrām Ebadollahi MS'99, PhD'05—and as the VP of innovation and chief science officer of IBM Watson Health, he's helping lead the charge to make health care smarter, faster, and more efficient around the world.

Announced in April, the new business unit from Armonk, New York-based IBM is dedicated to what Ebadollahi called "Computational Health": collecting and curating the ever-increasing amounts of health data being generated through clinical trials, studies, patient information, and even user-generated health information from tech wearables like FitBit or Apple Watch.

And more importantly, he remarked, it will use that data to chart insights and connections—and then take those insights to create solutions and drive improvements that help doctors, insurers, and researchers transform how they work.

"Health care is at an inflection point," Ebadollahi said. "Health care costs are unsustainable, data is becoming increasingly available through digital devices, and new technologies like cloud computing are giving us scale and the opportunity to do advanced analytics. There's a meaningful way we can work with that trove of available data to help researchers, health care professionals, and payers improve the delivery, efficiency, and outcomes across health care."

Ebadollahi's background in the field goes back to his time at Columbia Engineering. After getting his MS in electrical engineering, he began his PhD research focusing on signal and image and multimedia content analysis and retrieval under Shih-Fu Chang, Richard Dicker Professor of Telecommunications, director of the Digital Video and Multimedia Lab, and senior vice dean of the Engineering School. Ebadollahi's work was part of a Columbia Health Care Digital Library Project called PERSIVAL, designed to pull together disparate sources of health

care records and information for both physician and patient use.

His research at Columbia led to Ebadollahi being recruited by IBM after graduation. Between 2005 and 2014, he worked on the Health Care Transformation project, defining strategy and setting research objectives. He also started and led the Health Informatics research across IBM global labs. Last year, he was instrumental in the formation of what would become IBM Watson Health.

Ebadollahi says the possibilities for the unit are huge—whether it's using data and cognitive computing to help clinicians and patients to personalize and improve their interactions, or creating cloud-based technology platforms for use by biomedical companies to better manage disparate, regulated data. In addition, the unit has partnered with companies including Apple, CVS Health, Medtronic, and Johnson & Johnson, and through its network of partners could be involved in creating new solutions for use across health care and life sciences.

And, he added, not just for the United States. "This will be global," he noted. "The issues in many countries, especially emerging markets, may be different, such as access to health care."

Furthermore, while it is very early days, Ebadollahi said expectations are high. "As I talk to more and more people out there, there is a tremendous amount of interest in what we're doing, and a lot of expectations," he remarked. "Our CEO Ginni Rometty called [the impact we can have on health care] 'the moonshot of our generation'—so the biggest challenge will be how fast we can execute."

Ebadollahi credits his time at Columbia for putting him on the path he's on today.

"Working on PERSIVAL was the project that applied my background in electrical engineering to the domain of medicine," he said. "A lot of the know-how and domain expertise comes directly from that."

By Jennifer Ernst Beaudry



WELCOME BACK, SEAS ALUMNI!

More than 300 alumni returned to New York for Columbia Engineering Reunion Weekend, May 28 to 31. This included an amazing turnout from the Class of 2010, which was celebrating its fifth reunion; 139 classmates attended Reunion Weekend, nearly one third of the class. Reunion provides an opportunity for alumni to connect with old classmates as well as with friends from the College, Barnard, and the School of General Studies, which also celebrated their reunions over the weekend.

Festivities kicked off on Thursday, May 28, when 280 alumni, their guests, and administrators gathered in Low Rotunda for the annual Alumni Welcome Dinner sponsored by the Columbia Engineering Alumni Association (CEAA). The annual event also serves as the CEAA's awards ceremony.

This year, the CEAA honored three distinguished Columbians: Richard Axel '67CC, Nobel laureate, neuroscientist, and University Professor, with the Michael I. Pupin Medal; Donald E. Ross '52CC, BS'53, a mechanical and electrical engineering leader, with the Thomas Egleston Medal; and Ehud Geller BS'70, a pioneering biotech entrepreneur, with the Samuel Johnson Medal.

Dean Mary C. Boyce praised the three honorees as representing "the best that Columbia has to offer." She said, "Their contributions to their professions and to society at large demonstrate the positive impact that science, technology, and engineering have in today's world."

On Friday, reunion-goers chose from a set of morning lectures, including one given by Mike Massimino BS'84, a former NASA astronaut and now a professor of professional practice at SEAS, who talked about his two space missions to repair the Hubble Space Telescope. The departmental luncheon in Casa Italiana gave alumni a chance to hear from Dean Boyce, view a video from the School's second Senior Design Expo, and meet with faculty members and fellow alumni from each of the School's

nine departments. In the afternoon, Mechanical Engineering Professor Sunil Agrawal discussed his research in using robots to aid in physical therapy and rehabilitation.

In the evening, the School, the College, and Barnard cohosted the annual Young Alumni Party at State 48 in midtown Manhattan. Dean Boyce joined the Class of 1965 as they were inducted into the School's Golden Lions Society (for alumni who graduated at least 50 years ago) at a dinner at the Russian Tea Room. Meanwhile, other classes met for multischool receptions on campus and around Manhattan.

Boyce hosted the School's annual Dean's Day breakfast on Saturday morning. Outgoing CEAA President Hitoshi Tanaka led the nearly 100 assembled guests in the annual toast to CEAA benefactor C. P. Davis. The dean presented an overview of events at the School during the past year and showed a video from the MakeCU spring hackathon.

Later that morning Civil Engineering and Engineering Mechanics Professor Patricia Culligan discussed "Greening New York City to Promote Sustainability" as the Society of Columbia Graduates Great Teacher Lecture. At lunch, the Society of Columbia Graduates honored Culligan and Brent Stockwell, professor of biological sciences and chemistry, with the Great Teacher Awards. Following an afternoon of lectures, films, receptions, tours, and a wine tasting, alumni gathered for class dinners before coming together on Low Plaza for the annual Starlight Reception on Saturday night.

For information on Reunion Weekend 2016, for graduates of classes ending in "1" or "6," alumni should visit the Columbia Engineering alumni website in the coming months!

By Timothy P. Cross

FACULTY NEWS

NEW FACES AT SEAS

**SHIPRA AGRAWAL**

Assistant Professor, Industrial Engineering and Operations Research
Postdoc Research Fellow, Microsoft Research India, 2011–2013; PhD, Stanford University, 2011; ME, Indian Institute of Science, India, 2004; BE, M.B.M. Engineering College, India, 2002

Shipra Agrawal specializes in several areas of optimization and learning including data-driven optimization under partial, uncertain, or online inputs and related topics. She also works with prediction markets and game theory and will also be a part of Columbia's Data Science Institute. A former researcher at Microsoft, IBM, Bell Labs, and Yahoo, Agrawal will teach Deterministic Models and a PhD course on Sequential Decision Making in the spring.

**ALEXANDR ANDONI**

Associate Professor, Computer Science
PhD, MIT, 2009; MEng, 2005; BS, 2004

Alexandr Andoni explores the algorithmic foundations of massive data. As a theoretical computer scientist, he uses and develops tools from areas such as sublinear algorithms, high-dimensional computational geometry, metric embeddings, and machine learning. He plans to teach a class on Algorithmic Techniques for Massive Data, and, more generally, theoretical computer science classes, in particular on all things algorithmic.

**PAUL S. BLAER**

Lecturer in Discipline, Computer Science
PhD, Columbia University, 2008; MPhil, 2004; MS, 2002; BA, 2000

Paul S. Blaer is director of Computing Research Facilities in the Department of Computer Science and has previously taught undergraduate courses. His primary research interests are in mobile robotics, computer science education, 3D vision, and mobile computing, particularly view planning and automated data acquisition for 3D modeling of complex sites. This year, he will teach Introduction to Computer Science and Data Structures.

**ANTONIUS "TON" DIEKER**

Associate Professor, Industrial Engineering and Operations Research
PhD, University of Amsterdam, 2006; MS, Vrije Universiteit Amsterdam, 2002

Antonius "Ton" Dieker's research focuses on computer simulation techniques and design of service systems. His honors include the Goldstine Fellowship from IBM Research, an NSF CAREER Award, and the Erlang Prize from the Applied Probability Society of INFORMS. He joins Columbia from Georgia Tech, after spending a year at SEAS as a visiting professor. He also serves on the editorial boards of *Operations Research* and *Mathematics of Operations Research* journals. Dieker taught a PhD-level course on sampling methods and is teaching probability and statistics this fall.

**ADAM ELMACHTOUB**

Assistant Professor, Industrial Engineering and Operations Research
Postdoc Researcher, IBM T.J. Watson Research Center, 2014–2015; PhD, MIT, 2014; BS, Cornell University, 2009

Adam Elmachtoub concentrates in supply chain and revenue management, drug development, and sports analytics. Elmachtoub is a part of Columbia's Data Science Institute and teaches business analytics and operations management.

**ALEXANDER GAETA**

David M. Rickey Professor of Applied Physics and of Materials Science
PhD, University of Rochester, 1991; MS, 1985; BS, 1983

Alexander Gaeta's research focuses on nanophotonics, ultrafast nonlinear optics, nonlinear propagation in fibers and bulk media, non-classical light fields, and stimulated scattering processes. A fellow of the Optical Society of America and of the American Physical Society, Gaeta was most recently at Cornell University, where he was the Samuel B. Eckert Professor of Engineering. He plans to teach courses in the applied physics curriculum.

**XIAOFAN "FRED" JIANG**

Assistant Professor, Electrical Engineering
PhD, University of California at Berkeley, 2010; MS, 2007; BS, 2004

Fred Jiang's expertise includes cyber physical systems and data analytics, smart and sustainable buildings, mobile and wearable systems for health and fitness, and environmental monitoring and control. A former senior researcher at Intel Labs China, he also will serve as a faculty member of Columbia's Data Science Institute. Jiang plans to teach both undergraduate and graduate courses in electrical engineering and computer engineering this year.

**HOD LIPSON**

Professor, Mechanical Engineering
PhD, Technion, Israel, 1998; BS, 1989

Hod Lipson works in the general fields of robotics and additive manufacturing. He has pioneered methods for robots to self-replicate as well as to self-model and reprogram themselves in the context of damage recovery or change in environment. Most recently at Cornell University, Lipson's work on self-aware and self-replicating robots, food printing, and bio-printing has received widespread media coverage, including in *The New York Times*, *The Wall Street Journal*, and NPR. He is the coauthor of the recent book *Fabricated: The New World of 3D Printing*. In the spring, he plans to teach Digital Manufacturing.

**MICHAL LIPSON**

Eugene Higgins Professor of Electrical Engineering
PhD, Technion, Israel, 1998; MS, 1994; BS, 1992

Michal Lipson's research focuses on the physics and applications of optical nanostructures with dimensions significantly smaller than the wavelength of light including silicon photonics, high-performance optoelectronic devices, optomechanics, and novel on-chip nanophotonic devices. Most recently, Lipson was a member of the faculty at Cornell University, where she was the Given Foundation Professor of Engineering. Her honors and awards include a MacArthur Fellow, Blavatnik Award, IBM Faculty Award, and NSF Early Career Award.

**VINCENT QUENNEVILLE-BÉLAIR**

Chu Assistant Professor, Applied Mathematics
PhD, University of Minnesota, 2015; BS, McGill University, 2008

Vincent Quenneville-Bélair's research interests are in numerical analysis and scientific computation with applications to physics and wave propagation. In particular, he currently studies gravitational waves through the design and analysis of new mixed finite elements using the Finite Element Exterior Calculus framework. He is teaching a graduate course in partial differential equations.



ANSAF SALLEB-AOUISSI

*Lecturer in Discipline, Computer Science
PhD, University of Orléans, France, 2003;
MS, 1999; Dipl. Ing., University of Sciences and
Technology Houari Boumediene, Algeria, 1996*

Ansaf Salleb-Aouissi’s research interests lie in machine learning and data science, including frequent patterns mining, rule learning, and action recommendation in addition to recent work in crowd sourcing, medical informatics, and educational data mining. She was previously an associate research scientist at Columbia’s Center for Computational Learning Systems and an adjunct professor with Computer Science and the Data Science Institute. Ansaf will be developing new data science courses in the Data Science Institute and teaching discrete mathematics in the Department of Computer Science.



JAMES T. TEHERANI

*Assistant Professor, Electrical Engineering
Postdoc Researcher, MIT, 2015; PhD, 2015; SM,
2010; BS, University of Texas at Austin, 2008*

James T. Teherani’s research interests span the study of fundamental material properties to the optimization of real-world electronic devices, focusing on 2D semiconductors, graphene, and tunneling transistors. He is teaching both undergraduate and graduate courses in electrical engineering, including Semiconductor Electronic Devices.



EUGENE WU

*Assistant Professor, Computer Science
PhD, MIT, 2014; MS, 2010; BS, University of
California at Berkeley, 2004*

Eugene Wu investigates technologies that help users play with their data, integrating techniques from specialties including core database optimization, data provenance, and visualization to improve the interface between users and data. He is teaching Data Science and Introduction to Databases and plans to also teach graduate topics at the intersection of databases, visualization, and interaction.



YUAN YANG

*Assistant Professor, Applied Physics
and Applied Mathematics
Postdoc Associate, MIT, 2012–2015;
PhD, Stanford University, 2012; MS, 2010;
BS, Peking University, China, 2007*

Yuan Yang’s research interests include electrochemical materials and devices, thermal energy harvesting, and improving thermal management. In his postdoctoral research at MIT, he focused on thermal management and waste heat recovery.



NGAI YIN YIP

*Assistant Professor, Earth and
Environmental Engineering
PhD, Yale University, 2014; MS and MPh, 2011;
BEng, Nanyang Technological University,
Singapore, 2004*

Ngai Yin Yip pursues research in cutting-edge technologies for the sustainable production of water and energy, focusing on pioneering membrane-based processes for desalination, wastewater reclamation, salinity-gradient energy, and waste-heat conversion. He received the CH2M Hill/AEESP Outstanding Doctoral Dissertation Award in 2014 for his thesis on osmotically-driven membrane processes and ion-exchange membrane processes. Yip is co-instructing A Better Planet by Design in the fall.

PROMOTION TO TENURE



CHRIS MARIANETTI | Applied Physics and Applied Mathematics

Using theoretical and computational methodologies, Associate Professor Chris Marianetti predicts various materials properties that have potential applications for energy storage or conversion, such as battery cathodes, nuclear reactor fuels, thermoelectrics, and hydrogen storage materials. Marianetti's research group uses a broad range of theories and techniques, including classical molecular dynamics, density functional theory, and dynamical mean-field theory. He was awarded an NSF CAREER Award and DARPA Young Faculty Award. Marianetti joined Columbia Engineering in 2008 after serving as a postdoctoral researcher at Lawrence Livermore National Laboratory.



ARVIND NARAYANASWAMY | Mechanical Engineering

Associate Professor Arvind Narayanaswamy and his research group focus on theoretical and experimental investigations of nanoscale and microscale effects in thermo-fluid transport phenomena. Their goal is to use these fundamental studies to improve energy conversion and electronics cooling applications. Current projects include investigations of near-field enhancement of thermal radiative transfer, temperature variation of van der Waals and Casimir forces, far-field emission control using periodic structures, thermal metrology using bimaterial cantilevers, and resonance frequency characteristics of bimaterial cantilevers. Narayanaswamy is involved in the American Society of Mechanical Engineers and the American Physical Society.



SIMHA SETHUMADHAVAN | Computer Science

Associate Professor Simha Sethumadhavan is a leading researcher in hardware security and computer architecture. He directs the Computer Architecture and Security Technologies Lab (CASTL), and his group is focused on making computers better by improving their security with hardware enhancements and making them more energy-efficient through novel microarchitectures and program characterization techniques. He has been recognized with an Alfred P. Sloan Fellowship (2013), NSF CAREER Award (2011), and two *IEEE Micro* "top pick" awards (2004, 2013). He is a founder of a hardware security startup, Chip Scan, and serves on the Downloadable Security Technical Advisory Committee at the U.S. Federal Communications Commission.



HUIMING YIN | Civil Engineering and Engineering Mechanics

Associate Professor Huiming Yin specializes in the multiscale/physics characterization of civil engineering materials and structures with experimental, analytical, and numerical methods. His research interests are interdisciplinary and range from structures and materials to innovative construction technologies and test methods. Prior to joining Columbia Engineering in 2008, Yin was a civil engineer with the California Department of Transportation. He is a recipient of an NSF CAREER Award and a member of the American Society of Civil Engineers, The International Association for Computational Mechanics, and the U.S. Association for Computational Mechanics.

PROMOTION TO FULL PROFESSOR



SCOTT BANTA | Chemical Engineering

Scott Banta's research focuses on applying protein engineering and metabolic engineering tools to solve challenging problems in bioengineering, with a focus on bioenergy. Banta and his research group are working to engineer new features in proteins and peptides including the engineering of protein/nanomaterial interfaces, enzymatic biomaterials, bioelectrochemistry, and stimulus-responsive proteins. The group is also interested in bioelectrochemical systems for bioenergy conversions including biofuel cells and electrofuel systems. He is the past chair of the Biochemical Technology (BIOT) division of the American Chemical Society.

PROMOTION TO ASSOCIATE PROFESSOR



XI CHEN | Computer Science

Xi Chen specializes in algorithmic game theory / economics and complexity theory. He examines algorithmic issues related to some of the most classic and fundamental models and solution concepts in game theory and economics. He earned both his BS in physics/mathematics and PhD in computer science from Tsinghua University, in 2003 and 2007, respectively. Before joining SEAS in 2011, he was a postdoctoral researcher at IAS, Princeton University, and USC. He received an NSF CAREER Award, a Sloan research fellowship, and a Presburger Award by the European Association for Theoretical Computer Science (EATCS).



VINEET GOYAL | Industrial Engineering and Operations Research

Vineet Goyal is interested in the design of efficient and robust data-driven algorithms for large-scale dynamic optimization problems with applications in energy markets and revenue management problems. His research has been continually supported by grants from the National Science Foundation and industry. He received the NSF CAREER Award and the IBM Faculty Award in 2014 and a Google Faculty Research Award in 2013. Goyal received his PhD from Carnegie Mellon University in 2008 and spent two years as a postdoctoral associate at the Operations Research Center at MIT before coming to Columbia in 2010.



FRANCESCO VOLPE | Applied Physics and Applied Mathematics

Francesco Volpe specializes in magnetically confined tokamak and stellarator plasmas, with emphasis on microwave heating and magnetohydrodynamic stabilization. Volpe joined Columbia Engineering in January 2012. From 2009 to 2011, he was an assistant professor of engineering physics at the University of Wisconsin-Madison. A recipient of a Department of Energy Early Career Award and of the Otto Hahn Medal (thesis prize of the Max Planck Society, Germany), Volpe did his postdoctoral research at General Atomics in San Diego, California; has authored or coauthored more than 50 journal articles; and is a member of various national and international committees.



BRAZIL PARTNERSHIP DEBUTS NEW RIO INNOVATION HUB

Columbia University, led by the School of Engineering and Applied Science, and the city of Rio de Janeiro are partnering on a new innovation center that will spur technological growth and research advances in critical areas such as sustainability, data science, advanced materials, smart cities, and precision medicine. The new Rio Columbia University Innovation Hub—also in partnership with Columbia Global Centers; the School of International and Public Affairs (SIPA); the Graduate School of Architecture, Planning and Preservation (GSAPP); the Mailman School of Public Health; and other University schools—will be headquartered in “the Marvelous City” of Rio and will be a place for exciting new collaborations between University faculty, researchers, and students, and key Brazilian public sector and industry leaders, scholars, students, and researchers.

“This is going to bring new, innovative, technology-based solutions to critical issues facing cities and to transform lives both locally and globally using truly interdisciplinary approaches,” said Dean Mary C. Boyce at a special ceremony held in the spring, marking the launch of the innovation hub.

While the official opening of the hub is slated for July 2016 in Rio, a number of activities are planned to kick-start the collaboration. This includes design challenges on topics of interest to the citizens of Rio and to university collaborators in New York City and Rio.

At the spring ceremony on campus, Boyce credited University Provost John Coatsworth for spearheading talks with Rio, dating back six years ago, to collaborate on such a venture. She added, “I’m really excited about our new colleagues and how this partnership is really going to expand our impact not only here at Columbia but also the impact of faculty and students from our Rio university partners.”

Rio de Janeiro Mayor Eduardo Paes attended the celebration and echoed Boyce’s enthusiasm about this latest Columbia-Brazil partnership. Columbia established a Global Center in Rio in 2013.

“Innovation is what Columbia does best, and to promote that in Rio has been a priority for us,” said Paes. “The creation of an innovation hub in partnership with the Rio de Janeiro Federal University will stimulate the development of applied sciences in the city. . . . To be a global city, Rio needs to be connected to state-of-the-art scientific research done in major institutions around the world such as Columbia.”

At the ceremony, hosted at SIPA, Paes and Coatsworth signed an agreement to establish the innovation hub. Also in attendance were Shih-Fu Chang, senior vice dean of the Engineering School and the Richard Dicker Professor of Telecommunications; Thomas Trebat, director of the Rio Global Center; and Merit Janow, dean of SIPA.

Top left, from left to right: Merit Janow, Rio Mayor Eduardo Paes, Mary C. Boyce, John Coatsworth, and Thomas Trebat. Top right: Following the announcement, Rio Mayor Eduardo Paes (left) in conversation with Rit Aggarwala, adjunct professor at SIPA who specializes in cities, environmental programs, and transportation. (Photos by Lynn Saville)

By Melanie A. Farmer

THE BIG CITY SCALED DOWN FOR SUSTAINABILITY

COLUMBIA TO COLEAD \$12 MILLION LIVABLE CITIES RESEARCH PROJECT

Patricia Culligan, co-principal investigator of the new NSF research project focused on urban infrastructure (Photo by Jeffrey Schifman)

Two-thirds of people on the planet will live in cities by 2050, but few cities are prepared for the coming population boom. A \$12 million research project sponsored by the National Science Foundation (NSF) will explore a new model for urban infrastructure—the roads, pipes, and grids that move around people, food, water, and energy—to make cities cleaner, healthier, and more enjoyable places to live.

A consortium of cities, companies, and universities, led by Columbia University, University of Minnesota, and Georgia Institute of Technology, will form a Sustainability Research Network (www.sustainablehealthycities.org) to carry out the research, titled “Integrated Urban Infrastructure Solutions for Environmentally Sustainable, Healthy, and Livable Cities.” The lead investigator of the project is Anu Ramaswami at University of Minnesota. By 2045, cities will be home to 6 billion people, the United Nations estimates, creating an unprecedented demand for food, water, energy, transportation, and housing.

Columbia’s role in the Sustainability Research Network will be to look at the potential for designated cities to scale various sustainability solutions, be it planting rooftop farms or rewiring buildings for solar energy. How much capacity is there, and how big are the benefits? The Columbia researchers involved include Engineering faculty: Patricia Culligan, professor of civil engineering and engineering mechanics and deputy director of Columbia’s Data Science Institute; Upmanu Lall, Alan and Carol Silberstein Professor of Earth and Environmental Engineering and of Civil Engineering and Engineering Mechanics, who heads the Columbia Water Center; and Vijay Modi, professor of mechanical engineering, who directs Columbia’s Sustainable Engineering Lab.

By studying the infrastructure of cities in the United States and India, the Sustainability Research Network will identify the best mix of local and regional systems to meet city dwellers’ needs. The team will also explore the community attitudes and public policies that allow cities to evolve and adapt. Over the next four years, it will

develop a framework for change based on new technologies and trends already underway, including district energy systems, community solar energy, light-rail, bike share systems, and urban farms.

Cities to be analyzed include, among others, New York, Minneapolis–St. Paul, Detroit, and Atlanta, as well as cities in India with minimal infrastructure. The researchers, in collaboration with their partners, will focus on developing practical solutions that can be scaled and immediately put into action.

In New York City, Columbia has worked with City Hall, property owners, and local community groups to measure the impact of city initiatives to green the urban landscape by planting more trees and vegetation, including on rooftops and roadways. Trees and plants absorb rain and snow, reducing the amount of stormwater runoff that sewage treatment plants need to process. They also cool the air, helping to bring down temperatures on hot days. In addition to measuring the benefits of green infrastructure, Columbia researchers are studying the psychological factors that lead communities to care for city-planted trees and vegetation in their midst, protecting the public’s investment. Initial results of the ongoing research highlight the importance of involving neighbors in the stewardship of green infrastructure.

The shift to a city with local and decentralized services will require technology—sensors to pull in data from solar panels, weather stations, and so on—and systems to analyze it, make decisions, and coordinate with other systems. “The Internet of Things, where sensors talk to sensors and make decisions without any human involvement, is going to be key for the city of the future,” said Culligan. “Sensors on green roofs will tell sensors controlling irrigation when plants are thirsty and need to be watered.”

She added, “Big data and data science will be central to all of this.”

By Kim Martineau



NAE SYMPOSIUM *THE ENGINEERING IN MEDICINE*

The National Academy of Engineering (NAE) held its Northeastern Regional Symposium this spring at Columbia Engineering, showcasing the groundbreaking research of some of the University's leading engineers and scientists on "The Engineering in Medicine."

The daylong event, held in the Low Rotunda, highlighted Columbia's novel research initiatives to advance health informatics, engineer better medicines, and reverse-engineer the human brain. The symposium concentrated on four key areas: data science and health, imaging and health, regenerative medicine, and neuroengineering.

"By its nature, engineering is a profession whose mission is to seek creative solutions to societal problems, local and global, big and small," said Dean Mary C. Boyce, introducing proceedings and highlighting collaborations between Columbia Engineering, the Columbia University Medical Center (CUMC), and other schools. "Columbia Engineering is proud of its leadership and partnership roles in supporting the University's multidisciplinary initiatives in medicine and human health through the institutes and initiatives that cut across the University."

After remarks from NAE President C. D. Mote Jr., examining the "grand challenges" facing researchers, Lee Goldman, Columbia's executive vice president for health and biomedical sciences and CUMC's dean of the faculties of health sciences and medicine, gave the opening address. He discussed the rich history of bioengineering and biomedical engineering over the past century and the promise of emerging fields of research, including tissue engineering, microfluidics, nanoinstrumentation, and bioinformatics.

Chemical Engineering Professor Jingyue Ju joined Noémie Elhadad, associate professor of biomedical informatics, and Andrea Califano, professor and chair of chemical systems biology and director of the Sulzberger Columbia Genome Center, to discuss how using data impacts their work. Computer Science Professor Kathleen McKeown, director of Columbia's Data Science Institute, moderated a Q&A on

how the rise of sophisticated data analytics is advancing knowledge and treatments on both the individual and public health scales.

Illustrating the importance of imaging in human health, Elisa E. Konofagou, professor of biomedical engineering and of radiology, and Elizabeth Hillman, associate professor of biomedical engineering and of radiology, discussed their research in new elasticity imaging techniques and therapeutic ultrasound methods, and advanced in vivo optical imaging techniques, respectively. Andrew F. Laine, professor and chair of biomedical engineering and a professor of radiology, led a discussion on how groundbreaking imaging techniques enable more precisely tailored treatments for a variety of ailments.

Regenerative medicine and tissue engineering were at the center of presentations delivered by Biomedical Engineering Professor Helen H. Lu; Gordana Vunjak-Novakovic, Mikati Foundation Professor of Biomedical Engineering and Medical Sciences; and Matthew Bacchetta, associate professor of surgery.

An in-depth look at the cutting edge of neuroscience was provided by Paul Sajda, professor of biomedical engineering, electrical engineering, and radiology; Kenneth Shepard, Lau Family Professor of Electrical Engineering and professor of biomedical engineering; and Joshua Jacobs, assistant professor of biomedical engineering. In individual talks and then a Q&A moderated by Sajda, they addressed innovative research including reverse-engineering cortical networks underlying perceptual and cognitive processes, interfacing advanced integrated circuits with biological systems for a variety of applications, and charting the neural basis for human navigation and memory using recordings from surgically implanted electrodes in the brains of epilepsy patients.

"Engineering is about transforming lives," Boyce said. "Grand societal challenges provide a focus and a framework for research bringing a public visibility to the importance and impact of engineering and the applied sciences in shaping our world for the better."

From top to bottom: Biomedical Engineering Associate Professor Elizabeth Hillman, who specializes in 2D and 3D optical imaging; Lee Goldman, executive vice president for health and biomedical sciences at CUMC; the NAE regional symposium focused on data science and health, imaging and health, regenerative medicine, and neuroengineering. (Photos by Timothy Lee Photographers)

RESHAPING SEAS

SCHOOL OPENS NEW STUDENT COMMONS, MORE RENOVATIONS UNDERWAY

Those returning to campus this fall got a welcome surprise: a strikingly renovated lobby entrance into Mudd (campus level, fourth floor); an aesthetically modern new student space, Carleton Commons; and the newly opened Blue Java Café.

The former space housing the Carleton Lounge and cafeteria have been transformed into a beautifully reimagined space, comprising 2,800 square feet, with seating for 160 and areas for casual meetings, individual and group work, and quiet study. The versatile space can easily be reconfigured for special events. Adjacent to the Commons is Blue Java Café, a contemporary coffee bar that offers sandwiches, soups, pastries, salads, and even homemade cookies.

On May 1, 2015, Dean Mary C. Boyce presided over a special ribbon-cutting ceremony for the new Carleton Commons.

“The need for top-quality student space is among our most urgent,” said Boyce. “These student spaces are places where we foster all the student creativity and energy outside of our courses and our classrooms. In a remarkably short period of time, we have transformed the former Carleton Lounge, the primary student space at the Engineering School, into an entirely different experience for our students.”

The ceremony recognized the contributions of a group of Columbia parents—including Kaveepan and Supanavit Eiamsakulrat P’17CC, ’18 and Mehmet Nazif and Zeynep Gunal P’07, ’10, ’12, ’18—who made leadership gifts that helped make the renovation possible. “Your generosity highlights the vital role that parents and families play in our Columbia Engineering community,” Boyce added.

Over the busy summer, the School also completed construction of the Data Science Institute’s (DSI) main office space for its faculty, researchers, students, and staff. Located on Mudd’s fourth floor, the new space comprises 8,400 square feet, including faculty offices, conference rooms, and open areas for research collaboration and meetings; the Engineering Library, which was formerly housed in that space, is now at the Northwest Corner Building. Additional DSI spaces in the Northwest Corner Building, consisting of faculty offices, labs, and conference rooms on the 10th and 14th floors, were completed by September. In addition, the fifth floor of Mudd, which consists of DSI offices and two

classrooms, was also under construction over the better part of the summer. The renovated classrooms opened in time for the start of classes.

To provide state-of-the-art facilities for research that increasingly requires a contamination-free, controlled environment, an expansion of the clean room on the 10th floor of the Schapiro Center for Engineering and Physical Science Research (CEPSR) is well underway. Operated by the newly formed Columbia Nano Initiative (CNI), the CEPSR clean room is being fully renovated and expanded from 3,000 to 4,000 square feet and will provide faculty, students, and researchers the necessary state-of-the-art instrumentation and facilities to accommodate interdisciplinary nanotechnology research. It is scheduled for completion by March 2016.

Up and running in nearby Havemeyer Hall is the School’s new Electron Microscopy (EM) Laboratory, in partnership with Arts & Sciences, as part of CNI. Instrument acquisition and laboratory renovations were directed by Katayun Barmak, the Philips Electronics Professor of Applied Physics and Applied Mathematics. The EM Lab includes one transmission electron microscope (TEM), a precession electron diffraction system for phase and crystal orientation mapping in the TEM, one scanning electron microscope, and a suite of sample preparation instruments.

Also included in the many upgrades and construction projects, from small to large scale, are departmental lab spaces and facilities within applied physics and applied mathematics (APAM), biomedical engineering (BME), chemical engineering (ChemE), computer science (CS), mechanical engineering (MechE), and electrical engineering (EE). This summer, renovations to BME and EE teaching labs were completed, and additional projects currently underway include build-out and renovations for optics research labs in the basement of Engineering Terrace and in CEPSR for APAM and EE, as well as wet labs upgrades in Engineering Terrace for BME.

These enhancements of SEAS spaces are just the beginning of a program of renovations, construction, and facilities upgrades, underscoring the School’s mission to provide its talented student body and faculty with the facilities and resources they need to reach their full potential.

By Melanie A. Farmer



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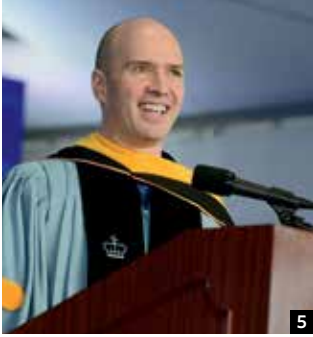
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CONGRATULATIONS, GRADUATES

CLASS OF 2015 EMBARKS ON NEW JOURNEYS

“The impact of engineering has never been more visible. Society looks to engineering for solutions to the many challenges facing our world—whether energy, water, air, the environment, food security, privacy, health, or medicine. Engineering is now recognized as a foundational degree that prepares you for any career, for any future.”

—Dean Mary C. Boyce

Opposite page: [1] Transmission Electron Microscope; [2] Carleton Commons study space; [3] new hallway displays; [4] Carleton Commons student space (Photos 1 and 2 by Jeffrey Schifman; Photos 3 and 4 by Timothy Lee Photographers)

Above: [5] Class Day Speaker Ben Horowitz '88CC, cofounder of VC firm Andreessen Horowitz; [6] Dean Mary C. Boyce (Photos by Eileen Barroso)

FACULTY AWARDS WERE PRESENTED AS FOLLOWS:

Distinguished Faculty Teaching Awards

James Hone, Wang Fong-Jen Professor of Mechanical Engineering
Shree K. Nayar, T. C. Chang Professor of Computer Science

Edward and Carole Kim Award for Faculty Involvement

Martha A. Kim, Associate Professor of Computer Science

Janette and Armen Avanesians Diversity Award

Helen H. Lu, Professor of Biomedical Engineering

Rodriguez Family Junior Faculty Development Award

Christine P. Hendon, Assistant Professor of Electrical Engineering

“Following your passion is a very ‘me’ centered view of the world, and when you go through life, what you’ll find is what you take out of the world over time . . . is much less important than what you put into the world. My recommendation would be: follow your contribution. Find the thing that you’re great at, put that into the world, contribute to others, help the world be better—that is the thing to follow.” —Ben Horowitz '88CC, Class Day Speaker

NEWS

From left to right: Dean Mary C. Boyce, David Aronoff, Ben Fried '88CC, and Professor Salvatore J. Stolfo (Photo by Michael DiVito)



NYC ENTREPRENEURSHIP NIGHT TALKS CYBERSECURITY

Cybersecurity was the headline topic at Columbia Engineering's NYC Entrepreneurship Night, where students, alumni, and faculty also got a glimpse at some of the exciting new startups from Columbia entrepreneurs. The event, cosponsored by Columbia Engineering and the Columbia Alumni Association, was held on March 12 at the AXA Event & Production Center in Midtown Manhattan.

After an introduction from Richard Witten, trustee emeritus and special adviser to the President of Columbia University, Dean Mary C. Boyce moderated a wide-ranging conversation on cybersecurity with three technology leaders: David Aronoff, general partner at Flybridge Capital Partners and a renowned tech investor; Ben Fried '88CC, chief information officer at Google and a member of Columbia Engineering's Board of Visitors; and Salvatore J. Stolfo, professor of computer science and head of the Columbia University Intrusion Detection Systems Lab.

"Nothing recorded on a computer can ever truly be safe or truly be private," said Stolfo.

Aronoff drew a distinction between the often conflated notions of security and privacy. "There's some element of voluntarism to private information," he said. "The security side is much more straightforward than privacy, which is more amorphous."

The speakers argued that protecting the firmware or software of the embedded devices making up the emerging "Internet of Things," as household items become increasingly computerized, is a key challenge moving forward.

"The Internet of Things is the next great frontier in cybersecurity," said Fried, who studied under Stolfo as a student at Columbia. "Devices are too cheap to have good security at the rate we're moving."

The speakers discussed innovative responses to online security threats in the age of ubiquitous mobile devices, ranging from continuous identity verification based on behavioral patterns to hiding sensitive information in a thicket of obfuscating junk data. They agreed that, in addition to the technical challenge of devising novel defenses against online adversaries, users themselves must learn to prioritize data security.

"People are one of the more fundamental problems with cybersecurity," Stolfo said. "People often see it as an obstacle to getting their work done."

After a lively Q&A, the evening continued with a session featuring demos from some of the many entrepreneurial ventures from the Columbia Engineering community. Two of them, Allure Security Technology Inc. and Red Balloon Security Inc., bring advances from Stolfo's lab to the cybersecurity marketplace. Stolfo cofounded Allure with Angelos D. Keromytis, associate professor of computer science and director of the Network Security Lab, who is currently on leave working with the Information Innovation Office at DARPA, part of the U.S. Department of Defense. Red Balloon was cofounded by Stolfo and PhD candidate Ang Cui.

Other demos spanned a broad range of market applications. Columbia Startup Lab member OnTarget, cofounded by Niran Shrestha MS'13, offers real-time project analytics for construction. With expertise in natural language processing from SEAS PhD candidates Bob Coyne BS'80, MS'09 and Daniel Bauer MPhil'13, WordsEye (also part of the Columbia Startup Lab) empowers users to generate three-dimensional scenes based on simple descriptions, like next-generation emojis. Text IQ aims to accelerate legal work with state-of-the-art natural language processing techniques, while startup KISI expands access control management of physical space with a cloud-based app.

Others who demonstrated their innovative plans included Kinno Inc., a startup cofounded by biomedical engineering senior Jason Kang and partners Katherine Jin and Kevin Tyan from Columbia College; and deCervo, cofounded by postdoctoral research scientist Jason Sherwin and PhD candidate Jordan Muraskin BS'07, MS'11, MPhil'14, with Paul Sajda, professor of biomedical engineering, of electrical engineering, and of radiology, as an adviser. Kinno has been widely acclaimed for its innovative, low-cost powdered bleach additive that aids in decontamination of infectious diseases, including Ebola. The company deCervo integrates brain imaging and big-data algorithms to better understand decision making in crucial moments.

"Nights like these tap into the strong entrepreneurial spirit of Columbia students and alumni from around the world," Boyce said.

By Jesse Adams

Right: Vice President Joseph Biden (Photo by Brandon Vick, University of Rochester)



SPOT NEWS ROUNDUP

COOL ANTS

Nanfang Yu, assistant professor of applied physics, has helped solve a long-standing evolutionary mystery in discovering how Saharan silver ants keep cool in one of the hottest, least hospitable environments on planet Earth.

Along with colleagues at the University of Zürich and the University of Washington, Yu demonstrated that the ants (*Cataglyphis bombycina*) are able to use their dense arrays of uniquely shaped hairs—which form distinctive silver coats that give the ants the appearance of mercury droplets flowing across the sands—to manipulate electromagnetic waves over a broad range from the solar spectrum to the thermal radiation spectrum to reduce body temperature. The African ants are thus able to forage for food in the Sahara Desert under the harsh midday sun, maintaining body temperatures below approximately 128° F even as surface temperatures climb to as high as 158° F.

Yu's group, including his PhD students Norman Nan Shi and Cheng-Chia Tsai, used optical and infrared spectroscopy, thermodynamic measurements, full-wave simulations, and heat-transfer modeling to explore how the ants achieve passive cooling by reflecting visible and near-infrared light, where solar radiation culminates, and offloading excess heat in the form of mid-infrared thermal radiation.

In addition to illuminating how evolution has shaped exquisitely adapted structures to control infrared light—a topic not yet well understood—the research, Yu anticipates, will advance novel flat optical components, or “metasurfaces,” that exhibit optimal cooling properties for thermoregulation, with applications including cooling surfaces for buildings, vehicles, and clothing. His group is presently extending their research to other organisms living in extreme environments.

Yu, Shi, and Tsai designed and conducted all experimental work at Columbia Engineering and at Brookhaven National Laboratory's Center for Functional Nanomaterials. Their research, published in *Science* magazine, was supported by the National Science Foundation and the Air Force Office of Scientific Research.



The ants' silvery appearance is created by a dense array of uniquely shaped hairs. The hair coating helps reduce body temperature substantially. (Photo courtesy of Nanfang Yu)

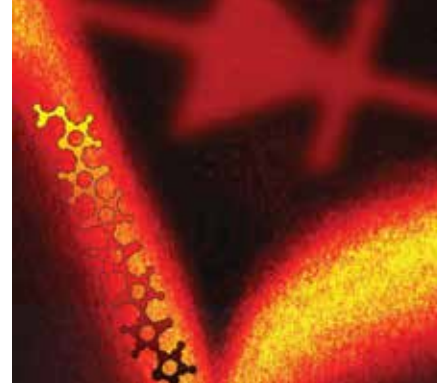
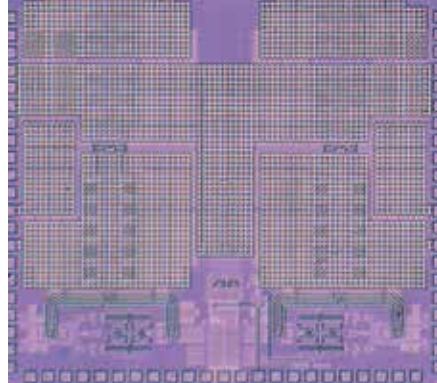
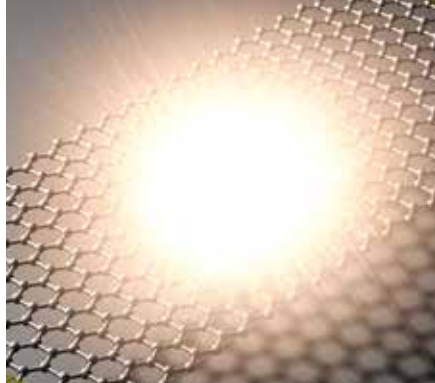
BIDEN ANNOUNCES NEW YORK PHOTONICS INNOVATION HUB

Columbia Engineering Professors Keren Bergman, Michal Lipson, and Alex Gaeta are a part of a new integrated photonics manufacturing innovation hub in Rochester, NY, announced by Vice President Joseph Biden on July 27. The American Institute for Manufacturing Integrated Photonics (AIM Photonics), a consortium of 124 companies, nonprofits, and schools, captured the largest federal investment to date under the administration's National Network for Manufacturing Innovation, totaling over \$610 million. Columbia is among the eight universities, which include SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering, MIT, UC Santa Barbara, University of Rochester, Rochester Institute of Technology, University of Arizona, and UC Davis.

Bergman, the Columbia lead for AIM Photonics, hailed the launch of the first U.S.-based manufacturing institute dedicated to integrated photonics.

“AIM Photonics will encompass the complete infrastructural ecosystem for fostering the growth of a new domestic industry propelled by the unique capabilities of integrated photonics to manipulate, transport, and control light at the chip scale,” said Bergman, “which will then catalyze the integration of powerful photonic capabilities in a multitude of industrial and military applications.”

The project highlights the research of the Columbia Nano Initiative, an interdisciplinary collective that advances innovation at the nanoscale. Columbia's expertise in optically interconnected embedded computing via terabit-scale integrated photonics promises to spark a range of domestic manufacturing opportunities.



GRAPHENE GETS BRIGHT

An international research team led by Young Duck Kim, a postdoctoral research scientist in Mechanical Engineering Professor James Hone's group, has pioneered what is essentially the world's thinnest lightbulb. In June, they demonstrated for the first time an on-chip visible light source with a filament made of graphene, an atomically thin and perfectly crystalline form of carbon.

Creating light in small structures on chips' surfaces is key to developing fully integrated "photonic" circuits that utilize light in place of electronic currents, but scientists have struggled with embedding incandescent lights onto chips because extreme heat tends to damage chip components. But because graphene becomes a poorer conductor of heat as it gets hot, it can reach extremely high temperatures while confining thermal energy sufficiently to avoid such damage.

Researchers attached small strips of graphene to metal electrodes, suspended the strips above the substrate, and passed a current through the filaments to make them glow brightly at temperatures above 2500°C. The graphene emitted light bright enough to be visible with the naked eye.

Kim, Hone, and their collaborators from institutions across the United States and South Korea expect that their research will advance graphene-based on-chip optical communications and help create transparent, atomically thin displays. They are presently working on integrating these novel devices into flexible substrates.

EXTREME MULTITASKING: WIRELESS RADIO EDITION

In a major advance for radio frequency data capacity that was long thought to be impossible, Columbia Engineering researchers have developed a technology enabling simultaneous transmission and reception at the same frequency in wireless radios.

The research team, consisting of Electrical Engineering Associate Professor Harish Krishnaswamy, director of the Columbia High-Speed and Mm-wave IC (CoSMIC) Lab, and PhD student Jin Zhou, developed full-duplex radio integrated circuits (ICs) that can be implemented in nanoscale complementary metal-oxide semiconductors (CMOS) to effectively double frequency spectrum resources and vastly enhance the data capacity of network infrastructure strained by the increasing profusion of wireless devices.

This technology, which the research team expects could be integrated into smartphones, tablets, and cellular and WiFi base stations, could help address one of the most fundamental challenges in the age of Big Data: the pressing shortage of frequency spectrum to support the continuing expansion of data transmitted wirelessly. The most vexing challenge the team was able to overcome with full-duplex technology was canceling the transmitter's echo, or self-interference.

The researchers presented their work at the prestigious International Solid-State Circuits Conference (ISSCC) in San Francisco on February 25.

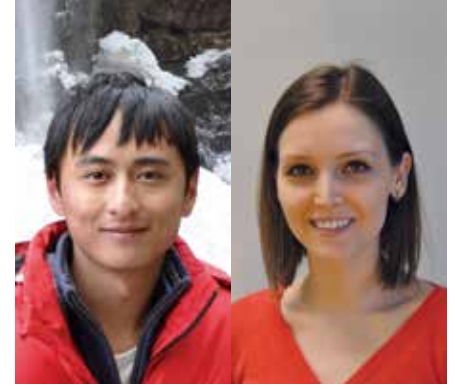
A STEP CLOSER TO A SINGLE- MOLECULE DEVICE

Under the direction of Latha Venkataraman, associate professor of applied physics, researchers have designed a new technique to create single-molecule diodes that perform 50 times better than all prior designs and are the first that may have broad real-world technological applications for nanoscale devices.

Constructing a device where the active elements are only a single molecule has long been a "holy grail" of nanoscience, representing the ultimate limit of functional miniaturization that can be achieved for an electronic device. Scientists have understood for decades that single molecules attached to metal electrodes can be made to act as a variety of circuit elements, from resistors and switches to transistors and diodes, but previous designs have suffered from low current flows and a lack of balance between flows for the "on" and "off" directions.

Venkataraman and her collaborators, including PhD student Brian Cappozzi, Columbia Assistant Professor of Chemistry Luis Campos, and Professor Jeffrey Neaton at UC Berkeley, developed an elegant method for creating necessarily asymmetrical environments by surrounding active molecules with an ionic solution and using gold metal electrodes of various sizes to contact the molecules. Their technique is easy to implement and applicable to nanoscale devices of all types, including those made with graphene.

The researchers are now investigating the fundamental physics underlying their discovery and how to optimize current flows to maximize the molecular diodes' charge-transport properties. Their paper, "Single-Molecule Diodes with High On-Off Ratios through Environmental Control," was published in *Nature Nanotechnology*.



SPEECH AND THE BRAIN

Nima Mesgarani, assistant professor of electrical engineering, won a major research project grant this spring from the National Institute of Deafness and Other Communication Disorders (NIDCD-NIH) to support groundbreaking research on how the brain analyzes speech.

He is slated to receive \$2 million over five years to support innovative, interdisciplinary work with colleagues at the Columbia University Medical Center (CUMC) recording highly detailed views of neural activity from electrodes surgically implanted in cortices of epilepsy patients as part of their clinical evaluations.

Mesgarani's team uses a combination of invasive and noninvasive methods to study cortical mechanisms and transformations involved in speech perception with high spatiotemporal resolution, advancing understanding of how brains internally represent and follow voices of speakers and linking neural response characteristics and their dynamic properties.

The team is developing a detailed neurobiological model of the cortical functions underlying robust speech perception that should help researchers analyze how these processes are impaired in communication disorders like dyslexia, aphasia, and language-learning delay. The research promises to revolutionize disciplines including neurolinguistics and speech engineering, as well as speech prostheses.

Mesgarani, a member of Columbia University's Neurobiology and Behavior Program, was also recently named a Pew Scholar by The Pew Charitable Trusts. Mesgarani will receive funding over the next four years in support of his research in neurophysiology, linguistics, and computational modeling to advance biologically inspired speech-recognition programs.

PRINT THE RAINBOW

A new computational technique is advancing the art and science of 3D printing in color, thanks to Assistant Professor of Computer Science Changxi Zheng and collaborators at China's Zhejiang University.

The research team designed a computational model that predicts and accounts for color film distortion during hydrographic printing, widely used in industry to transfer color inks on thin films to the variegated surfaces of manufactured 3D objects. The printing involves placing a chemically softened polyvinyl alcohol film with printed color patterns on top of water, and slowly dipping an object so that the film wraps around and adheres to the object's surface. The new technique has enabled the most precise alignment between objects and the patterned films ever attained, unlocking unprecedented versatility in 3D printing.

Zheng, a codirector of the Columbia Computer Graphics Group, built upon previous work on fluid and viscous sheet simulation to develop the new method for modeling and mapping color film stretch. He and collaborators developed and tested an innovative multi-immersion printing process that allows fine color printing on a variety of objects through multiple dips precisely calculated to achieve detailed textures and surface decorations.

The system is inexpensive, works for a variety of surface geometries and materials, and promises to be convenient for personal use. Zheng expects the system may be used for precise, personalized printing on products including toys and consumer goods.

STUDENTS WIN QUALCOMM INNOVATION FELLOWSHIP

Electrical Engineering PhD students Jelena Marasevic and Jin Zhou received a Qualcomm Innovation Fellowship for their proposal to increase wireless throughput in WiFi and cellular networks. They are one of just eight winning teams from a pool of 146 proposals that will receive \$100,000 and mentorship from Qualcomm engineers over the next year to support their ongoing collaborative research to enhance upload and download speeds and enable more flexible use of wireless technology.

The students, advised by Associate Professors Harish Krishnaswamy and Gil Zussman, won for "Realizing the Full-duplex Potential of OFDM-based Networks: From Circuits to MAC Layer," spanning the wide array of research they have done in full-duplex communication, which enables simultaneous transmission and reception in wireless radios at the same frequency.

Marasevic's research concentrates on optimization techniques and algorithms to maximize the potential of full-duplex technology, while Zhou's work focuses on innovative complementary metal-oxide semiconductor (CMOS) radio design to cancel out self-interference, or the transmitter's echo. Their nontraditional work aims to make full-duplex communication a reality in both WiFi and small-cell-based LTE cellular networks, a major advance in wireless applications.

This was the fourth straight year that a team from Columbia Engineering has won the highly competitive fellowship from Qualcomm, one of the world's largest wireless telecommunications companies.



MAKECU

engineering.columbia.edu/web/newsletter/makecu



At the wearable tech design challenge, graduate students showcased their one-of-a-kind prototypes like this one—Guide—a customizable device with applications ranging from navigation to emergency notifications.

ENGINEERING YOUR STYLE

As consumers seek to seamlessly integrate technology into their lives, wearable devices are an expanding field for engineers and entrepreneurs. Columbia Engineering graduate students showcased their own innovative designs this spring in the School's first annual "Engineering Your Style" competition.

From an initial field of 20, five student teams received \$500 to develop prototypes in Columbia Engineering's Makerspace between October and February. On April 16, they pitched their ideas and demonstrated their proposals to judges including Electrical Engineering Professor John Kymissis, entrepreneur Adam Rapp BS'04, and Theanne Schiros, who teaches at Columbia and the Fashion Institute of Technology. Judges weighed each team's marketability, innovation, and readiness to pursue commercial applications.

The competition was just too close to call, and two teams shared first place: Guide, a low-power customizable device with almost limitless potential applications, from mechanical engineering students Dhruv Nair and Vaibhav Paraashar; and Stride, an innovative insole for shoes with sensors to track gait and initiate vibrations to correct wearers' steps and prevent injuries in real time, from electrical engineering students Omar Kiyani and Arvind Srinivasan.

The other contenders comprised a device to help people who rely on sign language to communicate in emergency situations, a portable EEG headset to analyze brainwaves, and a brain-computer interface that lets users play video games with their minds.

WHAT A HACK!

What is a hack? That was the question animating the first annual MAKECU spring hardware hackathon, held over an intense 24 hours on campus from February 28 to March 1.

A new initiative for undergraduates launched by Columbia Engineering's student chapter of the Institute for Electrical and Electronics Engineers (IEEE), MAKECU aims to expand Columbia's maker culture and inspire the next generation of Columbia engineers.

Teams of two to four hackers, or makers, from Columbia and other schools including CUNY and the University of Maryland, had access to mentors, workshops, Columbia Engineering's Makerspace, a standard circuits laboratory bench, and equipment including power supplies, an Arduino, oscilloscopes, and 3D printers, as well as unmodified hardware they brought themselves. After a keynote speech from Tom Igoe, cofounder of the open-source electronic prototyping platform Arduino, groups creatively repurposed everyday components in pursuit of ideas as diverse and ambitious as their imaginations.

Projects included Fruitbox Hero, which made instruments of bananas and oranges; Simon Says Move, a gesture-based memory game; Conduct II, a light-sensitive statistical notes generator; Don't Push My Buttons, a glove with an embedded keyboard to help deaf people communicate; and CU_Later, a gesture-controlled wheelchair.

After 20 hours of furious brainstorming, prototyping, and testing, the projects were evaluated by experts from Arduino, littleBits, Ardent Cell Technology, Altium, and Makerbot.

DEPARTMENTS

Dear Fellow Columbia Engineers:

The Columbia Engineering alumni community enters the fall 2015 semester with positive momentum. We are still abuzz from the wildly successful Blue and White Gala hosted by Columbia Engineering Young Alumni (CEYA) in March and the conclusion of our School's yearlong 150th anniversary celebration, capped last November by a gala at the Cathedral of St. John the Divine. We saw record attendance at both of these events, reflecting the lifelong bonds so many of us share with our School and with each other as Columbia engineers. It is the mission of CEYA and the Columbia Engineering Alumni Association (CEAA) to promote these bonds, and we look to sustain the high levels of interest in the Columbia Engineering alumni community this coming year through our continuing celebrations and networking events.

Dean Mary C. Boyce and faculty representatives have spent time this summer traveling in East Asia and Europe, meeting with Columbians and updating them on the School's progress. The global network of Columbia engineers continues to impress and inspire with commitment to our School. Wherever you are based, we encourage you as Columbia engineers to stay connected through our programmed events and to let us know if you would like to be more involved in CEAA, CEYA, and the Columbia Alumni Association (CAA).

We warmly and enthusiastically welcome the newest members of our Columbia Engineering alumni community, the SEAS class of 2015, and also our future colleagues, the class of 2019, who just arrived at Morningside. We look forward to seeing many of you at our scheduled events this semester as we continue to support Dean Boyce and her vision for Columbia Engineering in the year ahead. Stay tuned through our websites myceaa.org and ceya.engineering.columbia.edu!



Professor Emeritus Rene B. Testa
MS'60, EngScD'63
President
Columbia Engineering Alumni Association



Jessica Aspis
BS'08, '13BUS
President
Columbia Engineering Young Alumni



CLASS NOTES: UNDERGRADUATE ALUMNI

1945

Class Correspondent:
Gloria Reinish
reinish@fdu.edu

1951

Class Correspondent:
Ted Borri
tjb63@columbia.edu

Robert A. Heller MS'53, PhD'58, professor emeritus at Virginia Tech, and coauthor Deborah J. Oakley have completed the manuscript of the fourth edition of *Salvadori's Structure in Architecture: The Building of Buildings*. The book is a tribute to the late Civil Engineering Professor Mario G. Salvadori, author (with Heller) of the earlier editions. The books have enjoyed worldwide popularity and have been translated into 10 languages. The new, updated and expanded edition will be published by Pearson Education Inc. in January 2016.

1953

Class Correspondent:
Don Ross
dross52@optonline.net

John Ragusa writes, "After graduation in 1953, I tried to stay out of the draft and got a job with the Corps of Engineers in New York . . . Unfortunately the army found me, took me out of the Marine Reserve that I had joined, and drafted me, as the Korean War had not "treatyed" out. After Basic, I got sent to Fort Sill, Oklahoma, as my hearing tests apparently aced the Morse Code . . . I graduated as a bona fide radio technician, got sent

CLASS NOTES

to Panama, and spent my Army career in the jungles protecting the Panama Canal and keeping communication gear operative. I married my wife, Edith Edwards, one week after I was released from the Army, and we will be married 60 years in January. I worked for M W Kellogg Co., an engineering/construction company, specializing in designing oil refineries, chemical plants, etc. I then spent 30 years at IBM as a systems engineer and marketing manager . . . Our four children blessed us with 10 beautiful grandchildren. Not all was happiness, as we lost a grandchild in an ATV accident, a handsome boy of 12. I designed and built my house, which we eventually sold. In retirement, I've pursued a genealogy hobby and spent 10 years as a volunteer for the Service Corps of Retired Executives, helping people with their businesses . . . It feels like it was just yesterday at Columbia."

1955

Class Correspondent:
Leo Cirino
lcirino3333@gmail.com

Leo Cirino writes, "Please send me information about yourselves so that I can post what our classmates are doing. I have been active over the past five years starting the Westport Electric Car Club. The club has been well received by my community, and membership continues to grow. Having an engineering background in power and energy helps with understanding the technology of electric car designs. You can see what the club is doing at westportelectriccarclub.com. Please keep us updated."

Philip Bonanno MS'64, '54CC has spent his entire career in the heavy construction industry. He started as a field engineer in 1955 with the Arthur A. Johnson

Corporation, a subway contractor in New York City. In 1964 he became a project manager with the Kiewit Company, and in 1968 joined the J.F. White Contracting Co. in Boston as vice president and general manager. In 1970 he became president and served in that position until 1998. He presently works as a senior consultant and also as an arbitrator for the American Arbitration Association, in addition to serving as a member of the Dispute Review Board Foundation helping review and adjudicate construction issues. He spends summers on Cape Cod and winters in Naples, FL, with his wife of 60 years, Maureen, enjoying time with his family of five children and grandchildren.

1956

Class Correspondent:
Lou Hemmerdinger
LHemmer@aol.com

William Epstein '55CC writes, "My granddaughter, Rebecca Brunsberg, has been accepted by Columbia Engineering and will start at SEAS this fall. She is the seventh member of my family, including myself, to attend Columbia: my son, Eric Epstein '83CC, my brother Ira Epstein, my brother-in-law Jeffrey Rosenstock, my niece Susannah Rosenstock, and my daughter-in-law Michele Shapiro."

1958

Robert Drucker writes, "I was fortunate to escape the last weeks of a rough winter in cruising the Caribbean. The highlight of June was attending my granddaughter Moriah Albert's graduation cum laude from Boston University. Nearby, my grandson **Brian Albert BS'10** (Chemical Engineering), continues his doctorate work at

MIT. On the Columbia University campus, my granddaughter Blythe Drucker is currently participating in an enrichment program at Barnard."

1959

Class Correspondent:
Betsy Altman
bmeca@comcast.net

1960

Bob Nelson MS'61 was recently elected an honorary member of the Arkansas Academy of Civil Engineers. Nelson retired as senior vice president of AFCCO Steel, for whom he worked summers while at Columbia. He had served as chair of the AISC Nuclear Design Specification Committee. Bob has lived in Little Rock, AR, all during and after his professional career. He is still active in local civic and church activities.

1962

Class Correspondent:
Marshal (Mickey) Greenblatt
mg840@columbia.edu

Lynn Conway MS'63 writes, "I so enjoyed attending our Class of '62 50th reunion in 2012. What a trip down memory lane that was! Life's been good since then. My husband, Charlie, and I are especially enjoying enhancing our 23-acre "nature preserve" in rural Michigan, just to the west of Ann Arbor. We've been together for 27 years now! Though retired as professor emerita of EECS at the University of Michigan, I also enjoy hanging out with young students and researchers there. In 2012 I finally wrote a career reminiscence about my research in VLSI microelectronics design during the 1970s. Published in a special issue of the IEEE *Solid-State Circuits Magazine*, it was

the first time I'd felt free to tell the story of how, as the "hidden-hand" behind the scenes at Xerox Palo Alto Research Center and at MIT, I'd created, demonstrated, and widely propagated via the ARPANET the innovations that triggered the VLSI chip design revolution in Silicon Valley in the '80s and '90s. Since 2012, major recognitions have begun coming my way, including election to the Hall of Fellows at the Computer History Museum in 2014 and being awarded the James Clerk Maxwell Medal by the IEEE and the Royal Society of Edinburgh in 2015. This spring I also had the honor of presenting the *Steinmetz Memorial Lecture* at Union College, on the occasion of the 150th anniversary of Charles Proteus Steinmetz's birth. It was a wonderful moment of closure to participate in so honoring Steinmetz, for he's long been an inspiration and powerful role model in my own work."

Andy Levine '61CC and his wife, Toby, have been living full-time in the Berkshires since he retired from Compaq Computer (formerly Digital Equipment, now HP) in 2001. He writes, "We love it here except for winter. So our big news is that we've recently purchased a modest condo in Bonita Springs, on the west coast of Florida, about 20 miles South of Fort Meyers and adjacent to Naples. We predicted many years ago that we'd NEVER spend winters in Florida, so we've rationalized that the purchase is for our Welsh springer spaniel, Rufus, who can now accompany us in our new, dog-friendly community (his 13 years are equivalent to my 74!). Before long, we may even become Florida residents, while remaining snowbirds for the foreseeable future."

1963

Class Correspondents:

Chuck Cole

ccole6250@att.net

Mark Herman

mnh18@columbia.edu

Mark Herman writes, "Ronnie and I have a new granddaughter, who is about 11 months old as I write this. Charley, now 11, loves being an older sister. Our two grandsons in Massachusetts are almost adults. We like being near our son Dan, a veterinarian, and our two granddaughters, in Nashville. Our other son, Ry, a playwright-director-novelist, lives in Edinburgh, Scotland, where his wife is a research professor of astrophysics at the University of Edinburgh. Visiting the two of them is a good excuse for European trips. Nashville is a return to big-city living, after being in a small town in Michigan for 23 years. Nashville's nickname is Music City, not only because it is the country music center of the United States, but because everyone, including us, seems to be in the music business, and not necessarily the country music business. Our own music business is opera and choral translation, and we are still at it. By the time you read this, we will have had a performance of a choral work in England. Also, our book on *Translating for Singing* will be published in England at the end of this year or the beginning of next. I look forward to receiving news from you, about anything you deem interesting: your career, your retirement, your solution to the problems of the world. Everything will either be printed exactly as I receive it, or, if I change it in any way, will be submitted to you for your approval before I send it to the editor of this magazine. Please include your current e-mail

address if you would like your fellow Columbians to contact you."

1964

Class Correspondent:

Tom Magnani

tm421@columbia.edu

1965

Harvey Rubin writes, "Our class celebrated its 50th reunion year this past May . . . It was great to see each other and to be together again, and our induction into the Golden Lions was a special treat. Quite a few of us came up to the podium that Friday evening to recall things we experienced more than 50 years ago . . . Several classmates also expressed an interest in a 55th reunion. Let us all be in shape to attend it. I can volunteer now to help organize it, but let's hear from others of you as the time approaches. We still have nearly five years to prepare . . . My wife, Connie, and I have moved from our home of 36 years in New Jersey to New York City, a plan that has been in motion for around five years . . . Now the boxes are being emptied and discarded, and we are adjusting to our new home, which happens to be in the Columbia neighborhood. Send an e-mail to harveyrubin43@gmail.com if you are coming to town."

1966

50TH REUNION

To take an active role in your Class Reunion activities, please contact Jack Reilly at jr2813@columbia.edu or 212-851-0734.

Harry L. Tuller MS'66,

EngScD'73 writes, "I am celebrating my 40th year as a faculty member in the Department of Materials Science and Engineering

at the Massachusetts Institute of Technology. I still find the work highly stimulating, particularly given the chance to contribute to alternative energy and environmental technologies such as fuel cells, solar-assisted hydrogen production and emission, and health-monitoring sensors. I continue as editor-in-chief of the *Journal of Electroceramics* and take over as president of the International Society of Solid State Ionics. I look forward to our 50th reunion next year."

1968

Howard Landsman was one of 24 recipients of the 2015 Jazz Hero award from the Jazz Journalists Association (JAA), a nonprofit organization of media professionals. This award is presented annually by the JJA to recognize individuals and organizations that have made a noteworthy, positive impact on the jazz scene in their local communities.

1969

Class Correspondent:

Ron Mangione

Ronaldm@archeng.com

1971

45TH REUNION

To take an active role in your Class Reunion activities, please contact Jack Reilly at jr2813@columbia.edu or 212-851-0734.

Alvin Roth, Craig and Susan McCaw Professor of Economics at Stanford, has published a new book, *Who Gets What—and Why: The New Economics of Matchmaking and Market Design* (Houghton Mifflin Harcourt, 2015).

1976

40TH REUNION

To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Bob McDonald has been promoted to professor of marketing at the Rawls College of Business, Texas Tech University.

1978

Class Correspondents:

Larry Chung

lpc34@columbia.edu

Peter Luccarelli

peter.luccarelli@piliplaw.com

1979

Class Correspondent:

Stewart Levy

srlcvy@att.net

1981

35TH REUNION

To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Class Correspondent:

James Reda

jfreda@jfreda.com

1982

Class Correspondent:

Dan Libby

kdl26@columbia.edu

1984

Daniel Smith is working as chief marketing officer at Outsell Corp and was recently accepted into the Eastern Association of Intercollegiate Football Officials.

CLASS NOTES

1986

30TH REUNION

To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

1988

Class Correspondent:

Caryn Frick
carynfrick@gmail.com
David Shofi
dshofi@atmi.com

1989

Class Correspondent:

Shreese Roy
Shre.roy@att.net

1990

Class Correspondent:

Laura Cordani Christopher
zchristophers@gmail.com

1991

25TH REUNION

To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Class Correspondent:

Radhi Majmudar
radhi@majmudar.org

Debra F. Laefer '89CC has brought 3D printing to Ireland by launching the country's first full-service, commercial-level 3D printing hub, U3D. Housed at the University College Dublin, where she teaches in the School of Civil Engineering, U3D offers scan-to-print services, 3D printing classes, and all major 3D printing technologies including metal printing. The endeavor is an outgrowth of her European Research Council (ERC)-funded research that developed mechanisms to auto-convert remote

sensing technology such as laser scanning into water-tight models appropriate for computational modeling. The same solutions were found to be cross-applicable for 3D printed models. The hub is available for both academic collaboration and commercial work and currently boasts a staff of four full-time technicians.

1992

Class Correspondent:

Janneth Ignacio Marcelo
jannethmarcelo@gmail.com

1993

Class Correspondent:

Herbert Kreyszig
Hek7000@gmail.com

1994

Aaron Winger writes, "I'm coming up on a decade in Shanghai. I'm currently a partner and Shanghai representative for Perkins Coie's Shanghai office, where I practice patent law. I help U.S. and Chinese companies develop their international intellectual property strategies and build global patent portfolios. My daughter Carol just turned 10 and has an interest in the sciences and math. Maybe SEAS class of '26?"

1996

20TH REUNION

To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Class Correspondent:

Enrico Marini Fichera
em75@columbia.edu

1997

Jonathan Speier wed last May in Florida with a number of Columbia graduates from the Class of '97 in attendance.

2000

Class Correspondent:

Daisy Chow
daisy@caa.columbia.edu

2001

15TH REUNION

To take an active role in your Class Reunion activities, please contact Beth Manchester at em2702@columbia.edu or 212-854-4472.

Class Correspondent:

Catherine Marcinkevage
marcinkevage@gmail.com

Kevin W. Tung writes, "I have joined Interplay Ventures as a venture partner in Q2 2015. I will be building and investing in IT companies at the firm."

2002

Class Correspondent:

John Morris
jpm53@columbia.edu

2003

Class Correspondent:

Amar Doshi
abd19@columbia.edu

2004

Class Correspondent:

Eric Rhee
eric.rhee@gmail.com

Eric Rhee writes, "It's been a great year for Columbia Engineering entrepreneurs in 2015. The one update I am excited to share is the story of one of the most interesting

businesses I have seen by one of our own, **Nai Nan Ko**. Over the past year, Nai has turned one of his passions into a business. As a licensed pilot, Nai has taken me for a spin on one of his Cirrus SR aircrafts. Now, he has an aircraft rental company called JetKo, based in Massachusetts, that allows pilots, both general and commercial, to experience "low and slow"—the romance of flying. Such a cool business! Best of luck on growing your business, Nai!"

2005

Class Correspondent:

Devang Doshi
devang.doshi@gmail.com

2006

10TH REUNION

To take an active role in your Class Reunion activities, please contact Jack Reilly at jr2813@columbia.edu or 212-851-0734.

Class Correspondent:

Nick Jennings
nfj2003@caa.columbia.edu

Karen Ceberek writes, "I spent nine years working for Schiavone Construction Co. LLC as a field engineer, superintendent, proposal writer, and claims administrator on major heavy civil infrastructure projects, such as NYCDEP City Water Tunnel No. 3, NYCDEP Croton Water Treatment Plant—Offsite Facilities, MTACC Northern Blvd. Crossing, and NYCDEP BT-1 Construction of Shafts 5B and 6B. At night, I completed my MS in civil engineering at the Newark College of Engineering from 2007 until 2012 at NJIT. Greg and I had our baby girl on June 9, 2014, and named her Giovanna Marie. I recently started work with Railroad Construction

Company, Inc., as an estimator. I've attached a recent photo of my daughter."

2007

Class Correspondent:

Tamsin Davies

tamsin.davies@gmail.com

Ryan Weed, a USAF pilot and physicist, is working to develop the world's first antimatter rocket. In a former nuclear fallout shelter a few blocks away from Lawrence Livermore National Laboratory in California, Ryan's company Positron Dynamics is harnessing the incredible energy density of positrons (anti-electrons) to produce a propulsion unit that is 1,000 times more efficient than state-of-the-art ion thrusters; it is an engine that promises to allow spacecraft to travel faster and farther than ever before, making it possible for humans to become a truly interstellar species. Weed is a Wired 2015 Innovation Fellow.

2008

Class Correspondent:

Amy Lin

seas2008.engineeringnews@gmail.com

Mike Karp writes, "My startup spinning out of the first Cornell Tech MBA class recently presented at Columbia's Future of Innovation. We're building the world's first emotion tracking wearable for dogs, which allows pet parents to make decisions that fundamentally improve the life of their dogs. Find us at @dogstarlife or dogstar.life. We are launching a kickstarter."

2010

Class Correspondent:

Heather Lee

meheatherlee@gmail.com

Mario Augustine Avila writes, "Even though I am no longer affiliated with the company, I am happy to write that my former company Hylion won first place and \$25K in the Columbia Venture Competition last April. Hylion is working on creating a new type of auxiliary power unit for tractor-trailers. This win came on the heels of coming in third place in the Rice Business Plan Competition. In Houston, we won \$82K in cash from organizations such as the Department of Energy, Shell Technology Ventures, and the Wells Fargo Cleantech Fund. I am transitioning away from my company but am exploring new opportunities in the California area."

2011

5TH REUNION

To take an active role in your Class Reunion activities, please contact Beth Manchester at em2702@columbia.edu or 212-854-4472.

Class Correspondent:

Justin Merced

jmm2238@columbia.edu

Catherine Fowles is currently completing her MFA in creative producing at the Royal Central School of Speech and Drama in London after a successful career off-Broadway as a general manager, stage manager, and actress, which led her to theatrical producing. In London, she cofounded a company called Backstage Forward (www.backstageforward.co.uk), which focuses on the artistic integrity of backstage work and champions theatre stage managers, technicians, and designers. The company aims to produce its inaugural production in Fall 2015. She specializes in site-specific theatre, both in producing and stage managing

with various companies, and is accompanying Royal Central to Prague Quadrennial 2015 as part of the educational component, SpaceLab. Harkening back to her roots, Catherine will also be producing a new science production (currently in development) that focuses on the performative elements of the laws of physics for Science in the Spotlight, part of Edinburgh International Science Festival in 2016.

Matthew Hayto writes, "I'd love to share the progress that we've made with Taproot+ since its launch in October. Taproot+ is a matchmaking service for nonprofits and professionals in various industries who want to give their skills pro bono and is linked to the Taproot Foundation, which has been facilitating pro bono since 2001. We launched in October 2014 and have since received 800 nonprofit projects, have a pool of 4,000 professionals who want to volunteer, and have directly facilitated almost \$1.5 million in pro bono service. I joined the Taproot Foundation in 2014 and am head of product for Taproot+. I encourage SEAS alumni to check out taprootplus.org to volunteer for a short project (or post one, if you're with a registered U.S. nonprofit)."

Michael Weng was wed this summer on July 4 to Alison Hard '12CC, '16TC in Groton, CT. He writes, "We got married on the day of the first hurricane of the East Coast season but are convinced it was good luck, as we were surrounded by wonderful friends and family. After honeymooning in France, we moved back to New York City and are now living on the Upper West Side. Ali started a master's program at Teachers College in Nutrition, Public Health, and Public Policy, and I continue to work for Adobe Systems. We're excited to reconnect with the

Columbia community here in New York!"

2012

Class Correspondents:

Rebecca Frauzem

rfrauzem@sbcglobal.net

Hannah Cui

hannah.cui@gmail.com

David C. Mills Jr. writes, "On June 9, I started a new job as a purchasing manager with Great Performances, a catering company that was rated by Zagat to be the number one in the city. Also, the one-year anniversary of my marriage was June 21. Quite a big month!"

2013

Class Correspondent:

Mary Byers

mbyers2202@gmail.com

2014

Class Correspondent:

Victoria Nneji

vcn2101@columbia.edu

2015

This summer, **Anthony Gong** is living in Massachusetts, applying to jobs, watching the Cavaliers-Warriors NBA series, and playing basketball.

SAVE THE DATE!

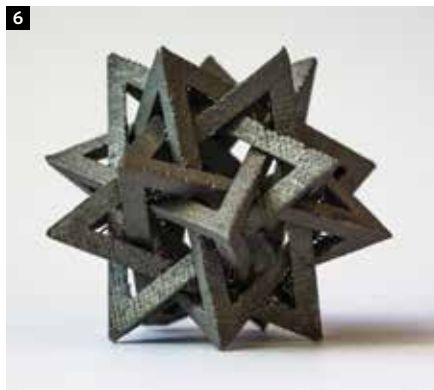
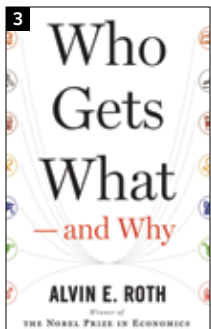
REUNION:

June 2-5, 2016

DEAN'S DAY:

June 4, 2016

CLASS NOTES



Alumni Host SEAS Students at WTC Transport Hub

Civil engineering alumni and former classmates **Lee-En Chung BS'88** of Ivy Ventures and **Doug Taylor BS'88** of Otis Elevator Company hosted six civil engineering students for a jobsite tour of the World Trade Center Transportation Hub in April. The site, featuring an “Oculus” design with a distinctive wing-like appearance, is larger than Grand Central Terminal and will be a key portal for lower Manhattan when complete. The visit allowed the students to appreciate the importance and complexity of elevator/escalator design and construction as it relates to the project as a whole.

Both Chung and Taylor have been in the construction industry for more than 25 years. Chung, former president of Columbia Alumni in Sarasota (2008–2014), has been mentoring civil engineering students—four graduated in May—and wanted the students to witness a landmark construction site. Taylor, manager at UTC Building & Industrial Systems, parent company of Otis Elevator, agreed: “I fondly remember visiting a construction site during my senior year, and it was a great learning experience. I hope that other SEAS alumni make the time and effort to organize similar tours for our students.”

Hao Pham BS'15, a civil engineering major, headed up the ASCE student chapter at Columbia and said, “The WTC Hub site visit was an amazing experience. Rarely do we get to see the construction of a multibillion-dollar project, so we were very excited and learned a lot from the visit. Big thanks to Ms. Lee-En Chung, Mr. Douglas Taylor, and Otis for making this visit possible.”

[1] Robert A. Heller BS'51, MS'53, PhD'58 completed the manuscript of the fourth edition of *Salvadori's Structure in Architecture: The Building of Buildings*. **[2] Lynn Conway BS'62, MS'63**. **[3] Alvin Roth BS'71** has published a new book, *Who Gets What—and Why: The New Economics of Matchmaking and Market Design*. **[4] Daniel Smith BS'84**. **[5]** Alumni Host SEAS Students at WTC Transport Hub (see sidebar, right). **[6]** 3D printed star in stainless steel. **Debra F. Laefer '89CC, BS'91** launched Ireland's first full-service, commercial-level 3D printing hub, U3D. **[7] Jonathan Speier BS'97** wed last May in Florida with a number of Columbia graduates from the Class of '97 in attendance. *Pictured from left to right: Allegra Blackburn-Dwyer '00BC, John O'Neill '97CC, Amir Arison '00CC, Felice Belle BS'97, Daniel Evans '97CC, Maya Arison Speier '01BUS, Jonathan Speier BS'97, Andre Avzaradel BS'97, Carter Turrell Celente '97CC, Cristina Rumbaitis del Rio '97CC, Kristian Concepcion BS'97, Anna Remet King '99CC.* **[8] Kevin W. Tung BS'01**. **[9] Nai Nan Ko BS'04** now has an aircraft rental company called JetKo. **[10] Karen Ceberek BS'06** had her baby girl, Giovanna Marie, on June 9, 2014. **[11] Catherine Fowles BS'11**. **[12] Michael Weng's BS'11** wedding: (*back row, left to right*) Ivy Fortmeyer '11CC, Samuel Beck '11CC, Louise Beck (née Stewart) '11CC, Kate Offerdahl '14CC, MIA '15, Brianna Morgan '12CC, Alex Lew '12CC, **Nate Levick BS'12**. (*second to last row, left to right*): Ayo Alston-Moore '11CC, Markrete Krikorian '11CC (hidden), Paul Lerner '11CC, Jenna Lauter '13BC. (*next row down, left to right—starting in the center*): Zoe Lubitz '11CC, Kelly Sinn '11BC, **Eugene Yao BS'11**, Molly Conley '10CC (*front row, left to right*): Aviva Hamavid '13BC, Katie Hamm '12CC, '16JD, Alyss Vavricka '12BC, Ali Hard '12CC, '16TC, **Michael Weng BS'11**, Nikki Lugo BS'12, Melissa Bermudez '12CC, **Carolyn Bykowski BS'11** (née **Popplewell**)).

PROGRAM NOTES: GRADUATE ALUMNI

APPLIED PHYSICS AND APPLIED MATHEMATICS

Yitao Chen MS'15 writes, "I will soon be a PhD student at Johns Hopkins University, majoring in mechanical engineering in the Whiting School of Engineering. My future academic and research adviser is an energetic young assistant professor. I am sure that he is an excellent researcher, and I feel very glad to have the chance to work with him. Looking back to my PhD application, it was unforgettable. I can be contacted via e-mail at ychen256@jhu.edu."

Bahram Jalali MS'86, MPhil'87, PhD'89 received the Achievement Medal from the Institution of Engineering and Technology in the UK for his "Pioneering Contributions to Silicon Photonics and High Throughput Instrumentation and Their Application to Cancer Detection." Bahram is the Northrop-Grumman Endowed Chair in Optoelectronics and Professor of Electrical Engineering at UCLA, with joint appointments in the Biomedical Engineering Department and in the UCLA David Geffen School of Medicine, and a member of Columbia Engineering's Board of Visitors. He is a Fellow of IEEE, the Optical Society of America (OSA), the American Physical Society (APS), and SPIE. He is the recipient of the R. W. Wood Prize from the Optical Society of America for the invention and demonstration of the first silicon laser, the Aron Kressel Award from the IEEE Photonics Society, and the Distinguished Engineering Achievement Award from the Engineers Council.

CHEMICAL ENGINEERING

Yue Kuo MS'78, EngScD'80 has received the prestigious Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology from the Electrochemical Society (ECS) for his groundbreaking interdisciplinary research in nano and microelectronics, particularly in the complicated relationship among device performance, material properties, and fabrication processes. The Gordon E. Moore Medal was named after the Intel cofounder who is famous for developing "Moore's Law," the discovery that the number of transistors on a silicon chip would double every 18 months. Yue currently holds the Dow Professorship at Texas A&M University School of Chemical Engineering. He has established the Thin Film Nano & Microelectronics Research Laboratory dedicated to solid-state research and education. Among his many honors, Yue has also been awarded ECS's Electronics and Photonics Division Award and the ECS Fellowship Award. He has authored many papers and edited many journals, including the *Journal of the Electrochemical Society* from 2003 to 2012.

CIVIL ENGINEERING AND ENGINEERING MECHANICS

Amy Moselhi MS'06 writes, "Since graduating, I have worked on heavy civil construction projects in New York City. At Tully Construction, I managed a portfolio in excess of \$100 million as the project manager of the East Side River Parks Project and many more. After eight years at Tully I moved to United Structure Solution Inc. as their chief executive officer in March, a very exciting opportunity to lead a minority MWBE/DBE firm that specializes in high-end architectural and ornamental iron work. In June, we became members of

PWC (Professional Women in Construction). We are a full-service Union Contractor with a 13,000-square-foot fabrication shop in East Williamsburg, and our Labor force has been widely recognized on many public projects for exceptional workmanship and attention to detail. We are thrilled to have been involved in the Transportation HUB, Croton Water Treatment Plant, 63rd street subway, 7 line, and much more. We take great pride in our work and are committed to helping young, tenacious engineers prosper. Recently we hired a wonderful new 2015 Columbia University grad. Over the years, I have taught individual lectures about construction management and engineering and spoken about women and minorities in construction at campus events. I am always eager to motivate young minds at Columbia and remain open to helping any of those who contact me through LinkedIn. Many students have visited our ongoing projects, too, to get a better handle on what a contractor's role is. I look forward to bidding on work on campus and using my professional achievement and association with United Structure Solution to help with construction on campus, too! Please visit www.unitedstructuresolution.com, where I proudly have Columbia Alumni Association listed in our affiliations!

Matthew Scanlon MS'13 writes, "I'm pleased to report that I passed the Civil Engineering PE exam this spring to become a licensed civil/structural engineer. Having already obtained architectural licensure several years ago, I am now one of a very few nationally that can legally practice both architecture and engineering. I credit the excellent instruction in the Civil Engineering Department, particularly Professor Meyer, as

well as Professors Smyth, Ratay, Tirollo, and others who provided the academic foundation for my exam success. With licensure in hand, I am now enjoying additional promotion opportunities here with the U.S. Army Corps of Engineers in Norfolk, VA."

COMPUTER SCIENCE

Dragomir Radev MS'96, MPhil'97, PhD'99, a visiting professor at Columbia and a University of Michigan computer science professor, serves as program chair for the North American Computational Linguistics Olympiad (NACLO), an annual competition to identify high school and middle school students with linguistic talent while acquainting them with the field of computational linguistics. NACLO is filled with puzzles and concepts seemingly unrelated to language or computational linguistics. The whole point is to expose the fun, challenging aspects of language to students before they graduate high school and encourage them to pursue computational linguistics at the university level. Radev is one of the cofounders of NACLO and head coach for the U.S. national teams. He is a recipient of the Linguistics, Language and the Public Award from the Linguistic Society of America.

Darshana Umakanth MS '14 writes, "I've been working at Hulu in Santa Monica, CA, for over a year now as a software developer. I work on the Content Platform team, which is primarily responsible for ingesting and transcoding all the content that needs to go on the site. I work with really cool cutting-edge, front-end technologies like React.js by Facebook and back-end tech such as Python. Santa Monica has been great so far; I'm soaking up the sun and learning to love the L.A. lifestyle! Fun fact:

PROGRAM NOTES

I work with a fellow Lion (**Hang Qian**) who graduated with me from Columbia last year with the same degree (MS in CS). However, we didn't know each other until we started working together!"

Seamus Carroll BS'82 writes, "My wife, **Marie Wieck MS'83**, was recently inducted into the Women in Technology Hall of Fame for her more than 30 years in a variety of technical and executive roles in IBM's hardware, software, and services divisions. In January she was named general manager of Middleware, overseeing digital platform software for today's emerging enterprise workloads."

Fengwei Zhang MS'10 has joined Wayne State University as a tenure-track assistant professor in the Department of Computer Science this fall. More information about Fengwei can be found on her home page, fengwei.me.

Howard Zhu MS'02 is now an executive director at MSCI's Hong Kong office, where his responsibilities include expanding MSCI's Analytics business across Asia and the Pacific region.

EARTH AND ENVIRONMENTAL ENGINEERING

Shahnoza Boboeva MS'15 writes, "I am from Tajikistan, Central Asia, and concentrated in sustainable energy. During my studies, I did my masters thesis on the "Current State of Waste Management in Tajikistan and Potential for a Waste-to-Energy Plant in Khujand City." Through my research I have analyzed existing energy sources and current state of waste management in Khujand and the potential of the plant for energy and material recovery from solid wastes using background research on renewable energy and waste-to-energy theory.

Also, I produced a step-by-step research plan for a yearlong thesis research project on energy sources in Tajikistan. I would like to thank my adviser Professor Nickolas J. Themelis for his guidance, advice, and his support throughout my life in Columbia University and during the research process of this thesis. I feel honored to have been able to know him and to work closely with him. I really enjoyed my program, and it was a great experience for me. I met many friends and amazing professors during my studies, learned new technologies and skills in energy, and graduated my program successfully. My parents are very proud of me. I am very glad for the amazing opportunity to pursue my MS degree at an amazing Ivy League University. Currently, I am exploring opportunities in the environmental and energy areas."

Vikas V. Gupta MS'94, EngScD'97 writes, "I head the hedge fund/equities arm of a leading asset management firm from India. We were ranked as the top-performing hedge fund (out of more than 11,000 hedge funds worldwide) in long-bias equities across the world for 2014 by Prequin, the top rating agency for hedge fund intelligence."

Alan Shapiro MS'14 writes, "Since graduating, I moved to Vancouver, Canada, and accepted a job with PGL Environmental Consultants. In the past year, I have been involved in conducting environmental impact assessments for proposed pipeline and mining projects as well as contaminated site investigations across western Canada. I continue my involvement in science communication and water policy research."

ELECTRICAL ENGINEERING

John Arroyo MS'06 writes, "My software company, Arroyo Labs (arroyolabs.com), turns three this summer. We are moving into a new office space and getting more recognition in the enterprise, eCommerce, and startup communities."

Neraj Bobra MS'15 relocated to San Francisco to work as an algorithm engineer at a wearable device startup called Misfit Wearables, where he works on algorithm and firmware development.

Jian Chen MS'11 is currently pursuing a PhD in engineering at Jesus College, University of Cambridge, UK. He recently married Shruti Bhutada, a 2010 graduate of Columbia Teachers College. The couple wed in Cambridge.

Daniel Clark MS'14 writes, "Since graduating in February of 2014, I have been living and working in New York City. I am a research engineer at the Child Mind Institute and have been primarily developing software to process and analyze neuro-imaging datasets. I've also been researching techniques in signal processing, machine learning, cloud computing, statistical analysis, and algorithm optimization to enhance our understanding of the functional connectivity of the human brain."

William M. Klages MS'48 will be inducted into the Rensselaer Polytechnic Institute Alumni Hall of Fame on November 2, 2015. He is an award-winning lighting designer who has been associated with some of the most honored productions in television history. His career started in theatrical lighting with NBC, and ultimately he lighted landmark shows of early TV starring legendary actors Milton Berle, Sid Caesar, and Perry Como. He lighted many acclaimed

entertainment specials for such entertainers as Barbra Streisand, Bob Hope, and Liza Minnelli, and awards shows including the *Emmy Awards* and the *Grammy Awards*. With more than 300 lighting credits to his name, he has won seven Primetime Emmy Awards and received 23 Emmy nods. In 2012, he was the first lighting designer and only the third designer overall to be inducted into the Academy of Television Arts & Sciences Hall of Fame.

Thomas Joseph Re MS'95 completed his radiology residency at the University of Milan in July 2014 and is now finishing a research fellowship in pediatric neuroradiology at Boston Children's Hospital of Harvard Medical School. His interests include technology applications in medicine.

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

Ritvik Singh MS'04 writes, "After working in finance as a derivatives trader for the last 10 years, I recently started PsyInnovations, a digital mental health startup based in New York. My cofounders are also Columbia alums: Navya Singh (MA'08, Teachers College) and **Stan Miroshnikov MS'04** (Computer Science). PsyInnovations is bringing evidence-based therapy to anyone with a smart phone, overcoming the barriers of stigma, access, and cost. We are currently in beta version for our first app, wayForward, which helps users overcome anxiety."

Yan Zhang MS'08 writes, "I moved back to Sydney, Australia, after graduation in May 2008 and am currently working as a derivatives analyst in Perennial Investment Partners. Our fund, Perennial Value Wealth Defender Australian Share Trust, recently won the 2015 retirement product innovation award by Money

Management, and also has recently been listed on the Australian Stock Exchange (ticker: WDE)."

Hanxiao Zheng MS'15 writes, "As a Columbia Engineering student, I am obsessed with everything here in the Mudd building and every moment in the past one and a half years. With passion and contribution, I finally made it through the academic path and end with my dream diploma. Now I am an Accenture senior analyst and ready to start my career. I would love to bring my value back to the school and help more students like me."

MECHANICAL ENGINEERING

Ryan Cooper MS'10, MPhil'12, PhD'14 writes, "After I got my PhD I moved to East Tennessee to work as a postdoctoral research assistant in the Material Science and Technology Division at Oak Ridge National Laboratory (ORNL). The laboratory is a federally owned facility managed by UT-Batelle. Originally, the lab was built as part of the Manhattan Project. The material science program has since grown into a multitude of projects that build on the Department of Energy initiatives for energy, environmental, and security issues. My research involves funding from the Department of Energy and collaborations with Cummins Inc., Fiat Chrysler Automotive, Nemak, and GE. I have been combining experimental and numerical work investigating ceramics and metals to reduce emissions and increase efficiency of automobiles and coal power plants. I am also the Professional Development Chair of the Oak Ridge Postdoc Association. This position has involved preparing postdocs and other young professionals for scientific careers with workshops and seminars, and I organized the first ORNL postdoc career fair in over five years. We hosted other



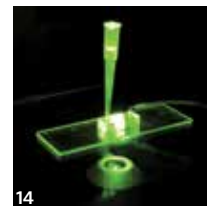
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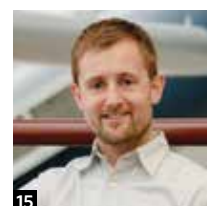
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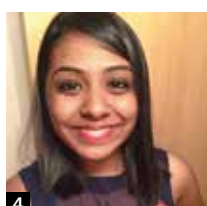
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APPLIED PHYSICS AND APPLIED MATHEMATICS:

[1] Bahram Jalali MS'86, MPhil'87, PhD'89

CHEMICAL ENGINEERING:

[2] Yue Kuo MS'78, EngScD'80

CIVIL ENGINEERING AND ENGINEERING MECHANICS:

[3] Amy Moselhi MS'06

COMPUTER SCIENCE:

[4] Darshana Umakanth MS '14; [5] Marie Wieck MS'83; [6] Howard Zhu MS'02

EARTH AND ENVIRONMENTAL ENGINEERING:

[7] Shahnoza Boboeva MS'15

ELECTRICAL ENGINEERING:

[8] Jian Chen MS'11 recently married Shruati Bhutada '10TC; **[9] Daniel Clark MS'14; [10] William M. Klages MS'48; [11] Thomas Joseph Re MS'95**

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH:

[12] Yan Zhang MS'08; [13] Hanxiao Zheng MS'15

MECHANICAL ENGINEERING:

[14] Anurag Mathur MS'07, MPhil'11, PhD'12 is part of a team of UC Berkeley bioengineers who developed the first human "heart-on-a-chip." The system could one day replace animal models for drug safety screening.
[15] Ryan Cooper MS'10, MPhil'12, PhD'14

PROGRAM NOTES

national laboratories, industries, and universities with over 160 job seekers. It has been a fantastic experience to work with a number of talented scientists across national laboratories and industries creating lasting impacts in energy use and emission reduction."

Anurag Mathur MS'07, MPhil'11, PhD'12, currently working as a California Institute for Regenerative Medicine (CIRM) Fellow in the Department of Bioengineering at UC Berkeley, has developed the first human "heart-on-a-chip," which can be used for drug screening and disease modeling applications. Anurag was supervised by SEAS Professors James Hone and Michael Sheetz as a PhD student, and the "heart-on-a-chip" breakthrough was published in March in the journal *Scientific Reports*.

Wilbur Shapiro MS'59 writes, "After an engineering career spanning some 54 years, I retired in 2005 at the age of 75. Since then, I have written several fiction books. My latest book is called *Oil-Free*. The book details an engineer's struggle to develop an oil-free piston engine. The book should be of interest to engineering students, and it is available on Amazon. Columbia has a distinguished history in the field of tribology (friction and wear, bearings and seals) with eminent Professors Harold Elrod, Vittorio Castelli, and Dudley Fuller. I would love to see Columbia return to that technology."





IN MEMORIAM

Joseph F. Traub, Computer Science Department Founder and Longtime SEAS Professor

Joseph F. Traub, 83, a pioneering computer scientist and founder of Columbia's Computer Science Department, died on August 24, in Santa Fe, New Mexico. Traub was among the first to fully grasp the potential of computers and spent his career exploring new algorithmic methods while building and strengthening institutions that promoted computer science.

Traub, Edwin Howard Armstrong Professor of Computer Science, was most known for his work on optimal algorithms and computational complexity of continuous problems. In collaboration with Henryk Woźniakowski, now professor emeritus of computer science, Traub created the field of information-based complexity, where the goal is to understand the cost of solving problems when information is partial, contaminated, or priced. Understanding the role of information about a problem was a unifying theme of Traub's research.

He contributed many significant new algorithms—including the Jenkins-Traub algorithm for polynomial zeros, the Kung-Traub algorithm for comparing the expansion of an algebraic function, and the Shaw-Traub algorithm to increase computational speed—and wrote or edited 10 monographs and 120 papers in the fields of computer science, mathematics, physics, computational finance, and quantum computing.

Dean Mary C. Boyce said, "Joe's contributions to Columbia's Computer Science Department have been instrumental in establishing the strong foundation of excellence of our Computer Science Department today, enabling our ongoing frontier leadership in this field. He will be sorely missed by all of us at Columbia and by the computer science community across the globe."

Traub attended Bronx High School of Science and City College of New York before entering Columbia University in 1954, where he earned his PhD in 1959 under the Committee of Applied Mathematics at Columbia. After graduation, Traub joined Bell Labs, where he began his work on computational complexity. In 1971, he was appointed chair of the Computer Science Department at Carnegie Mellon University; under his direction, the department grew from fewer than 10 faculty members to 50 to become one of the top computer science departments in the country. In 1979, at the invitation of Engineering Dean Peter Likens, Traub returned to his alma mater to become founding chair of Columbia's Computer Science Department.

Because of his reputation and contacts, he was able to raise funds for the new department and attract top faculty and students. Within a year, the department was awarding BS, MS, and PhD degrees. Traub chaired the department for 10 years, and, in 1982, he oversaw the construction of the Computer Science Building.

In 1985, he became the founding editor-in-chief of the *Journal of Complexity*, a position he held at the time of his death. He founded also the Computer Science and Telecommunications Board of the National Academies, serving as chair from 1986 until 1992, and again in 2005 and 2009.

His numerous awards and honors included election to the National Academy of Engineering in 1985, the 1991 Emanuel R. Piore Gold Medal from IEEE, and the 1992 Distinguished Service Award from the Computer Research Association (CRA). He was a fellow of the Association for Computing Machinery (ACM), the American Association for the Advancement of Science (AAAS), the Society for Industrial and Applied Mathematics (SIAM), and the New York Academy of Sciences (NYAS).

In 2012, his 80th birthday was commemorated by a symposium at Davis Auditorium to celebrate his research and contributions to computer science.

At the time of his death, he also was an external professor at the Santa Fe Institute and played a variety of roles over the years, often organizing workshops to bring together those working in science and math. He is survived by his wife, Pamela McCorduck, and two daughters, Claudia Traub-Cooper and Hillary Spector.

IN MEMORIAM

ALUMNI

1961

Devoted alumnus and retired engineering professor **Daniel Dicker EngScD'61**, who taught at Stony Brook University for many years, passed away on April 4, 2015, in Jericho, NY.

Daniel received a BS from City College, ME from New York University, and EngScD from Columbia, all in civil engineering and engineering mechanics. After graduation, he worked in New York City, including a stint at C.L. Bogert and at Praeger-Kavanagh Engineers, where he did structural engineering for the Sprain River Parkway, the Brooklyn-Queens Expressway, and the Cleveland subway.

An expert in boundary value problems of solids and fluids and the aeroelastic analysis of suspension bridges, Daniel joined SUNY-Stony Brook as a professor of engineering and applied mathematics. He received the Norman Medal and the Arthur Wellington Prize from the American Society of Civil Engineers for his analyses of the 1940 collapse of the Tacoma Narrows Bridge and the 1967 collapse of the "Silver Bridge" over the Ohio River.

In 1969, Daniel was elected a fellow of the New York Academy of Sciences. He was a visiting research fellow at Harvard and MIT and visiting professor at Imperial College of Technology in London and the University of the West Indies in Barbados.

At Columbia Engineering, Daniel was a singularly devoted alumnus. Over the years, he was a class agent for the Engineering Fund, a member of the Leadership Gifts Committee, president of the Columbia Engineering Alumni Association, and chair of the CEEA executive committee and the Egleston Medal Selection Committee. In 1994, he received

the Alumni Federation Medal for his service to the University.

He is survived by his wife, Belle, and his children, Stephen and Barbara.

Health care businessman and philanthropist **Stanley Dicker EngScD'61**, a University benefactor and longtime, loyal supporter of Columbia Engineering, passed away peacefully on April 15, 2015, at his home in Kings Point, NY.

Stanley received his BS from Brooklyn Polytechnic and his EngScD from Columbia Engineering, both in mechanical engineering. He began his long, successful career in the health care industry shortly after graduation from Columbia. By the time of his death, Stanley owned and operated two nursing homes, a health homecare business, an adult day care center, and an ambulatory surgical care center.

Stanley credited Columbia with helping launch his career. "When I became a graduate student, I had a family with two young daughters that I needed to support," he said. "SEAS helped me find a position as a research engineer at Columbia, which allowed me to complete my doctoral studies."

His philanthropy combined his interests in engineering and health care. In 1996, he endowed the Stanley Dicker Professorship in Biomedical Engineering at Columbia, held by Van C. Mow, founding chair of the Department of Biomedical Engineering. He later established two scholarships for undergraduates majoring in biomedical engineering in honor of his father and mother, the Jack Dicker Scholarship and the Freda Dicker Scholarship.

Stanley is survived by his wife, Eileen Shapins; daughters Marcia Trupin and Meryl Dicker; stepdaughter, Lisa Lawrence, and her husband, Jon; and four grandchildren.

2005

Edward "Ed" James Alfano BS'05 of Southampton, NJ, died May 25, 2015, after a fatal fall in a rock-climbing accident. He was 31. Ed graduated from high school near the top of his class, then went on to pursue an engineering degree at SEAS, where he majored in chemical engineering. He graduated magna cum laude in 2005.

"Ed was a close friend, and I am deeply saddened by his death," said Edward Leonard, longtime professor of chemical engineering at SEAS. "He was a very broad gauge, thoughtful, energetic, and morally good person."

Shortly after graduating from Columbia, Ed worked as a consultant at the Monitor Group and subsequently at Extera Partners. In 2007, Ed and his brother, Mark, cofounded Lumina Prep, an online educational company. The startup enjoyed some success, including pro bono contributions to several local charities whose mission was to improve the educational prospects of low-income students. Ed soon returned to school, earning both his MS and MBA from MIT in 2013.

He met wife, Waenyod Wongtrangan, in 2008, and they wed on August 4, 2013, in Bangkok. They shared the same adventurous spirit and love for travel. After graduating from MIT, Ed joined McKinsey & Co. as a consultant. While there, he spearheaded an effort to reform internal conflict-of-interest and disclosure policies and practices. He also worked on teams in Texas, the United Kingdom, Indonesia, Thailand, Korea, and elsewhere. In 2015, his efforts were recognized with a promotion to engagement manager. Around this time, Ed and Waenyod began to consider settling down in Bangkok, where they planned to raise a family.

According to his obituary, "His family, his loving wife, and his many friends will miss his ready wit, his forgiving disposition, his fierce loyalty, and his thirst to savor every hour before that eternal silence." Ed is survived by his wife, Waenyod; his parents, Ronald and Marge Alfano; brother and sister Mark Alfano and Shelley Berad; brothers-in-law Pinrath and Makutchai; and Waenyod's parents, Kanok and Chaloeylakana Wongtrangan.

2014

Spencer I. Omuemu BS'14

of New York City, formerly of Blackstone and Framingham, MA, died suddenly on March 1, 2015. He was 23. After graduating in 2014 from SEAS, where he majored in biomedical engineering, Spencer worked at Blackrock Financial in New York City. According to his obituary, Spencer had a passion for the Big Brother/Sister organization, which he held dear to him. He did volunteer work in New Orleans and Argentina, loved to cook, and held a black belt in mixed martial arts. Born in Natick, MA, Spencer was the beloved son of Mercy Morgan and cherished nephew of Kate Morgan. He leaves siblings Stephanie, Sylvester, and Sophia. He also leaves his father, Sylvester Omuemu Sr., and many beloved aunts, uncles, cousins, extended family, and friends.

OTHER DEATHS REPORTED

We also have learned of the passing of the following alumni:

V. Hamilton Baillard BS'25, '23CC
Charles J. Frehner BS'32,
ChE'33, '31CC
Cleveland R. Horne Jr. MS'38
Allan L. Tarr MS'38
William O. Jewett Jr. MS'39
Charles H. Doersam Jr. BS'42,
MS'44, '42CC
Francis A. Brandt BS'43
Dr. Gilbert M. Turner BS'43,
'43CC
Seymour F. Rappoport BS'44,
MS'51
George Sege BS'44, MS'47
Thomas Sege BS'44, MS'48
Warren L. Serenbetz BS'44,
MS'49
I. Meyer Pincus, Esq. BS'45,
'49LAW
August E. Sapega BS'46, MS'51
Barnet R. Adelman BS'47, MS'48
Roger W. A. LeGassie BS'47
'48CC
Victor J. Magistrale BS'47
Irwin R. Schneider, USN MS'47
Fiorino Dipaolo BS'48
Morton H. Dorenfeld BS'48,
MS'50
Varne M. Kimmick BS'48
Leon Lipson BS'48
George H. Snyder BS'48
Bernard J. Yokelson BS'48
Dr. Stanley W. Dziuban MS'49,
PhD'55
Bob Gresl BS'49, MS'54
Howard E. Lustig BS'49, MS'51,
PhD'56
Robert G. McCoy MS'49
William J. Herbert BS'50
Ralph A. Hess BS'50
John Q. McQuillan BS'50
William E. Thomas BS'50, MS'51
Dr. Raphael R. Thelwell BS'51
Dr. James J. Kauzlarich MS'52
Samuel Schalkowsky BS'52
Chichang Hsu BS'53, '52CC
Elliot J. Brebner BS'54, MS'59,
'53CC
Dr. Mitchell Litt BS'54, MS'56,
EngScD'61, '53CC

Robert L. Simis BS'54
John B. Campbell BS'55
Harold Goldwasser MS'55
Dr. Robert B. Ash BS'56, MS'57,
PhD'60, '55CC
Dr. Frank P. Kuhl Jr. BS'57
Bruce Scott BS'57
Richard W. Bossert, PhD
BS'59, '58CC
Frederick G. Simpson BS'59
Dr. Joseph C. Wyman EngScD'59
Shelby T. Brewer BS'60, '59CC
David M. Mandelbaum MS'60
William C. Abbott MS'61
Pablo G. Bechteler MS'63
Thomas H. Becker MS'64,
PhD'68
Joseph P. Napolitano MS'64
Kenneth Brayer MS'65
Kenneth S. C. Fung EngScD'65
Dr. Benjamin F. Logan Jr.
EngScD'65
Thomas L. Dutton BS'67
Dr. Aristides C. Fronistas MS'73
Eugenia M. Flatow MS'75
Terence W. Murphy MS'75
Franco A. Colalillo MS'79
Mark P. Pettigrew MS'79
Alice Christensen MS'83
Dr. Rakesh Bali MS'89,
PhD'95BUS
Andrew Gabriel Merey BS'92
Charles Egidio Bettinelli Jr.
BS'98, '98CC
Sergio Coutinho de Biasi MS'08
Rustam Salari MS'08, '04CC

DONOR SPOTLIGHT

WILLIAM AND HARRIET LEMBECK TO ENDOW MECHANICAL ENGINEERING PROFESSORSHIP



Bill and Harriet Lembeck

In an inspiring act of generosity, William BS'53, '52CC and Harriet Lembeck have made a \$2 million bequest intention to endow the William Lembeck Career Development Chair in Mechanical Engineering. This new professorship will support a tenure-track junior faculty member.

Bill Lembeck, who attended Brooklyn Tech, graduated from the College in 1952 and the Engineering School in 1953 with a degree in mechanical engineering. He remembers being friends with celebrated *New York Times* editor Max Frankel '52CC; TV pioneers Roone Arledge '52CC and Lawrence Grossman '52CC; and engineer Donald Ross BS'53, '52CC. He then completed postgraduate work in aeronautical engineering at Princeton.

While still an undergraduate, Lembeck, who describes himself as “essentially a machine designer,” started a vitamin dropper business with his father. He invented the machines used in his original enterprise, which gradually developed into a thriving glass-decorating business that used equipment of his own design.

At 40, he sold his company and joined New York University Medical Center as a senior research scientist. He taught the fundamentals of mechanics to medical students and worked on the design of prosthetic limbs and hands. Lembeck was addressing a worldwide problem; while there were new possibilities because of the invention of smaller motors and batteries, the field was still nascent. “It is easy to forget how difficult it was at the time,”

Career development professorships, including the Lembeck Professorship, are designed to support young tenure-track faculty members as they establish themselves as leaders in their fields.

he says. “There was really no bioengineering then, and it was difficult to find a school that taught something like that. Our only model was *The Six Million Dollar Man*.”

He even hired a young Gerard Ateshian BS'86, MS'87, PhD'91—now the Andrew Walz Professor of Mechanical Engineering, department chair, and professor of biomedical engineering—as a temporary worker for one summer, encouraging the young engineer to stay on at Columbia. He credits his friendship with Ateshian as a major reason he remains connected to the School.

In 1989, Lembeck left NYU to become director of operations at Hypobaric Systems, from which he retired in 2010. Over the course of his long career, he was awarded four patents for his inventions.

Nowadays, he spends his time consulting and working with his wife, Harriet, who has spent her career as a wine and spirits educator. Mrs. Lembeck leads the renowned New York City-based Wine & Spirits Program and has taught spirits classes since the 1970s. She was wine director of the New School for 15 years, authored two editions of *Grossman's Guide to Wines, Beers, and Spirits*, and has been a judge at wine competitions around the world.

Mr. Lembeck has been a longtime leadership donor to the University, especially to Columbia Engineering. He is a past member of the School's Board of Visitors and a past chair of the Egleston Medal Committee. In addition to their support of the School, the Lembecks contribute to Bryn Mawr College (Harriet's alma mater), the Salk Institute, and the Chamber Music Society of Lincoln Center.

Career development professorships, including the Lembeck Professorship, are designed to support young tenure-track faculty members as they establish themselves as leaders in their fields. The chairs help the School recruit and retain the best and brightest young faculty.

Lembeck believes this objective is the “best way to make a gift.” He says, “The talented people that you recruit make a department stronger.”

By Timothy P. Cross

Change Lives
Change the World



It starts with you.

On October 21, join Columbians around the globe for 24 hours of giving, connecting, and chances to win matching funds for your favorite school or program.

givingday.columbia.edu

[#ColumbiaGivingDay](https://twitter.com/ColumbiaGivingDay)

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Lee Photographers)

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