

INSIDE THIS ISSUE: DISCOVERY AND INNOVATION FROM OUR ENGINEERS, THEN AND NOW

# COLUMBIA | ENGINEERING



**SEAS AT 150**

**THE CELEBRATION  
CONTINUES**



facebook.com/CUSEAS



twitter.com/CUSEAS



youtube.com/ColumbiaSEAS

Dean of the School  
Mary C. Boyce

Executive Director of Communications  
Margaret R. Kelly

Editor: Melanie A. Farmer

Writers: Amy Biemiller, Timothy P. Cross, Janet Haney,  
Dave Meyers, and Elaine Rooney

Design and Art Direction: Columbia Creative

Principal Photography: Jeffrey Schiffman

Secondary Imagery: University Archives, Eileen Barroso

Contributors: Jesse Adams, Jane Nisselson, David Simpson

*Columbia Engineering* is published twice a year by:

Columbia University in the City of New York  
The Fu Foundation School of Engineering and Applied Science  
500 West 120th Street, Room 510, MC 4714  
New York, NY 10027

Comments, suggestions, or address changes may be emailed to  
[engineering.mag@columbia.edu](mailto:engineering.mag@columbia.edu) or sent to our address above.

For the latest news and updates about Columbia Engineering,  
visit [engineering.columbia.edu](http://engineering.columbia.edu).





**W**elcome to the second special issue of *Columbia Engineering* magazine as we continue our celebration of the 150th anniversary of the School's founding.

Over the past year, we have reflected on the pioneering advances that have taken place over our 150-year history. In concert, we have examined with great pride our remarkable present and the even greater promise of the expanding future for engineering at Columbia.

In 1864, the first class of 20 young men began their studies taught by a faculty of three in what has been described as an old broom factory on the south side of 50th Street. Today, in one of the most competitive entries into engineering in the country, Columbia Engineering welcomed 320 first-year students, an entering class that is 44% women and 31% from under-represented groups, with our total undergraduate student body numbering more than 1,500 students from 49 states and 53 countries! (Read about some of this incredible student talent on page 46.) We also now offer a highly selective and sought after suite of Master's degree programs with more than 2,000 MS students, and our research efforts serve to educate and mentor more than 700 PhD students across nine departments. SEAS has become a magnet for attracting exceptional faculty; our faculty now numbers more than 172 and continues to grow. This fall alone we welcomed 13 new professors to further expand our teaching and research, and three lecturers to enhance the engineering education programs for our students.

Our broom factory origins have also transformed into research and education spaces that now encompass two campuses and six buildings: the Mudd Building, Engineering Terrace, Computer Science, Schapiro Center for Engineering and Physical Science Research (CEPSR), and Northwest Corner Building on Morningside, and facilities at the Medical School campus uptown. We continue to expand and to renovate space to meet our needs. Over the next year, we will complete an expansion and renovation of Carleton Lounge, and add 21,000 square feet of research space for interdisciplinary data science. We are expanding and upgrading our nanoscience and engineering facilities and are completing

laboratory renovations within Biomedical Engineering and Electrical Engineering. The amazing collaborative, interdisciplinary research of our faculty and students is extending onto the Manhattanville campus, where engineering faculty will have laboratories in the Zuckerman Mind Brain Behavior Institute housed in the Jerome L. Greene Science Building, scheduled to open in 2016.

Today's students still follow a rigorous curriculum, one that is now fostering creativity and innovation inside and outside the classroom. (See the story on our Senior Design Expo on page 6, watch the video at [engineering.columbia.edu/senior-design-expo](http://engineering.columbia.edu/senior-design-expo) and read about the new Makerspace on page 58.) We are also exploring new ways to utilize our burgeoning online capabilities to enhance on-campus education.

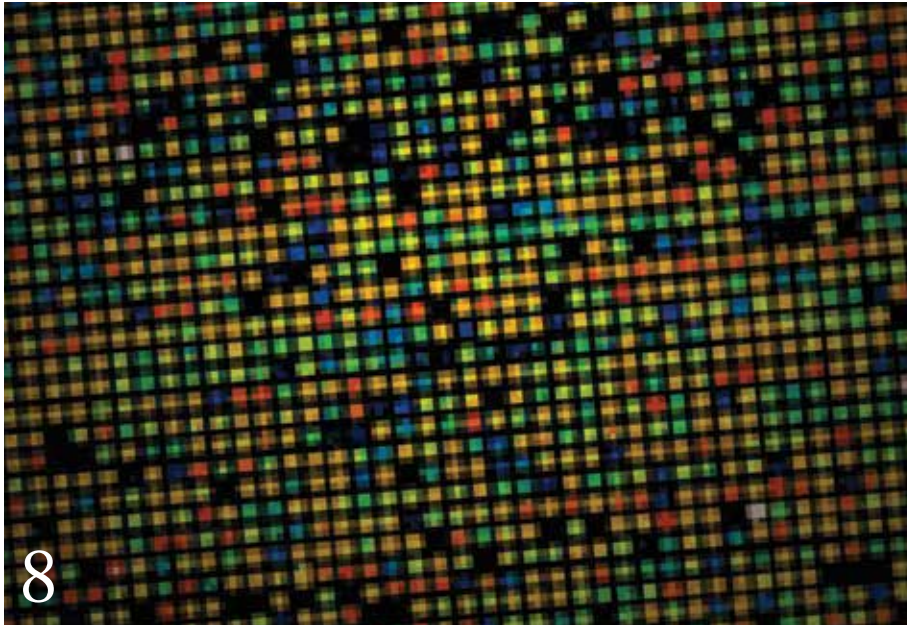
These transformative changes propel us into a future grounded by our past and by our steadfast commitment to our guiding principles: attracting and enabling talent and leadership in our students, faculty, and alumni; fostering creativity, innovation, and translation; and pioneering research efforts that push disciplinary frontiers and that bring novel engineering solutions to the world's grand challenges.

The stories and features in this issue provide snapshots of contributions from our past as well as of the people, places, and programs that represent today's vibrant Fu Foundation School of Engineering and Applied Science community. I hope that you have enjoyed discovering more about your Alma Mater during our 150th, a year where engineering at Columbia and around the world is so widely recognized for its impact!

Wishing you all a Happy 150th!

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

# CONTENTS



## FEATURES

### 8 **DISCOVERY+INNOVATION**

#### THE PAST & THE FUTURE

Learn more about the incredible work Columbia Engineering professors are doing in the areas of communications research, data science, nanoscience, personalized medicine, sensing and imaging, sustainability, and urban infrastructure. We also pay tribute to some of the School's legendary innovators—alumni and professors who brought the world FM radio, the Henry Hudson Bridge, and major advances in tissue engineering.

10 SUNIL AGRAWAL

14 MARIA Q. FENG

18 UPMANU LALL

22 DAN ELLIS

26 HELEN H. LU

30 GIL ZUSSMAN

34 LATHA VENKATARAMAN

38 SAL STOLFO

42 JINGYUE JU

### 4 **SEAS AT 150**

#### THE CELEBRATION CONTINUES

The festivities abound as Columbia Engineering continues its 150th anniversary celebration. The spring kick-off included a beautiful light display on Low Memorial Library, an inaugural Senior Design Day Expo, and *Columbia Engineering at 150*, a historic exhibition at the Rare Book & Manuscript Library. This fall, the School rounds out its sesquicentennial year with a Founders Day Gala and “SEAS 150 Symposium.”

### 46 **MEET THE FUTURE**

#### THE BOLD AND DYNAMIC STUDENTS OF SEAS

Get to know a cross-section of the School's exceptional student body, young engineers who are, right now, making their marks at Columbia Engineering.



46



30



26

---

## NEWS

### 58 **THE MAKERSPACE**

A NEW DIY WORKSPACE FOR INNOVATIVE IDEAS

Makerspace is a new place to collaborate, explore, experiment, and create prototypes.

### 60 **BIG DATA RESEARCH**

INTERDISCIPLINARY COLLABORATIONS

Columbia's Institute for Data Sciences and Engineering announces the recipients of the Moore/Sloan research grants.

### 61 **QUALCOMM FELLOWS**

A TRIFECTA OF FELLOWSHIPS

### 62 **CEOS IN THE MAKING**

A NEW HOME FOR START-UPS  
The new Columbia Startup Lab is home to 43 teams of Columbia entrepreneurs, including 24 seats devoted to SEAS alumni.

---

## CAMPUS

### 64 **COMMENCEMENT '14**

CONGRATULATIONS TO OUR RECENT GRADUATES

During Engineering Class Day, featured speakers highlighted the endless opportunities new graduates face armed with Columbia Engineering degrees.

### 65 **NEW FACES AT SEAS**

WELCOME, NEW FACULTY  
Introducing the School's recent faculty appointments, an impressive crop of professors.

### 70 **A HISTORIC LOOK**

AN ENGINEERING RENAISSANCE AT SEAS  
Historian Robert A. McCaughey takes us through the School's anniversary milestones.

---

## DEPARTMENTS

### 72 **CEAA/CEYA LETTER**

FROM THE ALUMNI ASSOCIATION PRESIDENTS

### 72 **CLASS NOTES**

UNDERGRADUATE ALUMNI

### 80 **PROGRAM NOTES**

GRADUATE ALUMNI

### 83 **IN MEMORIAM**

MORTON B. FRIEDMAN

### 84 **GIVING BACK**

THE FU MEMORIAL SCHOLARS

# THE CELEBRATION CONTINUES SEAS AT 150

1864–2014



Not only is it a milestone year for Columbia Engineering, it is, indeed, a significant moment for engineering overall. As Dean Mary C. Boyce has said through the course of her inaugural year at SEAS, there is an Engineering Renaissance taking place, and the impact could not be more evident and more alive than at the Engineering School.

“We are in an Engineering Renaissance, and the pace of translating technological innovations into real-world impact has never been faster,” Boyce says. “Our faculty and students remain at the forefront of innovation, whether advancing disciplinary frontiers or working to solve society’s grand challenges. Through

their great research, invention, and creativity, they are extending the School’s legacy of excellence and leadership into the next 15 decades.”

The School officially kicked off its sesquicentennial in February with a week of events on campus that included a beautiful light display on Low Memorial Library. In the spring, Senior Design Expo gave the entire Columbia Community a taste of the breadth and depth of student innovation and creativity that goes on in and around Mudd. Typically, each department at the Engineering School hosts its own individual senior design day toward the end of the academic year. But in honor of the 150th anniversary this year, the School

COLUMBIA ENGINEERING  
The Fu Foundation School of Engineering and Applied Science

150  
1864-2014

Special 150th banners were displayed on the front of Low Memorial Library during the School's official anniversary kick-off.

Opposite page, center: Recent graduates Halvard Lange (left) and Charlie Mackenzie-Smith pose with their winning senior design project, a pedal-powered Strandbeest.

## HAVING FUN AT 150 YEARS!

HERE'S A LOOK AT SOME OF THE WAYS THE SCHOOL IS COMMEMORATING ITS SESQUICENTENNIAL

- ✕ [Seas150.columbia.edu](http://Seas150.columbia.edu)—Take a trip down memory lane and share your photos and Columbia Engineering memories on the dedicated 150th anniversary website.
- ✕ Track anniversary updates using [#seas150](https://twitter.com/seas150).
- ✕ Pick up your copy of *A Lever Long Enough: A History of Columbia's School of Engineering and Applied Science Since 1864* (Columbia University Press) by Robert McCaughey, professor of history and Janet H. Robb Chair in the Social Sciences at Barnard College. Save 30 percent when ordering the book from Columbia University Press ([cup.columbia.edu](http://cup.columbia.edu)). Use coupon code SEAS to receive the discount.
- ✕ Trivia Giveaway! Check Facebook and Twitter routinely for a chance to win a SEAS umbrella and a copy of *A Lever Long Enough*.
- ✕ *SEAS in Pictures*—a new photo book illustrating Columbia Engineering through the years, available this fall.
- ✕ View the 150th Anniversary video at [seas150.columbia.edu/multimedia](http://seas150.columbia.edu/multimedia).
- ✕ Learn more about the Senior Design Expo 2014: [engineering.columbia.edu/senior-design-expo](http://engineering.columbia.edu/senior-design-expo).

took the opportunity to more visibly spotlight its students and their senior projects, collectively. The Senior Design Expo for the first time brought together, on the same day and in the same place, all student teams, representing each of the nine Engineering departments.

On May 8, 2014, Boone Arledge Auditorium was packed, as teams of Engineering students demonstrated their 66 innovative projects, ranging from new medical devices with the promise of cutting costs and improving effectiveness, to clever new applications that address a variety of issues, to product solutions for the sports and fitness arenas. One student, Halvard Lange BS'14, proudly showcased his team's design, Strandbeest, which won first place in the design competition for the Mechanical Engineering Department.

Lange and his teammates Ben Aguilar BS'14, Eric Laukkanen BS'14, Charlie Mackenzie-Smith BS'14, and Regina Zmuidzinas BS'14 designed a pedal-powered Strandbeest inspired by the work of Dutch kinetic sculptor Theo Jansen. "It was a purely mechanical project, involving over 1,500 parts, and my team and I had to custom make more than 400 of them," said Lange, who added that the project was a challenge but the experience overall was more than memorable.

"To design, analyze, and manufacture a product of your choice together with four awesome friends was an incredible experience. I am grateful I got to work with such a talented group of people."

It was a special event that brought together not just the Columbia Engineering community but also Columbia College classmates, science and engineering enthusiasts, and local high school students. As Dave Vallancourt, senior lecturer in the Department of Electrical Engineering, said, "The 150th Expo was like binge-watching five-minute documentaries on all things technical, except you actually got to play with real stuff and speak with the designers."

Other exciting projects showcased at the Expo included engineered, replaceable "crumple zone" helmet inserts to reduce concussion rates among football players, a novel microfluidic platform for embryo maintenance to reduce the high failure rate of IVF embryos, and an app that accurately identifies foodborne disease outbreaks in New York City by analyzing data in real time from multiple social media sources.

Columbia University's Rare Book & Manuscript Library prepared a special exhibition, *Columbia Engineering at 150*, featured through September 5, 2014, celebrating the School through a vivid array of photos, documents, and memorabilia drawn from the archives' extensive collection. Curated by Jocelyn K. Wilk, associate University archivist, the installation traced the origins and evolution of what began as the School of Mines from its founding in 1864. Topics explored in depth included the inimitable founding dean Charles Chandler, legendary innovator Michael Idvorsky Pupin, radio pioneer Edwin Howard Armstrong,



Columbia Engineering will round out its sesquicentennial with two marquee events—an academic symposium scheduled for November 14, 2014, and a Founders Day Gala to be held at St. John the Divine on November 15.

the history of Columbia Engineering's facilities and curriculum, and the School's much-missed Camp Columbia.

This fall, Columbia Engineering will round out its sesquicentennial with two marquee events—an academic symposium scheduled for November 14, 2014, and a Founders Day Gala to be held at St. John the Divine on November 15. The 150th Anniversary Closing Symposium will feature faculty speakers who will give brief overviews, TEDx style, on research topics that span the School's history, showing advancements in personalized medicine, sustainability, nanoscience, data science, and more. The entire Columbia community of students, faculty, and alumni are encouraged to attend this celebration of academic achievement. The Gala on the following evening will include an

elegant cocktail reception and dinner and an opportunity for attendees to gather with faculty, administrators, select alumni, and government officials to mark the School's many accomplishments through the years, as well as its bright future ahead.

*Melanie A. Farmer*

*Pictured clockwise, from top left: A book of the School's history. The exhibition included an array of documents, photos, and memorabilia drawn from the University Archives' extensive collection on SEAS. In-depth timelines showcase the School's rich history.*



DISCOVERY +

THE DAY

THE FUTURE

When it comes to research discovery and innovation, Columbia Engineering, for the past 150 years, has remained at the forefront of disciplinary frontiers, defining and pushing the boundaries of new fields, such as nanotechnology, data science, computation-based engineering science, and a myriad of devices capable of sensing, imaging, and visualizing everything from the health of bridges to the health of the human brain.

At the same time, the School's faculty, alumni, and students have successfully tackled many of society's grand challenges, developing solutions to problems across the years: from providing safe drinking water in New York City to creating the first automatic tabulating machines in the 1800s, to mass producing antibiotics and developing the first industrial robots in

the 1900s, to areas as diverse as engineering human tissues, creating the world's smallest FM radio, and designing green infrastructure that can enhance human health and reduce pollution in the 2000s. Through the decades, Columbia Engineering remains a game changer in engineering and the applied sciences.

"We are now in an Engineering Renaissance, and the pace of translating technological advances into real-world impact has never been faster," Dean Mary C. Boyce says. "As you will read in the following pages, our current faculty continues the School's legacy and tradition in excellence in creative research and true engineering innovation."

In this issue of *Columbia Engineering* magazine, we continue to celebrate the School's 150th anniversary and honor its long line of innovative thinkers, tinkers-



# INNOVATION PAST @ FUTURE

ers, and inspired problem solvers. Here, we spotlight a cross-section of professors who, together with their students, are making a significant impact in the areas of personalized medicine, sensing and imaging, urban infrastructure, sustainability, communications, nanoscience, and big data. From Professor Upmanu Lall's grand push to address the global water crisis and Sal Stolfo's persistence in making our cyber world secure to Jingyue Ju's breakthrough work creating technologies to inexpensively decode the human genome and Maria Feng's revolutionary ideas to make smart cities a reality, this Discovery + Innovation feature will illustrate some of the path-breaking research at Columbia Engineering today.

We are pairing these current faculty with profiles of pioneers of the past who, in their own time, pushed

disciplinary boundaries and defined new research frontiers that significantly affected society at large. As history shows, today's Columbia Engineering leaders stand on the shoulders of giants of the past as they continue to create science, engineering, and technological breakthroughs that will influence our next generation of engineering and applied science leaders, and generations to come.

Professor Jingyue Ju's four-color DNA sequencing by synthesis data using four cleavable fluorescent nucleotide reversible terminators on a DNA chip (page 42)

Sidebars by Jesse Adams



Sidebar, top: Ferdinand Freudenstein (University Archives); bottom: A spherical four-bar linkage of the crank-rocker type kept in Freudenstein's laboratory. Four-bar linkages, normally confined to a two dimensional plane, can also be constructed on the curved surface of a sphere. Freudenstein developed synthesis procedures to identify the proportions of such linkages that optimize transmission-angle variations and peak rocker accelerations.

# SUNIL AGRAWAL

## PERSONALIZED MEDICINE

### ROBOTS TO THE RESCUE

Science is often about inspiration. “Aha!” moments can result in ideas that can help solve problems or interpret situations differently. For Sunil Agrawal, professor of mechanical engineering and rehabilitative medicine, the inspiration to design innovative robots and human-machine interfaces that enable people with impairments is close to his heart.

“Having seen my father suffer from Parkinson’s disease in his late years, I have observed, firsthand, the debilitating effects of neurological disorders on gait and motion functions,” he confides. That very personal motivation has led to

pioneering work in robotic exoskeletons and robotic interfaces to help adults and children move more easily or retrain their bodies to regain lost function. The work has resulted in 10 new U.S. patents in the last five years, with an additional dozen currently under review.

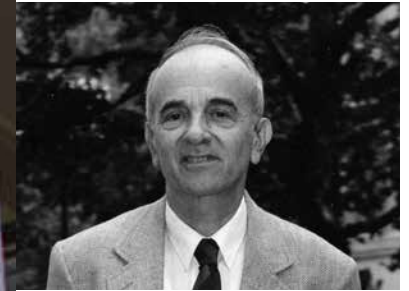
“Robotics can help people who suffer from Parkinson’s or Lou Gehrig’s disease maintain muscle health. For children born with medical conditions such as cerebral palsy, spina bifida, and scoliosis, robotics can help alleviate the effects of these diseases on their lifespan,” says Agrawal, who directs the Robotics and Rehabilitation Laboratory (ROAR) and



ALEX III (Active Leg Exoskeleton, Version 3) is designed to help in retraining of gait of human subjects. The drive motors, along with force and motion sensors within the robot, modulate in real-time the machine applied forces on the human leg so that the motion of the leg is closer to a specified template, shown to the user on a screen.



## BEHIND MODERN KINEMATICS



### FERDINAND FREUDENSTEIN

ALUMNUS AND FORMER FACULTY

Often called the father of modern kinematics, Ferdinand Freudenstein PhD'54 (1926–2006) developed what became known as the Freudenstein equation, which utilizes an algebraic method to determine the positions of output levers in linkage mechanisms. After he received his doctorate degree from Columbia Engineering, the Department of Mechanical Engineering quickly offered him an assistant professorship. After less than four years, he became chair of the department and a full professor shortly thereafter.

By the beginning of the 1960s, Freudenstein's kinematics program was known around the world, attracting top engineers and shaping *[continued on page 12]*



**FERDINAND  
FREUDENSTEIN**

*[continued from page 11]*  
hundreds of students. He was nearly as well known for his teaching as the brilliance of his scholarship, winning the Great Teacher Award in 1965. Freudenstein's work, in analytical kinematics, dynamics of mechanisms, and industrial applications, led to numerous patents and consulting work with many major corporations. He was also appointed an honorary life fellow of the American Society of Mechanical Engineers.

His story began in Germany, from which he fled Nazi persecution in the 1930s. He lived briefly in Wales and Trinidad before securing entry to the United States in 1942. He served in the U.S. Army and studied at New York University, Texas A&M, and Harvard, earning a master's in mechanical engineering. After working for the American Optical Company, he reached the Engineering School—where he would remain for the rest of his career—to pursue doctoral research in kinematics of mechanisms.

A few years after his 1979 induction to the National Academy of Engineering, Freudenstein was named Higgins Professor of Mechanical Engineering at Columbia Engineering, a title he retained until his death in 2006. His legacy lives on at the School, particularly in research and innovation in the fields of robotics, microelectromechanical systems, and biochemical engineering.

**“I have seen stroke survivors learn to walk faster and with a more natural gait after several weeks of training with our robotic exoskeletons.”**



Robotic Systems Engineering Laboratory (ROSE), located at both the Engineering School and Columbia University Medical Center.

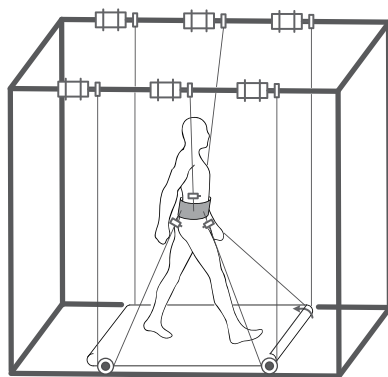
While robotic exoskeletons have previously been the stuff of science fiction, research in Agrawal's lab has helped advance the science to a point where

robotic interfaces and exoskeletons are closer to real-world application. Cleverly designed to conform to the degrees-of-freedom within the skeleton of the human body, these devices are powered by motors that supplement the forces provided by the muscles and interact with the wearer—similar to the brain-controlled suit that helped a paralyzed Brazilian teenager kick a soccer ball at the World Cup opening ceremony.

“Neural disorders caused by stroke and spinal cord injury limit a person's ability to do things we all take for granted: reach and raise our arms, walk, and perform activities of daily living. My research is aimed at helping these people accomplish everyday tasks.”

Perhaps some of the most fulfilling results from Agrawal's research come when he sees how his work in robotics and movement has helped improve people's ability to walk or use their arms again after a stroke or cerebral accident.

“I have seen stroke survivors learn to walk faster and with a more natural gait after several weeks of training with our robotic exoskeletons,” Agrawal says. “We have developed wire-driven arm and leg exoskeletons that can help train limb movements of adults neurally impaired



Motors are mounted on a rigid frame and cables are routed using pulleys to the subject's pelvis. A-TPAD is currently being used to study how subjects lose balance under perturbations during walking. The goal is to develop perturbation training methods to help elders avoid falls.



by stroke. We have also designed robots that help infants and toddlers as young as six months learn to be mobile in their environment. I have seen how this technology changes lives.”

In addition to working on technology that improves patient outcomes, Agrawal receives funding from the National Science Foundation for novel design, trajectory planning, and control of intelligent machines like free-floating robots that can operate in the micro-gravity conditions of space, as well as for cable-actuated robotic platforms.

Agrawal’s robotic exoskeletons for arms, legs, torsos, and neck also help physical therapists provide frequent and intense therapy on patients to help build muscle memory, which can restore functionality.

“Robots can be similar to training wheels on a bicycle. They help the user gain proficiency in function until their support is no longer needed,” he says.

For infants and toddlers, Agrawal and his team have designed and tested novel mobility enhancement robots and control interfaces that have the ability to teach six-month-old infants seated on a mobile robot to purposefully drive using a joystick, and also to maneuver the robot

**Agrawal and his team have developed wire-driven arm and leg exoskeletons that can help train limb movements of adults neurally impaired by stroke. They have also designed robots that help infants and toddlers as young as six months learn to be mobile in their environment.**

in cluttered environments in their home using a force-feedback joystick. “This technology can help a child with limited mobility to interact with others and not be left far behind in achieving childhood milestones,” he explains.

Agrawal joined Columbia Engineering in 2013. Prior to that, he was a professor of mechanical engineering and director of the Mechanical Systems Laboratory and Rehabilitation Robotics Laboratory at the University of Delaware. His PhD advisor at Stanford University was Professor Bernard Roth who was the first PhD student under the guidance of Professor Ferdinand Freudenstein at Columbia University. Agrawal is an active contributor to the Institute of Electrical and Electronics Engineering and the American Society of Mechanical Engineers. He currently serves as chair of the ASME’s Design

Division, which has more than 11,000 active ASME members.

Always on the lookout for novel approaches to solving problems, Agrawal is also targeting a new and growing population who will likely benefit from even more advanced robotic applications: seniors.

“As we age, our musculoskeletal and sensory systems decay, leading to a variety of health issues. This is getting to be a pressing challenge for our rapidly aging society,” he says. “We are currently developing and testing novel exercise and sensory interfaces for the elderly to enhance their balance and prevent fall-related morbidities. Robotic technologies will be a substantial solution to keep our older population healthy and safe.”

*By Amy Biemiller*

## BUILDER OF BRIDGES



### DAVID STEINMAN

ALUMNUS

In late 1936, at the dedication of the Henry Hudson Bridge connecting Manhattan and the Bronx, master bridge builder David B. Steinman (Class of 1911, PhD) had realized a dream that went back to his years at Columbia Engineering. When he was earning his doctorate in civil engineering, his thesis had proposed an elegant steel arch design at that very location. Twenty-five years later, the bridge was built with few changes from his original design, becoming at that time the longest plate girder arch and fixed arch bridge in the world.

Raised and educated in New York City, once working as a newsboy, Steinman (1886–1960) taught at the University of Idaho for a few years after graduating from the Engineering  
*[continued on page 17]*



**T**aking the sometimes-varied temperatures of maturing buildings, bridges, and roads to determine general deterioration and ward off natural disaster damage is a monumental challenge that Maria Q. Feng meets head on.

Feng has been revolutionizing real-time sensory technology and structural health monitoring over the last 20 years in an effort to go beyond traditional visual inspection-based maintenance.

“We need tools more advanced than visual inspection to discover hidden problems,” says Feng, Renwick Professor of Civil Engineering and Engineering Mechanics. “I aim for practical applications of my research to make our aging civil infrastructure healthier and safer.”

Feng adheres to a multilayered approach to stave off any potential civil infrastructure issues. First, she says, a sensor embedded in a structure can detect fatigue and stress in real time. Next, the captured data will help guide engineers toward seeking a cost-effective treatment to prevent a major calamity, while a warning can be issued to prepare people for a potential catastrophe.

“We need analytical methods and computer algorithms to extract meaningful information from the sensor data for diagnostics and prognostics of the struc-

tural health,” she advises. “This is like giving a brain to the structure to process signals from the sensors.”

Feng’s recipe for long-term, real-time monitoring is currently used on three bridges and one office building, all located in Orange County, CA, where sensor data is constantly collected.

“Meanwhile, I have been developing sensor data analytics for remote, real-time structural damage detection and health diagnostics,” Feng reveals. “The results can be used for supporting decisions on post-event emergency response and recovery, as well as intelligent asset management.”

Feng, who also directs Columbia Engineering’s SMarT (Sensing, Monitoring and Robotics Technology) Laboratory, grew up in a big family surrounded by engineers and scientists. She became fascinated with engineering after listening to her beloved oldest uncle describe in great detail how he and other engineers used primitive tools to build the first railroad, now more than 60 years ago, in the steep mountains of southwest China.

“The creativity of engineering inspired me to pursue an engineering career,” Feng observes. “It is the creation of a solution to a problem that inspires my research.”

Even with today’s modern technology, Feng admits there are challenges associated with the wide implementation of sensor technology for civil infrastructure monitoring. She notes that the sensor should be less expensive and easier to implement; advanced data analytics also are required to extract meaningful and

Sidebar, top: Portrait of David Steinman (University Archives); bottom: Mackinac Bridge, designed by David Steinman

Feng has been revolutionizing real-time sensory technology and structural health monitoring over the last 20 years in an effort to go beyond traditional visual inspection-based maintenance.



DISCOVERY+  
INNOVATION

# MARIA Q. FENG

## URBAN INFRASTRUCTURE

SMARTER, HEALTHIER CITIES





reliable information from the sensor data; and end users need a way to adopt the research results into practice.

To that end, Feng is also busy developing vision sensors using low-cost video or digital cameras to measure infrastructure deformities, along with creating the analytics needed to assess any

deformations. Likewise, she's exploring the feasibility of using smartphone sensors to track structural integrity.

Feng's research isn't limited to civil infrastructure; she's also concerned about protecting military personnel from unexpected brain impacts. Her integrated sensing and data fusion technology is

being used to develop a personal airbag protection system to prevent traumatic brain injuries caused by blasts, accidents, and other sources of possible head damage. If a blast event occurs, the wearable airbag is triggered by unique electromagnetic sensors before shock waves strike.

Sponsored by the U.S. Department of Defense's Rapid Innovation Fund, Feng and her team have developed the prototype sensor system to combine intelligent data fusion and a triggering algorithm. They have successfully tested the sensor system with the U.S. Army.

Feng's impressive engineering career isn't without a touch of irony; she confesses to having a fear of heights

**“The creativity of engineering inspired me to pursue an engineering career. It is the creation of a solution to a problem that inspires my research.”**

DAVID STEINMAN

*[continued from page 14]*  
School, before returning east to work on the Hell Gate Bridge between Manhattan and Queens. Developing a reputation for resilient and economical structures, he steadily rose to the top of the profession, building more than 400 bridges on five continents, including the Mackinac Bridge connecting the upper and lower peninsulas of Michigan and, his personal favorite, the St. John's Bridge in Portland, OR. Steinman was also commissioned to remodel the Brooklyn Bridge to accommodate the bustling traffic of the postwar boom.

An expert in airflow and wind velocity with a cautious approach to building aerodynamically stable bridges, Steinman founded the National Society of Professional Engineers in 1934 to uphold excellence in the profession. Particularly after correctly predicting the spectacular collapse of the original Tacoma Narrows Bridge in Washington, he championed the highest standards in engineering construction and education, and upheld them in his own work.

Steinman was also an author of some distinction, becoming a historian and ambassador of his profession in acclaimed works of biography and verse. "A bridge is a poem stretched across a river," he wrote. More than 50 years after his death, Steinman's artful designs and passion for safety continue to inspire the engineers who follow in his footsteps.



but still enjoys going to bridge and building sites to conduct her own field experiments.

"I remember how frightening it was to climb a 1,017-foot-tall TV tower to install my fiber optic sensors to measure the tower's dynamic characteristics," she recalls. "I always say to myself 'this is going to be the last time,' but I forget about that when an opportunity arises to test or use our sensors on an actual building or bridge."

For the future health of city infrastructures everywhere, let's hope "the last time" for Feng stays further down the (well-monitored) road.

*By Janet Haney*



Testing new sensors at the Vincent Thomas Bridge, a 1,500-foot-long suspension bridge in Southern California

## GREENING ENGINEERING



### HERBERT KELLOGG

ALUMNUS AND  
FORMER FACULTY

When the bequest of Henry Krumb (Class of 1898) re-invented the School of Mines (now also known as the Department of Earth and Environmental Engineering) in the late 1950s, the industry and Columbia Engineering's curriculum were nearing the end of an era. In years to come, with evolving understanding of environmental sustainability, the focus would necessarily shift from maximizing extraction techniques to responsibly stewarding natural resources for the long term.

Herbert H. Kellogg BS'41, MS'43 was an early and eminent advocate for systematizing best practices to preserve the environment. A leading expert in minimizing waste and runoffs at mining sites  
*[continued on page 20]*



Sidebar, top: Portrait of Herbert Kellogg (University Archives); bottom: electrowinning refining plant

(Image courtesy of NASA)



# UPMANU LALL

## SUSTAINABILITY

### PROBLEM H<sub>2</sub>O

**I**n the not-so-distant future, even those of us who take for granted that a turn of a tap will produce a flow of water may be faced with the problem one billion people in arid and semiarid regions already experience: no clean drinking water.

While we do live on a water-covered planet, only 3 percent of that water is fresh. That supply is found in glaciers and ice, in rivers and lakes, and below the ground. Groundwater, the source we depend upon for drinking, producing food, and cleaning, is being depleted and polluted, and climate change, the force that governs where and when water is

available, is conspiring to shrink fresh water supply worldwide.

“We are in the middle of a dramatic global water crisis that is silently progressing,” warns Upmanu Lall, the Alan and Carol Silberstein Professor of Earth and Environmental Engineering and director of the Columbia Water Center, a unit of the Earth Institute that Lall helped found in 2008. “While climate change is expected to exacerbate these problems in many places in the world, our current use pathway leads to perhaps the most significant resource sustainability problem that humanity faces today. The recognition of this challenge is still limited, since people

## HERBERT KELLOGG

*[continued from page 18]*

and more efficiently processing a variety of minerals, he helped shepherd the field's transition to its modern form.

After a few years at Penn State, specializing in mineral dressing and rising rapidly to lead their mineral preparation division, Kellogg returned to Columbia in 1946 to join what was then the Department of Mines, Metallurgy, and Mineral Engineering. Concentrating on extractive metallurgy, he became a full professor in 1956 and served as department chair for many years, beginning in 1968. He published extensively on improving extraction techniques, perhaps most prominently in chlorine metallurgy, and was widely renowned for his ability to unite theory with practical industry needs.

In 1978, Kellogg was elected a member of the National Academy of Engineering. He taught at the Engineering School for 44 years, earning the Great Teacher Award in 1982. He was also a highly active member of the American Institute of Mining, Metallurgical, and Petroleum Engineers. After his retirement as the Stanley Thompson Professor Emeritus of Chemical Metallurgy in 1990, Kellogg continued to write passionately about engineers' responsibility for the environment. His imprint remains apparent in the ongoing work of today's Department of Earth and Environmental Engineering.

think about water place by place rather than by what is happening globally.”

To find a fix, Lall is tackling water sustainability on multiple fronts: hydrology, climate dynamics, water resource systems analysis, and risk management. He has spent a career honing his expertise in statistical and numerical modeling of hydrologic and climatic systems, and water resource systems planning and management. The outcome has resulted in pioneering statistical methods and their application to the prediction of hydrologic and climate conditions, and advanced tools for decision analysis and risk management.

How does math and modeling help with sustaining a natural resource like water? Consider Lall's statistical prediction model for river flow in northeast Brazil.

“The wet season there is January through May, and we can forecast the water that will be available in that season in the previous July. Our novel algorithm uses as predictors Atlantic and Pacific Ocean climate conditions that were identified as potential important

determinants of the January–June climate,” Lall explains.

The model's accuracy is comparable to what other models achieved in December, just before the start of the wet season. Having the information six months earlier helps in decision making to allocate water in the regional reservoirs to minimize loss due to evaporation and spillage, provide water or save water in anticipation of the future conditions, and improve the area's economic performance relative to what would be expected in a cycle of severe droughts in the region.

“Nearly four million people, plus farms, industries, and cities are served by the systems in which we put this forecasting and decision-making system in place. In effect, we have created a system for adaptation to a changing climate in one of the most extreme climate regimes in the world,” he says.

Lall, who has a joint appointment in Civil Engineering and Engineering Mechanics, also tackles understanding extreme weather events that impact water supply, such as flooding. By studying



Columbia Water Center's America's Water Initiative has mapped water risk for the U.S.

(Right: Image courtesy of NASA)



“We are in the middle of a dramatic global water crisis that is silently progressing. While climate change is expected to exacerbate these problems in many places in the world, our current use pathway leads to perhaps the most significant resource sustainability problem that humanity faces today.”

the mechanisms of extreme floods and how they can be identified from data and climate models, Lall and his team are working to better predict the risk of floods in the face of the world’s changing climate.

“We have identified that moisture transport from tropical oceans to land is a primary factor in determining extreme floods and are building models to understand the factors that lead to connecting specific moisture sources to specific locations with flood potential,” he says.

This global view is expected to lead to answers about why floods happen at roughly the same times in different parts of the world and how to predict that

impact. This science could help relief organizations to better prepare to meet needs, and businesses and flood-prone countries to better manage supply chains.

Lall’s research has yielded some surprising outcomes. “The big surprise is that improving water use efficiency in agriculture is eminently feasible and could, by itself, solve much of the global water stress,” he says. This would require shifts of crops to better match climate and water availability, precision irrigation technologies that improve productivity while reducing water use, and climate forecasts that lead to better use of reservoir and groundwater storage. Those are all achievable, Lall says. But perhaps the

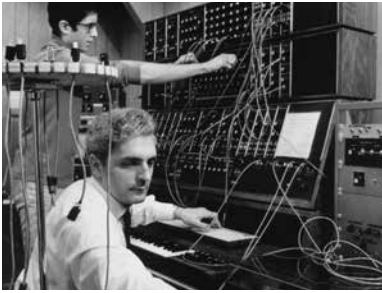
biggest change needed, he says, is one that is contentious for people who take water resources for granted.

“Right now, water is a high-value commodity at a very low price,” he explains. “We need to price water better so there are incentives for everyone to adopt better use practices.”

*By Amy Biemiller*



## ROCK N' ROLL ENGINEER

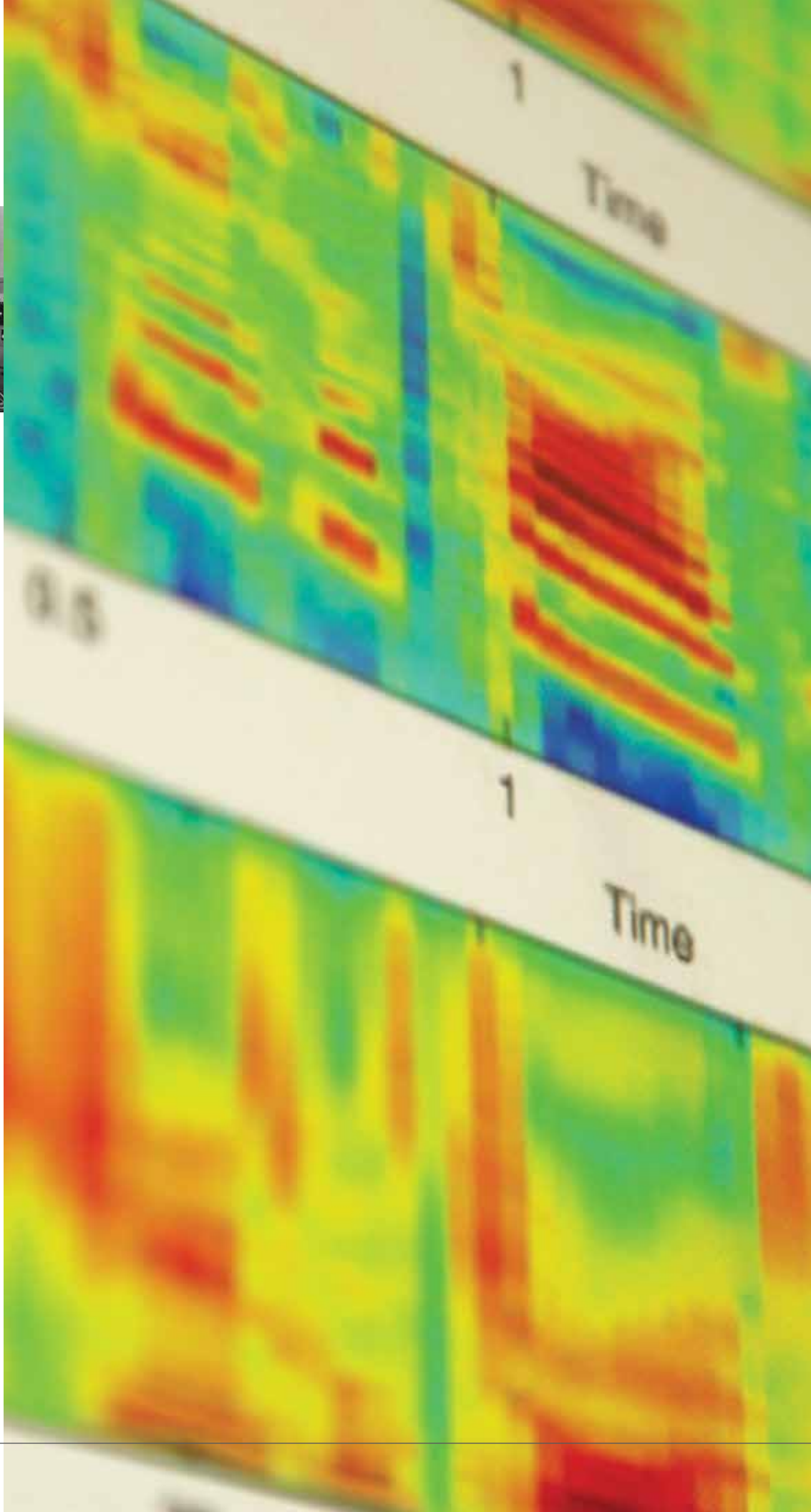


### ROBERT MOOG

ALUMNUS

Before Robert Moog MS'56 (1934–2005) revolutionized electronic music in the 1960s, synthesizers were bulky, expensive, and intimidating machines. Largely dependent on vacuum tubes, early synthesizers required extensive customization to generate different sounds and were used primarily by experts.

A lifelong enthusiast of the Theremin, an early and eerie-toned electronic instrument controlled by using one's hands to manipulate electromagnetic fields around metal rods, Moog (rhymes with “vogue”) developed his own designs while attending the Bronx High School of Science. He was still a teenager, studying physics at Queens College, when he founded his first company to sell his  
*[continued on page 25]*







Log-frequency spectrograms of speech give the computer a view of sound modeled on what we know about the information carried from the ear to the brain. It's also a good domain for manipulating and modifying sounds in ways that make sense to listeners.

Sidebar, top: Robert Moog at work; bottom: Detail of an iconic Moog Synthesizer. (Photos Courtesy of Moog Music Inc.)

# DAN ELLIS

## SENSING & IMAGING

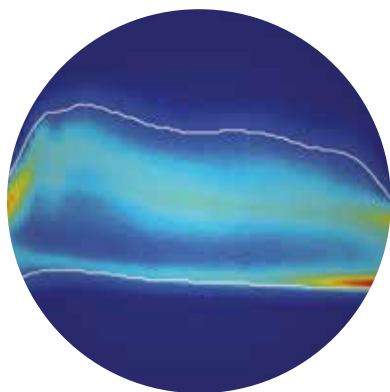
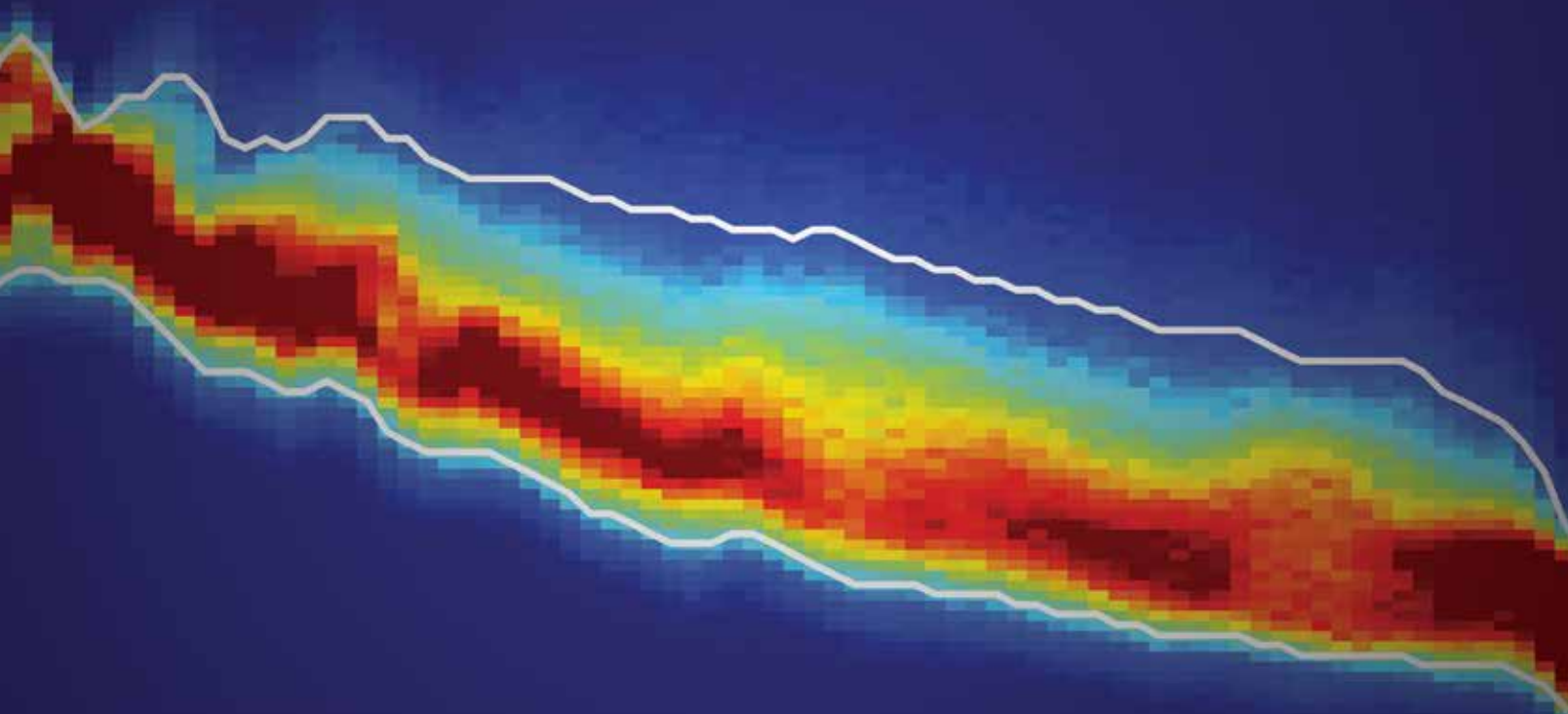
### THE SOUND OF SCIENCE

**G**o shopping with a friend and you will be bombarded by a cacophony of sounds: your shared dialogue, the chatter of other shoppers, the rhythmic hum of in-store music, and even the buzzes and beeps of cell phone alerts. These represent just a handful of acoustic signals your brain automatically processes for you. Is it possible that machines could learn this intuitive process?

That is a question for Dan Ellis, professor of electrical engineering and founder of the Laboratory for Recognition and Organization of Speech and Audio (LabROSA) at Columbia Engineering. As the leader of the nation's only lab to combine research in speech recognition,

music processing, signal separation, and content-based retrieval for sound processing in machines, Ellis is making a lot of noise. His work in soundtrack classification pioneered the idea of using statistical classification of audio data for general classification of videos by their soundtracks. Now he is leading a group of researchers in investigating how to create an intelligent machine listener able to interpret live or recorded sound of any type in terms of the descriptions and abstractions that would make sense to a human listener.

"We've performed work in supporting speech recognition in noisy environments, which has obvious commercial



To visualize the statistics of different sound signals, we can plot “heat maps” of the distribution of different energy levels in each frequency band. Normally recorded speech (top left) shows a single main peak for each band, with a long tail toward higher energy. The white line shows the 95th percentile. Speech carried over a telephone channel, however, can easily be distinguished by a separate “low energy mode” (circular image), resulting from the gating of gaps between utterances.

applications in things like better voice-control systems or searching soundtrack databases for particular utterances,” Ellis says. “But we’re also very interested in other kinds of sounds, which, in general, have been neglected by research in favor of speech.”

Led by Ellis, recent research at LabROSA has included the classification of videos based on soundtracks. Instead of categorizing videos based on speech, this research allows machines to extract information based on sounds present, which is useful in the categorical organization of large collections of consumer-style videos.

“This means we’ll be able to search for unspoken audio similarly to how we search for spoken audio,” Ellis explains. “As society gathers more and more raw media recordings and demands easier, more effective retrieval, I see a lot of potential for commercial applications of such technology.”

With the development of very powerful machine learning techniques like deep neural networks—sets of algorithms in

**“The essence of research is identifying and exploring new ideas that have been overlooked, or coming up with novel and more powerful solutions.”**

machine learning used to model complex abstractions in data—it has become necessary to access significant volumes of data. That is why Ellis and his team at LabROSA are currently developing new techniques to accelerate the process of classifying those data troves.

Motivated by an intrinsic interest in improving our understanding of audio—especially music—and how it varies, Ellis is largely focused on developing a series of new software libraries and annotated data that are expected to make a particularly significant impact on the



## ROBERT MOOG

[continued from page 22]  
advanced Theremins.

At Columbia Engineering, Moog studied electrical engineering and saw the potential of transistors, then still an emerging technology, to transform and popularize electronic music. He graduated shortly before the Columbia-Princeton Electronic Music Center (today known as the Computer Music Center) installed an enormous state-of-the-art RCA Mark II Synthesizer on campus but kept close tabs on his alma mater's progress in the field.

In the early 1960s, Moog worked with composer Herbert Deutsch to develop the first modular voltage-controlled subtractive synthesizer, played via keyboard. He demonstrated prototypes at the October 1964 convention of the Audio Engineering Society, stunning attendees with his instruments' unprecedented portability and ease of use. Within a few short years, Moog synthesizers could be heard in music ranging from The Beatles' *Abbey Road* and Simon & Garfunkel's *Bookends* to Wendy Carlos's '65GSAS best-selling *Switched-On Bach* album, which reimagined Johann Sebastian Bach on Moog's creation.

Working closely with musicians, for whom he considered himself a "toolmaker," Moog never stopped refining his instruments, including the even more accessible Minimoog and a series of influential guitar pedals. Although the popularity of his analog synthesizers dipped in the '80s with the mass emergence of digital alternatives, they are now celebrated and coveted for their classic sound. By the time of his death in 2005, Moog's legend and legacy were stronger than ever.

music audio research community. "We're excited by the prospect of helping people organize and manage their personal music collections, and helping people discover new music based on their listening preferences," Ellis explains.

The origin of Ellis's passion for music and electronics can be traced back to his childhood experiences. "While attending a music-centric school in England, I took lessons in piano, harp, bassoon, and percussion. I also took up electronics as a hobby, and I was particularly fascinated when a friend showed me his electronic synthesizer," Ellis recalls. "I remember it very clearly, and for me, it presented the ideal intersection between the musical sounds that I loved and electronics technology."

Although music and engineering may seem like an odd pairing, for Ellis, they share more in common than what meets the eye—or ear.

"I think the whole notion of technical research as being independent from the kind of creative exploration we expect

from artists is a serious mistake," he asserts. "The essence of research is identifying and exploring new ideas that have been overlooked, or coming up with novel and more powerful solutions." To do that, Ellis applies an interdisciplinary focus.

"Before coming to Columbia, I hadn't considered the value of departments beyond engineering," he admits. "But I find myself regularly collaborating with colleagues from Columbia's Sound Arts program and with researchers in the College of Physicians and Surgeons. Plus, being in New York has afforded me opportunities to interact with organizations like Google and Spotify. Together, we are contributing to the city's positioning as a mecca for new sound-processing technology."

By Dave Meyers

## TISSUE ENGINEERING PIONEER



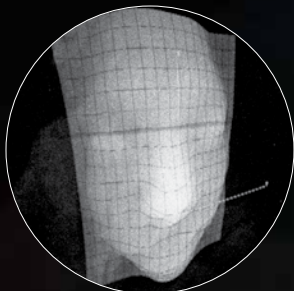
### RICHARD SKALAK

ALUMNUS AND  
FORMER FACULTY

Richard Skalak BS'43, MS'46, PhD'54 (1923–1997) was already a distinguished professor of civil engineering and engineering mechanics, specializing in fluids and oil extraction, before turning his formidable attention to bio-engineering in the late 1960s.

In a groundbreaking series of studies, many with Columbia colleague Shu Chien, Skalak was among the first to apply principles of engineering mechanics to understand the behavior of biomaterials. His 1969 paper, “Deformation of Red Blood Cells in Capillaries,” a collaboration with P. I. Branemark published in *Science*, precisely described and quantified the flow of red blood cells.

*[continued on page 29]*



# HELEN H. LU

## PERSONALIZED MEDICINE

### BODY BUILDER

**G**iven the breadth of Helen Lu's tissue research around sports-related injuries and other bodily setbacks, one might think she is a busy MD rather than a pioneering engineer who has achieved White House recognition for advancing the field of soft tissue engineering.

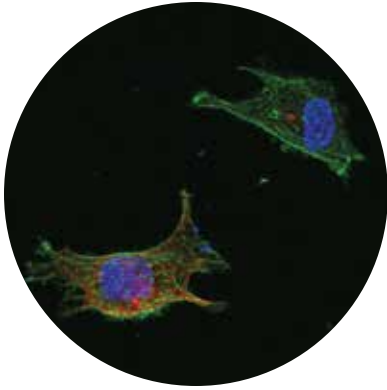
Lu, professor of biomedical engineering, and her research team specialize in tissue regeneration and are focused on growing multiple tissues to build functional organ systems that will assimilate with the body. Their main goal is to promote long-term

healing and restoration of native tissue functionality. The group, which collaborates with Columbia and other New York-based doctors, currently is working on three projects related to orthopaedics and sports medicine—the repair of the anterior cruciate ligament (ACL), rotator cuff, and articular cartilage. They are also focused on two other ventures related to dental issues—periodontal repair and dental pulp regeneration.

“We’re developing new ways to help the body heal after soft tissue injuries. Our approach is novel because it focuses



Sidebar, top: Portrait of Richard Skalak (University Archives); bottom: an example of Skalak's later research, which explored bone and soft tissue growth among many other subjects



Human rotator cuff fibroblasts on degradable polymer scaffolds. Pictured in green are actin fibers and in red is beta-tubulin, both elements of the cytoskeleton. In blue is the cell nucleus. These images demonstrate that cells form stress fiber on the biomaterials and are attaching well.

Bottom, left: Stem cells on aligned nanofiber scaffolds. The cells are alive (green) and adhered along the long axis of the fiber, i.e., from the left to right side of the image.

on the regeneration as well as functional integration of the soft tissue graft, post repair or reconstruction,” Lu says.

Their technique is important for these tissue-engineered grafts—tendon, ligament, and cartilage—to perform within the body. Once the grafts are in place inside the human body, they easily meld well with connective tissues.

“Our holistic approach to soft tissue repair uses living, engineered components that can remodel to the physical demands they encounter,” explains Lu, who’s been teaching at Columbia Engineering since 2001 and is also director of Columbia’s Biomaterials and Interface Tissue Engineering Laboratory.

Lu’s discoveries also aren’t age discriminate. She noted that unlike metal and plastic prostheses, these engineered tissues have the potential to grow with and adapt to meet the functional demands of both young and old physically active patients.

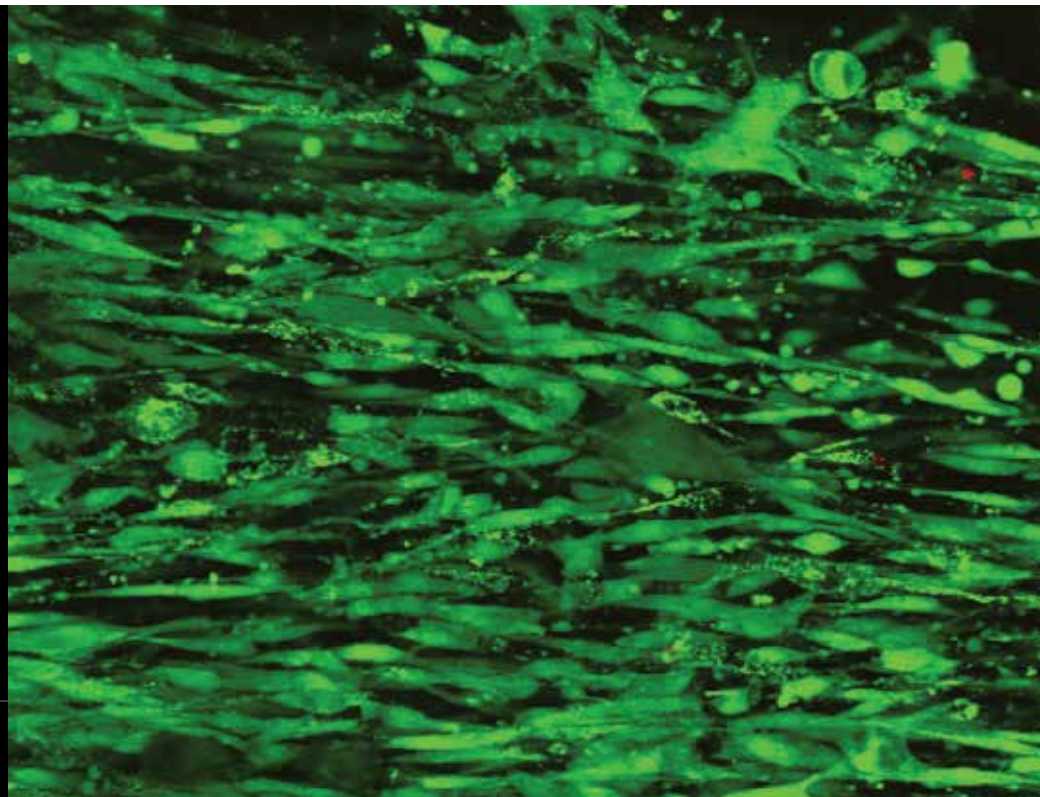
Among her many projects, Lu and her team, in collaboration with Dr. Scott Rodeo at New York’s Hospital for Special Surgery, developed a novel “scaffolding” method to help ACL sufferers grow the

three distinct tissue types within one functional system tissue-engineered, integrative interference screw. The innovative interference screw holds the ACL graft in place and lacks the disadvantages of traditional metallic implants. Lu’s own relationship with ACL technology dates back to when she was a postdoctoral fellow at Drexel University, and the development she worked on then is now in clinical trials in Europe.

Lu’s group also developed another scaffolding technique—this one for rotator cuff injuries. They are presently seeking FDA approval of a nanofiber, bilayer scaffold applied as an inlay inserted between the tendon and bone to help the two adhere together. By contrast, conventional rotator cuff devices are applied as a patch over the tendon during surgery. Lu works with William Levine, professor and chair of Clinical Orthopaedic Surgery, and director of the Sports Medicine Department of Orthopaedic Surgery at Columbia, on the rotator cuff scaffolding design.

One of the benefits of Lu’s interface tissue engineering is that the technology

“I’m inspired by the opportunity to help many people on a large scale through our work, as well as the excitement of discovery and satisfaction gained in problem solving.”



**RICHARD SKALAK***[continued from page 26]*

Later research—published in more than 200 papers—delved into cell membranes, bone and soft tissue growth, immune response, and many other topics.

Skalak also worked to develop titanium dental implants, contributing significantly to the broader practice of skeletal reconstruction. His work has proved foundational to advances in understanding and treating cancer, hypertension, atherosclerosis, and many other diseases.

Having joined the Department of Civil Engineering and Engineering Mechanics in 1944, Skalak taught at the Engineering School for more than 40 years. He chaired the department from 1972 to 1975 and became James Kip Finch Professor of Engineering Mechanics in 1977. From 1978 to 1987, he was director of Columbia's Bioengineering Institute. After retiring from Columbia in 1988, he directed the Institute for Mechanics and Materials as a professor of bioengineering at UC San Diego, passing away in 1997.

Skalak, a recipient of the Theodore von Karman Medal from the American Society of Civil Engineers, was a member of the National Academy of Engineering, the American Society of Mechanical Engineers, and the New York Academy of Medicine. He also served as president of the Society of Biomedical Engineering. The School holds the annual Richard Skalak Bioengineering Lecture in his honor.

helps lower failure rates of traditional soft tissue grafts, and, in turn, saves the patient money. Since they've determined how to connect different tissues, researchers may ultimately regenerate a whole joint or eventually an entire limb in the future.

Lu might have caught a glimpse of her own future in engineering during high school when she took an interest in math and biology and became fascinated by the concept of the human body as a machine. Now, she's able to put her enthusiasm into motion.

"I'm inspired by the opportunity to help many people on a large scale through our work, as well as the excitement of discovery and satisfaction gained in problem solving," Lu says.

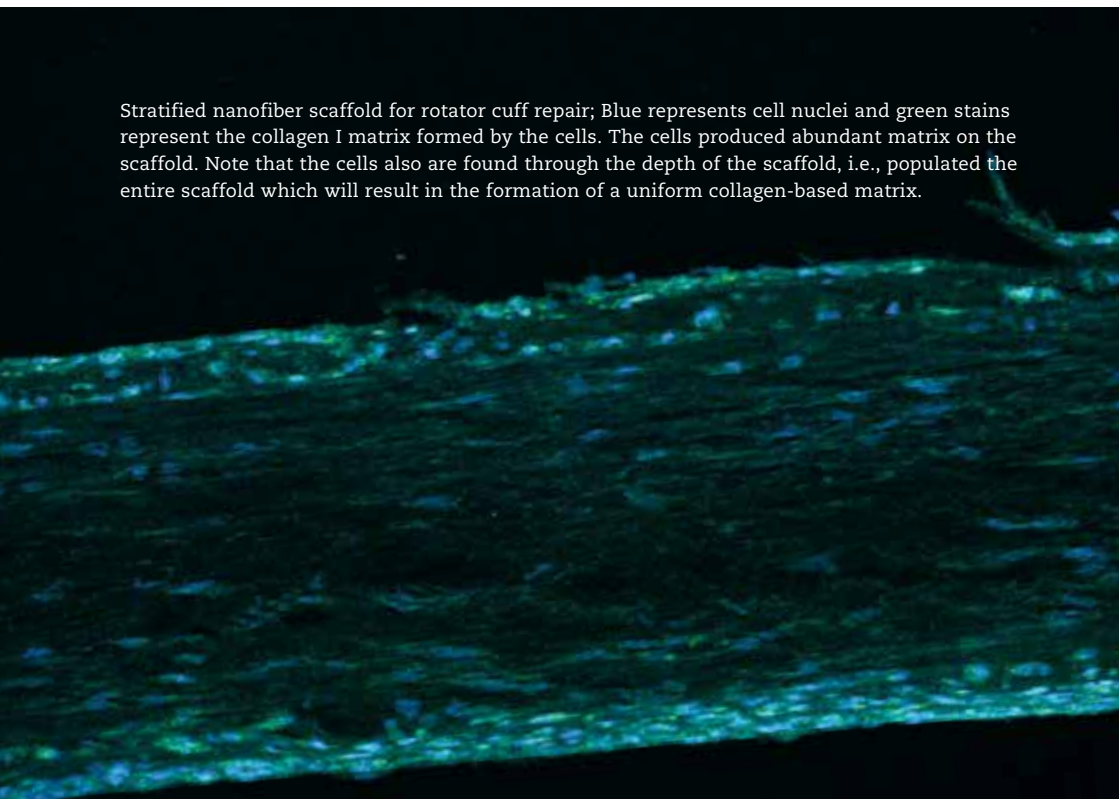
Her achievements were recognized in 2009 when she was presented with the Presidential Early Career Award for Scientists and Engineers, the highest honor bestowed by the U.S. government on outstanding scientists and engineers in the beginning years of their independent research.

"Most satisfying," she says, "has been working with my students, figuring out how much we need to learn from Mother Nature in scaffold design, as well as the development of devices that can ease suffering and enable patients to achieve and maintain a satisfactory quality of life."

*By Janet Haney*

**Lu and her research team are developing new ways to help the body heal after soft tissue injuries. Their novel approach focuses on the regeneration as well as functional integration of the soft tissue graft, post repair or reconstruction.**

Stratified nanofiber scaffold for rotator cuff repair; Blue represents cell nuclei and green stains represent the collagen I matrix formed by the cells. The cells produced abundant matrix on the scaffold. Note that the cells also are found through the depth of the scaffold, i.e., populated the entire scaffold which will result in the formation of a uniform collagen-based matrix.



## MAN OF HIGH FIDELITY

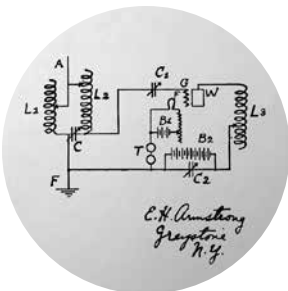


### EDWIN ARMSTRONG

ALUMNUS AND FORMER FACULTY

One warm, summer night in 1912, a Columbia Engineering student named Edwin Howard Armstrong, about to enter his senior year, made a momentous discovery. At his home in Yonkers, later designated a National Historic Landmark, Armstrong had built the regenerative circuit, which would forever change long-distance communications.

Armstrong's new circuit, patented in 1914, fed radio signals back through an audion circuit to reinforce themselves. His innovation not only greatly amplified signals, but the positive feedback made the circuit an "oscillator" capable of transmitting its own signal. In one masterstroke, Armstrong made radio practical, the first in an  
*[continued on page 32]*



Professor Gil Zussman and undergraduate student Ben Zhu set up an experiment in a testbed composed of EnHANTs prototypes.

Sidebar, top: Portrait of Edwin H. Armstrong (University Archives); bottom: feed-back circuit drawing

# GIL ZUSSMAN

## COMMUNICATIONS

### MAKING THE CONNECTION

On any given day, the first thing most of us do is rev up our mobile device of choice: smartphone, laptop, tablet, or smart watches. Then they all magically sync together. The future of interconnectedness is quickly moving beyond just popular gadgets into wirelessly connecting even everyday objects. Gil Zussman, associate professor of electrical engineering, has devoted his research to exploring the continuing evolution of these advanced wireless networks.

Following the 1990s Internet boom, a wireless and mobile networking transformation began. Now, networks such as cellular, wireless, local area, sensor, and

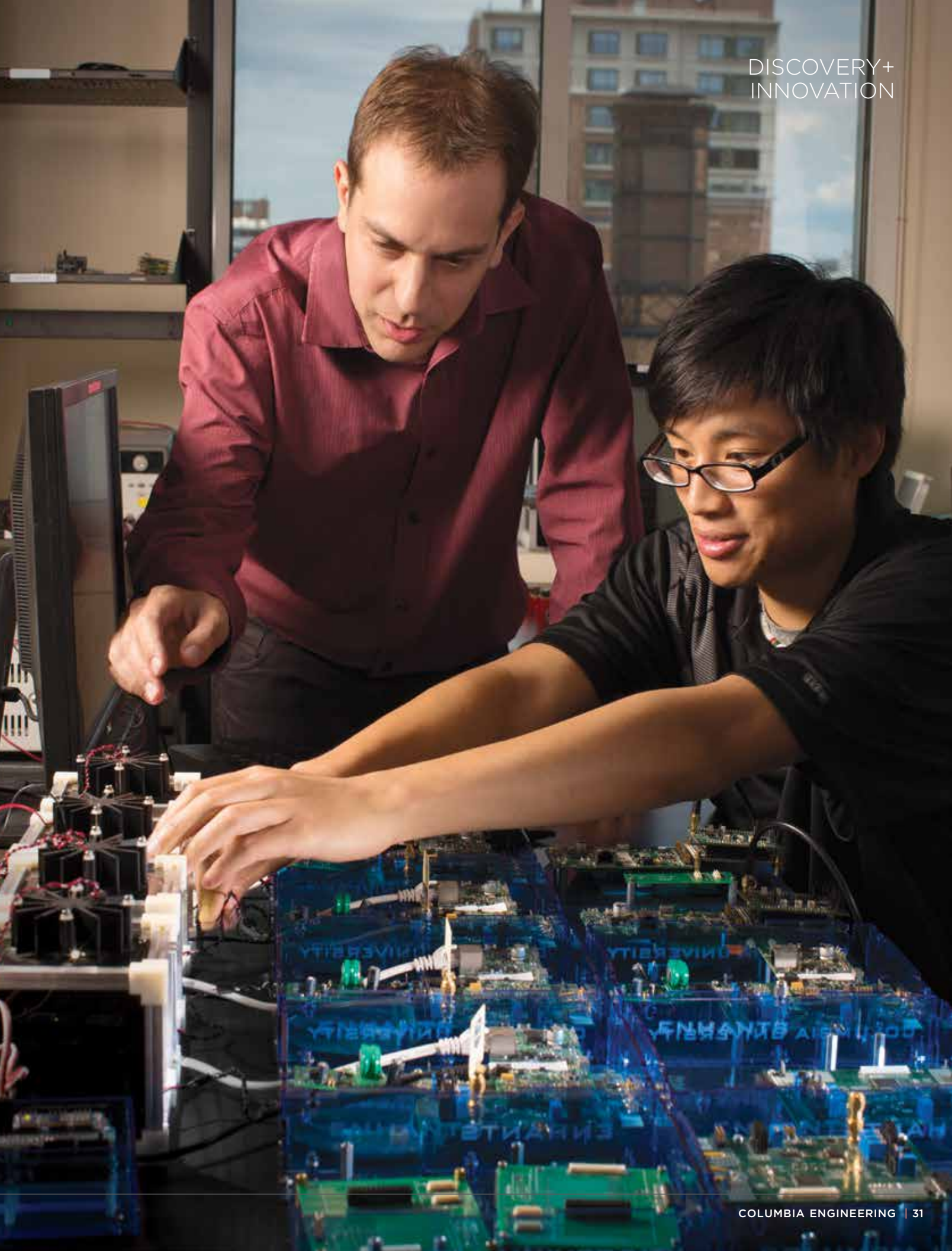
vehicular are continually being enhanced and deployed.

"These wireless networks found numerous applications in diverse areas such as broadband access, military operations, health care, supply chain management, and public safety, and in general, the wireless revolution has already transformed the way we communicate," Zussman says.

Zussman studies the ever-changing wireless networking technologies and their related challenges, which include interference during simultaneous transmissions, limited capacity on the wireless channel, mobility, and battery life constraints on the devices. As a simple example of the first-mentioned challenge, interference,

Zussman's research is central to the Energy Harvesting Active Networked Tags (EnHANTs) Project at Columbia, a collaboration among several Engineering professors who are developing novel hardware, algorithms, and software to actively track everyday items otherwise not tracked, such as books, furniture, toys, keys, clothing, and even food.





**EDWIN ARMSTRONG**

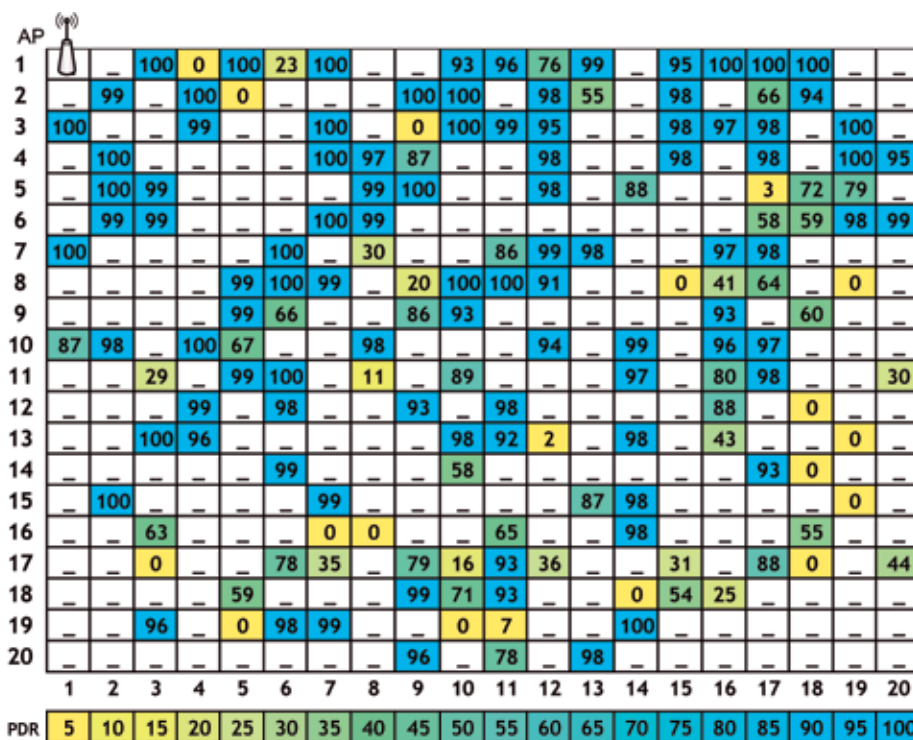
*[continued from page 30]*  
extraordinary string of historic breakthroughs during four decades at Columbia.

Armstrong stayed on after graduating in 1913, working as an assistant to the legendary Michael I. Pupin 1883CC, cofounder of the Electrical Engineering Department 25 years before. Pupin secured him access to the Marcellus Hartley Laboratory in the basement of Philosophy Hall, where Armstrong was to make many more advances.

During World War I, while serving in France in the Army Signal Corps, Armstrong again revolutionized radio by developing the superheterodyne receiver, the basis for modern reception technology. He earned the rank of major and conducted experiments from the Eiffel Tower.

Returning to Columbia Engineering as assistant professor, flush from his inventions, Armstrong turned down a salary to focus exclusively on research. He developed the super-regenerative receiver, refining his earlier work, and turned to the puzzle of reducing static in radio signals. After 10 years of feverish research, he engineered wideband FM radio in the early 1930s. Beset by a long series of dubious lawsuits, however, Armstrong spent much of the rest of his life fighting for credit and just compensation. He died in 1954.

Without the legal battles that consumed his later years, there's no telling what else Armstrong could have achieved, but the judgment of history is clear. His preeminence earned him a U.S. postage stamp in 1983, and Columbia's Armstrong Hall bears his name.



A WiMAX base station (on top of the Mudd Building) used for hands-on experimentation in Electrical Engineering and Computer Science networking classes.

Top, left: Packet delivery ratios to various nodes in an experiment in a large-scale WiFi testbed; right: EnHANTs prototypes

Zussman explains that if you have a set of wireless device users simultaneously communicating with each other, unless they decide who transmits when, in many instances the transmitters will collide. In that case, no one will get anything. However, according to Zussman, devices that employ clever algorithms can achieve high throughput.

That's what Zussman, director of Columbia's Wireless and Mobile Networking (WiMNet) Lab, and his team of researchers and students zero in on. They tackle the networking challenges by focusing on developing architectures and algorithms that run across multilayered network protocol stacks.

"We aim to provide a sound theory for real systems by dealing with wireless and mobile networking problems that have a strong grounding in reality and by obtaining a fundamental understanding of these problems," Zussman says.

The WiMNet Lab has aligned itself with the likes of IBM Research, AT&T Labs Research, and Alcatel Lucent Bell Labs.

"We've been collaborating with them mostly on scheduling problems with either WiFi or cellular networks, thinking about how to develop the scheduling



algorithms for the next generation,” Zussman says. He went on to explain that most of the collaborations are within the research arms of those companies. “The main idea is to collaborate with very talented researchers and to try to develop solutions that they will be able to internally market to their R&D or product teams.”

Another major part of Zussman’s research focus is the Internet of Things, or the seamless interconnectedness of computing devices within the Internet stratosphere—specifically, within the Energy Harvesting Active Networked Tags (EnHANTs) Project, a collaboration among the research teams of several Columbia Engineering professors, including Professors Peter Kinget, Ioannis (John) Kymissis, Dan Rubenstein, and Luca Carloni. The project team has been developing novel hardware, algorithms, and software to actively track everyday items otherwise not tracked, such as books, furniture, toys, keys, clothing, and even food. EnHANTs will be small, flexible, self-reliant tags that can be attached to any object to determine its location in cases of natural disasters, physical moves, or simple misplacement of belongings. Most recently, the team has been conduct-

Following the 1990s Internet boom, a wireless and mobile networking transformation began. Now, networks such as cellular, wireless, local area, sensor, and vehicular are continually being enhanced and deployed.

ing measurements of harvested energy availability, developing harvesting-aware algorithms, and prototyping EnHANTs.

Zussman cited a library, a grocery store, a courier truck, and a warehouse as real-life examples of where and how these small, self-powered, networked tags could replace scanning of bar codes and potentially make items and merchandise self-organizing.

“Imagine you put these tags on the outside cover of every book in a library, and the tags start harvesting the indoor light energy and communicating with each other,” Zussman suggests. Further illustrating this example, Zussman explains that if a math book has been erroneously placed in the literature section of the library, its tag could figure it out by communicating with its new neighbors. Then, the tag can alert the librarian via the network and an LED light on the

misplaced book would help the librarian spot it on the wrong shelf.

Zussman’s own interest in wireless networking research was spurred by the dot-com bust that occurred right after he started his PhD studies.

“The area that was interesting for me was using analytical tools I was very familiar with to solve problems in the real world, and my sense, at that time, was that wireless was the next big thing in networking,” he says.

Indeed, wireless networking continues to rapidly evolve due, in part, to the discoveries of Zussman, together with his students and postdocs.

*By Janet Haney*

DISCOVERY+  
INNOVATION

# LATHA VENKATARAMAN

## NANOSCIENCE

GETTING A CHARGE OUT OF  
NANOTECHNOLOGY



Professor Venkataraman leads a laboratory that investigates fundamental physical and chemical properties of nanoscale electronic devices.

## ENGINEERING ICON

**E**ver since the dawn of the electronic age, science has been on a quest for miniaturization, making transistors smaller in order to integrate many into a circuit and further miniaturizing to build microprocessors. The potential for further miniaturization is predicated on physics: The tiniest transistors must still be large enough to control the on or off flow of electrons. The smallest transistors that can be envisioned consist of just a few atoms or a small molecule. The potential for making such small electronic circuits has captivated Latha Venkataraman, associate professor of applied physics.

“By developing circuits with components that consist of a single molecule (a collection of a few atoms), I am working at a size regime that is close to the fundamental limit,” she says. “There’s something exciting about exploring how things work at such an extreme and largely uncharted scale.”

The underlying focus of Venkataraman’s research is to fabricate single-molecule circuits, a molecule attached to two electrodes, with varied functionality where the circuit structure is defined with atomic precision. That’s the holy grail of molecular electronics and a goal Venkataraman had been pursuing even when popular science relegated the idea to theory.

“When I started at Columbia, the field of molecular electronics was plagued with uncertainty. No one could imagine that a single-molecule circuit could actually function reliably and reproducibly,” she explains. Through collaboration with

chemistry groups at Columbia, a method was devised to create workable single-molecule devices.

“This was a major breakthrough, because we could finally probe the properties of such circuits and relate these to the chemical and physical natures of the molecules,” she says.

Now, Venkataraman is focused on learning how these circuits work and how to optimize their function as active device components. Her findings will also enhance the understanding of charge transport in molecular systems and across metal-organic interfaces, with impact on the fields of organic electronics, photovoltaics, catalysis, and even biological processes (such as photosynthesis and respiration).

“We are now measuring how electronic conduction and single bond-breaking forces in these devices relate not only to the molecular structure but also to the metal contacts and linking bonds. Our experiments provide a deeper understanding of the fundamental physics of electron transport, while laying the groundwork for technological advances at the nanometer scale,” she says.

Improving the understanding of how molecules transport charge can help in

*Sidebar, top: Portrait of Irving Langmuir; bottom: an example of the sorts of light bulbs Langmuir engineered and that led to his historic discoveries in surface chemistry (Chemical Heritage Foundation / CC-BY-SA-3.0)*



### IRVING LANGMUIR ALUMNUS

A renowned chemist whose cutting-edge research incorporated engineering and physics, Irving Langmuir was a giant in his field. It all began at Columbia Engineering, where he studied metallurgical engineering at the turn of the twentieth century. He graduated in 1903, having developed a passion for understanding atomic and molecular properties, especially in relation to vacuum phenomena. Twenty-nine years later, he would receive the Nobel Prize.

After attaining his PhD in Germany for research on the behavior of dissolved gases in a new kind of electric lamp, Langmuir briefly taught at the Stevens Institute of Technology before joining the General Electric research laboratory, where he became associate  
*[continued on page 37]*

“By developing circuits with components that consist of a single molecule—a collection of a few atoms—I am working at a size regime that is close to the fundamental limit. There’s something exciting about exploring how things work at such an extreme and largely uncharted scale.”



Venkataraman is focused on learning how single-molecule circuits work and how to optimize their function as active device components. Her findings will enhance the understanding of charge transport in molecular systems and across metal-organic interfaces, with impact on the fields of organic electronics, photovoltaics, catalysis, and even biological processes (such as photosynthesis and respiration).

development of next-generation devices, and Venkataraman is on the verge of technological breakthrough. A team in her lab recently substituted layered materials for a gold electrode in a molecular circuit.

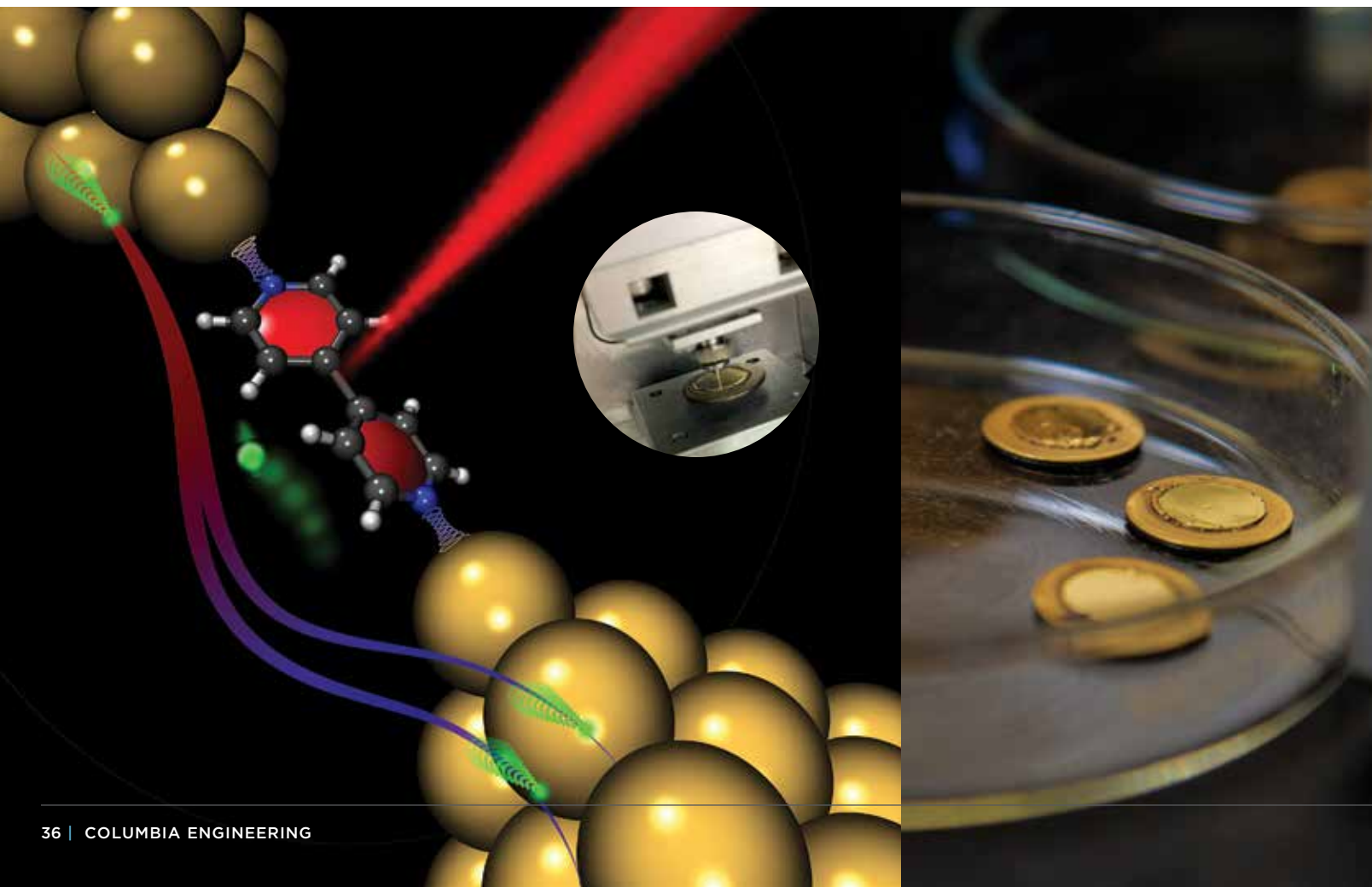
“We’ve always used gold metal electrodes to contact molecules in our circuits, but when we switched to using multilayered graphene flakes as one

electrode, these devices ended up functioning as diodes, which are the basic building blocks for a transistor,” she explains. That research was published in *Proceedings of the National Academy of Sciences* this summer.

The next step for Venkataraman is to figure out how to make more interesting circuit components such as switches or optically active elements and build these

into circuits. In this process she is also exploring new ways to control the interface between molecules and electrodes.

“We are working on creating molecular devices with varied functionalities that are controlled through chemical design,” she says. To understand the interplay of physics, chemistry, and engineering at the nanometer scale, Venkataraman works with a range of scientists and encourages



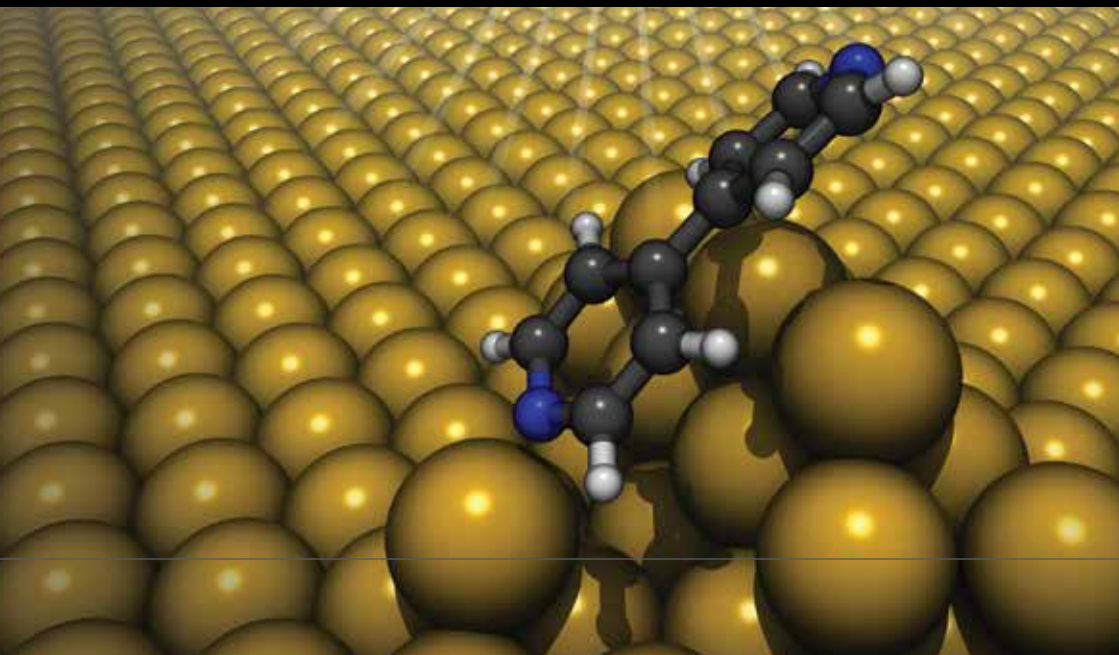
the graduate students in her lab to get comfortable with collaboration.

“Collaboration is really what makes my research possible and fun,” she says. “Most of my graduate students and I are trained as physicists. We do not know much chemistry, and all the work that we do requires understanding molecular structures to relate them to the electronic functions that we measure. Without our spending hours talking with our chemistry collaborators, none of this would be possible.”

By Amy Biemiller

*Pictured below, left: Illustration of a single-molecule bridging two gold electrodes that is interrogated by multiple probes highlighting the complexity of these conceptually simple devices; middle: gold metal surfaces used for measurements as illustrated in the circular inset; right: illustration of a molecule on gold surface bonded through chemical and van der Waals interactions. The forces required to break these bonds were first measured in Venkataraman's lab.*

Improving the understanding of how molecules transport charge can help in development of next-generation devices. Venkataraman's Lab is working towards creating such molecule based electronic circuit elements.



“Collaboration is really what makes my research possible and fun. Most of my graduate students and I are trained as physicists.... Without our spending hours talking with our chemistry collaborators, none of this would be possible.”

## IRVING LANGMUIR

*[continued from page 35]*  
director and remained for 40 years. At first his research centered on developing gas-filled incandescent lamps and improving vacuum tubes, but he delved into surface chemistry upon discovering that hydrogen formed a layer one atom thick on the surface of bulbs with tungsten and platinum filaments. A 1917 paper on the chemistry of oil films forming molecular monolayers, and his subsequent general theory of adsorbed films, led to his 1932 Nobel Prize for advances in surface chemistry.

Ever restless in his research, Langmuir developed the atomic hydrogen welding process and made important contributions to understanding valence and atomic structure. He was among the first to work with plasmas and coined the term. He also became interested in atmospheric chemistry and, after working to improve various military technologies during World War II, researched the possibilities of cloud seeding.

Langmuir served as president of the American Chemical Society, whose journal of surface chemistry today bears his name. He remained devoted to the Engineering School, supporting the campaign that funded construction of Mudd Hall and the Engineering Terrace, and his research lives on in countless technologies that remain in common use.



- A. Symbiote Payload
- B. Host Program
- C. Symbiote Manager
- D. Intercept Point

Security software is automatically injected into any embedded device without its source code and without knowing its Operating System.

# SAL STOLFO

## DATA SCIENCE

### CYBERSECURITY'S SUPERHERO

**O**n the surface, traffic lights, printers, cell phones, and routers that operate power grids don't have much in common. But embedded into each of those is a small chip with programming that makes each work the way they are supposed to work and enables automatic updates. The combination of memory, program code, and data stored on the chip is called firmware and is considered as important as the operating system.

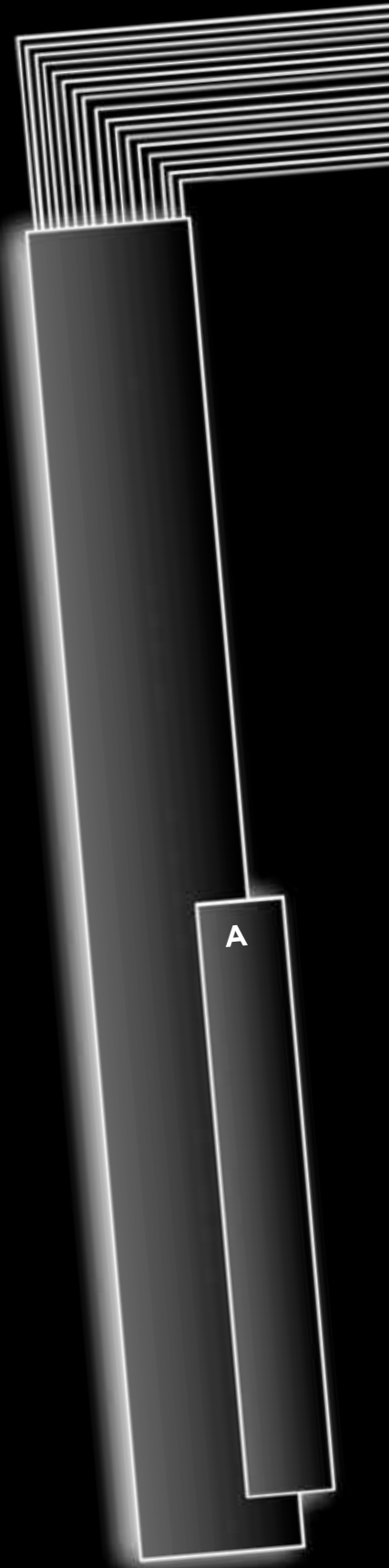
The problem is, firmware acts just like a general purpose computer and is virtually unprotected from attack.

"The damage possible to our critical infrastructure highlights the importance

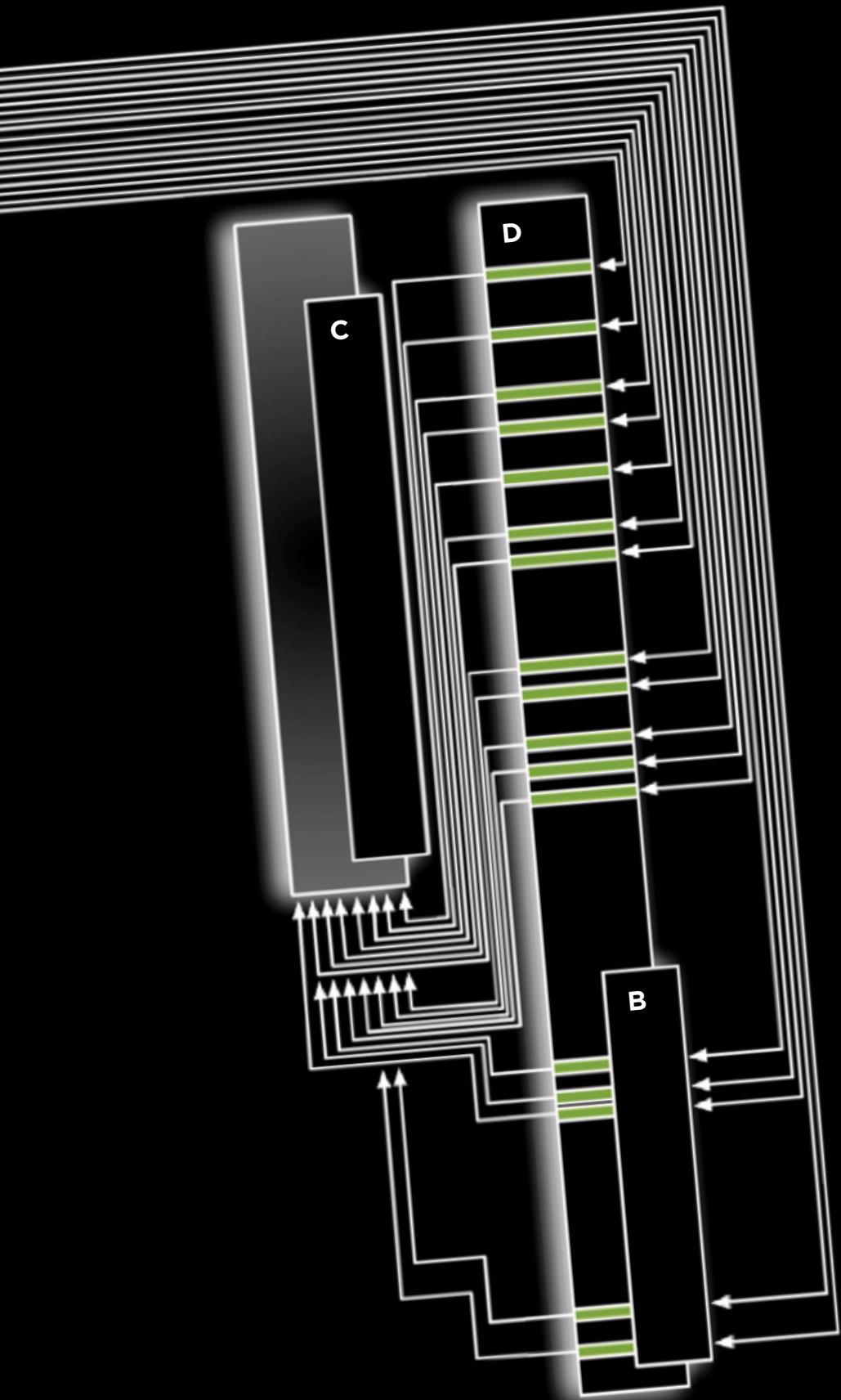
of computer security," explains Salvatore J. Stolfo, professor of computer science. "It is technically feasible to essentially disable the world's communication infrastructure. What would modern life be like if the network connecting everything was disabled? We have built a very fragile infrastructure that everyone depends upon."

In his quest to make the Internet safe, Stolfo first became enamored with security research and the creative, malicious nature of credit card transaction opportunists.

"I learned years ago when studying credit card transaction fraud how clever adversaries could be and how difficult it can be to detect their activities," he says.







## COMPUTING COMPLEXITY



### JOSEPH TRAUB

FACULTY

After his renowned career at the forefront of complex computation, and serving as founding chair of Columbia's Department of Computer Science, it is perhaps surprising that, when Joseph Traub '59GSAS first came to Columbia in 1954, he planned to study physics. But, at the Watson Scientific Computing Laboratory, he found nearly unparalleled access to computers and was hooked. As a Watson Fellow in Applied Mathematics, Traub's doctoral thesis concerned computational quantum mechanics.

Joining the research division of Bell Labs, Traub, the Edwin Howard Armstrong Professor of Computer Science at the Engineering School, developed optimal iteration theory,  
*[continued on page 40]*



**JOSEPH TRAUB**

*[continued from page 39]*  
exploring the minimal computational resources needed to solve nonlinear equations. On sabbatical at Stanford, with Michael Jenkins, he published the Jenkins-Traub algorithm for polynomial zeroes in 1970. In 1971 he became head of the Department of Computer Science at Carnegie Mellon and worked on algebraic complexity and further algorithms. With Henryk Wozniakowski, now a professor of computer science at Columbia Engineering, he pioneered information-based complexity, which explores optimal algorithms for continuous problems.

In 1979, Traub returned to Columbia to start the Department of Computer Science, when the School had just one computer. He built up the faculty, brought on young researchers, and forged partnerships with IBM and the Defense Advanced Research Projects Agency (DARPA). He led the fast-growing department to leadership in a field coming into its own and presided over construction of the Computer Science building, while serving as founding coeditor of the *Journal of Complexity*. He was elected to the National Academy of Engineering in 1985 and the next year founded the Computer Science and Telecommunications Board of the National Research Council.

In the 1990s, Traub collaborated with Spassimir Paskov '94GSAS to demonstrate that, for real-world financial computation, quasi-Monte Carlo methods with quasi-random samples beat random Monte Carlo methods. He currently works on quantum computing with Anargyros Papageorgiou '90GSAS.

**“If we can organize layers of defense so the cost of an attacker bypassing each layer has multiplicative cost to the attacker, rather than linear cost as the state-of-the-art today, we will come a big step closer to making the Internet safe.”**

“It’s a rigorous challenge, and that’s what immediately hooked me.”

To defend the technological systems that cyber criminals target, Stolfo leverages equal creativity and inventiveness. His Intrusion Detection System (IDS) lab, established in 1996 and sponsored by the Defense Advanced Research Projects Agency’s (DARPA’s) Cyber Panel program, pioneered the use of data analysis and machine learning techniques for the adaptive generation of novel sensors and anomaly detectors for advanced cyber defense. Most recently, work in his lab resulted in symbiote technology that thwarts and frustrates those targeting firmware. The solution, co-invented by Stolfo and his student Ang Cui, is easily interwoven into any firmware and operates alongside it to defend it

from any unauthorized changes to the host firmware.

“I believe the symbiote technology represents a real achievement. We’ve raised the bar with this technology,” he says.

The symbiote is a general security solution for all embedded devices and can scale to very large numbers of devices, whether they are already deployed or being produced on a manufacturing line. It’s a solution that successfully protects firmware without interfering with the overall operating system and greatly frustrates would-be attackers.

“We essentially created a sequence of randomized symbiote-protected firmware images, each distinct from the prior generated firmware. This prevents a single malicious attack from succeeding for all the distinct devices. Worm propagation is



disabled, and the attacker would have to study each device in order to figure out how to disable the defense,” he explains.

That technology, which is already protecting Cisco routers, is being tested by the U.S. Air Force. Stolfo expects detailed performance reports from them later this fall.

“If they give the green light, I believe symbiotes will be widely deployed to protect our Department of Defense networks,” he says.

While symbiote technology is poised to make a splash as a new superhero in technology security, the world can thank Stolfo for plenty of other technological advances.

His earliest work on parallel computing for high-speed speech recognition resulted in the creation of the DADO large-scale parallel computer that powered the automated telephone operator speech

recognition system. This research served as a model for deductive data base systems research for years. His work has also informed the Intrusion Detection Systems industry and is deployed within the U.S. government for network defense.

“I am keen on decoy technology, active defense, and scalable deception,” he says. “I now see numerous organizations using these techniques to protect their sensitive data. I believe it will be a common defense across most large enterprises, very soon.”

As far-reaching as Stolfo’s Internet security solutions are, he knows that there are people who are just as nefariously looking for gaps in software and hardware. But he has some clever insight into how to foil those attempts as well.

“If we can organize layers of defense so the cost of an attacker bypassing each layer has multiplicative cost to the attacker,

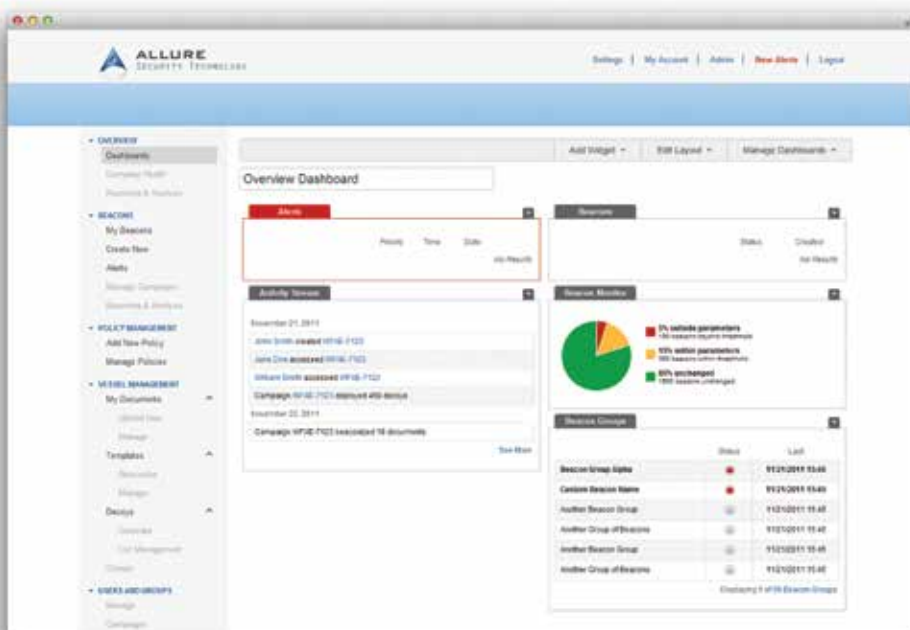
rather than linear cost as the state-of-the-art today,” he explains, “we will come a big step closer to making the Internet safe.”

While worry about cyber criminals doesn’t keep Stolfo up at night, a deep understanding of the consequences of a large-scale cyber attack drives him to stay one step ahead of those who would benefit from a global IT meltdown.

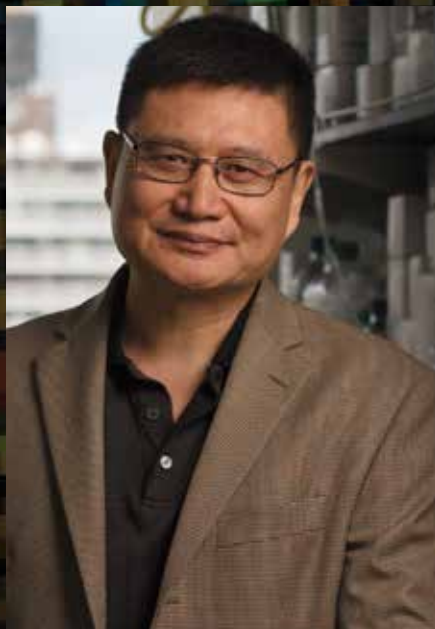
“Think about what it was like in lower Manhattan just after Hurricane Sandy, or in the Northeast during the 2003 blackout,” he cautions. “It doesn’t take much to push our society back into the Stone Age.”

*By Amy Biemiller*

Stolfo’s earliest work on parallel computing for high-speed speech recognition resulted in the creation of the DADO large-scale parallel computer that powered the automated telephone operator speech recognition system.



Allure Security developed scalable decoy technology to confound and confuse thieves while providing Data Loss Alerting.



# JINGYUE JU

## PERSONALIZED MEDICINE

### HUMAN GENOME DECODER

**D**eep inside a single cell is the genome, the DNA repository containing instructions for the development and function of all living organisms. Those DNA instructions in a human genome are comparable to a string of three billion genetic letters in a unique language. Deciphering this biological lexicon holds potential for understanding how and why disease affects people; how genes work together to direct the growth, development, and maintenance of an entire organism; and more about gene regulation.

Genomics may as well be considered the extreme sport of the scientific world.

It's a rigorous, complex, and demanding discipline that requires researchers to have a natural fascination for decoding the function of humanity's blueprint, an ability to integrate different areas of science and engineering, and a desire for the adrenaline rush that comes with discovering new knowledge about what makes each human unique.

"Intense effort and interest go hand in hand in using molecular science and engineering to pursue genomic research," says Jingyue Ju, the Samuel Ruben–Peter G. Viele Professor of Engineering, professor of chemical engineering and pharmacology, and director of the Center

## ANTIBIOTICS FOR THE MASSES



### ELMER L. GADEN

ALUMNUS AND  
FORMER FACULTY

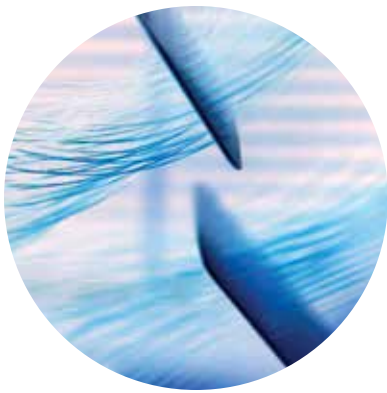
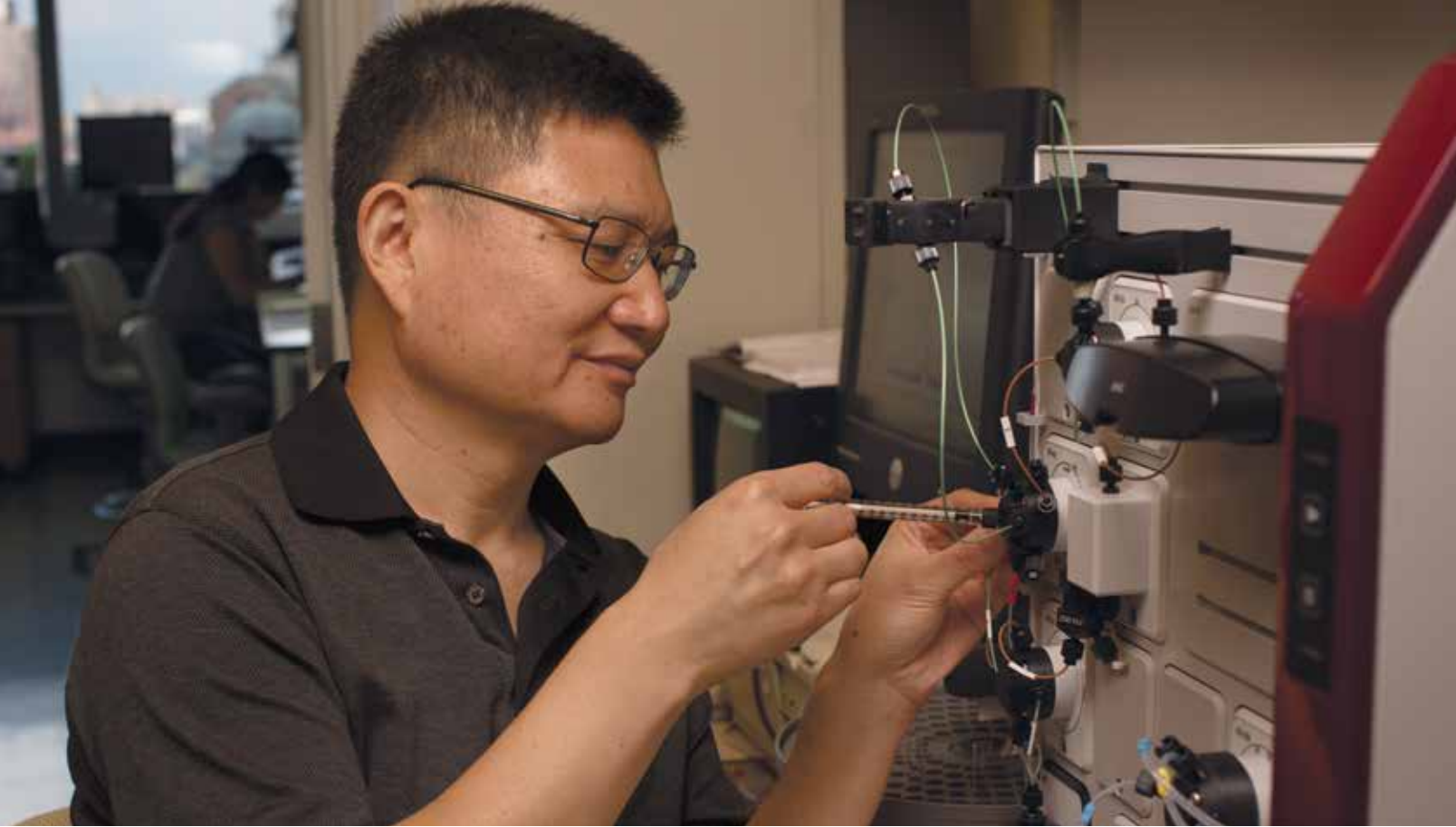
A true Columbia institution, Elmer L. Gaden (1924–2012) began his remarkable career in biochemical engineering as a student, logging long hours at Havemeyer Hall, ultimately earning a BS in 1944, an MS in 1947, and a PhD in 1949, all from the Engineering School. He returned to campus to join the faculty after a year at Pfizer.

Gaden's pioneering thesis explored what concentration of oxygen enables penicillin to ferment, grow, and multiply most rapidly, setting the stage for mass production of a wide range of antibiotics and a new epoch for medicine. With a passion for harnessing biological processes to serve human needs, Gaden published widely and founded the research  
*[continued on page 45]*

Four-color DNA sequencing by synthesis data using four cleavable fluorescent nucleotide reversible terminators on a DNA chip.

Sidebar, top: Elmer L. Gaden (University Archives); bottom: One of Gaden's many lab experiments





Multiple capillary arrays from a four-color DNA sequencer that was used to complete the Human Genome Project.

Top, center: A mass spectrum of a tagged-nucleotide, the re-engineered DNA building block, used to electronically sequence DNA with single-molecule sensitivity.

for Genome Technology & Biomolecular Engineering at Columbia. “The rewards are that there is an almost daily advancement of this science, which fuels our excitement for inventing new molecular engineering approaches to investigate the genetic and molecular mechanisms underlying health disorders in order to maintain a healthy life.”

Leveraging his expertise in molecular science and engineering, Ju and his team are developing revolutionary technologies to dramatically reduce the cost of DNA sequencing so that each person’s genome can be routinely decoded on a credit card-sized chip for just \$1,000. Dramatically reducing the cost of DNA sequencing could mean that, soon, sequencing an individual’s genome could become a routine part of medical research and health care.

Ju co-invented the fluorescence energy transfer labeling technology for DNA sequencing that was widely used to successfully complete the international Human Genome Project. The Ju Laboratory at Columbia, along with its collaborators, invented several generations of new DNA

sequencing technologies, which include the development of a four-color DNA sequencing-by-synthesis platform using cleavable fluorescent nucleotide reversible terminators, currently the dominant approach used in next-generation DNA sequencing systems. What really intrigues scientists like Ju is constantly inventing new approaches for deciphering the entire genome sequence efficiently and cost-effectively, a proposition that requires a great deal of expertise from different areas of science and engineering, along with substantial funding for long-term research.

“This comprehensive project is great fun, because we create new ideas from the vast knowledge of various areas of science and engineering,” Ju says. “The initiative creates a wonderful learning environment for myself and for my students.”

The Ju Laboratory is currently collaborating with Genia Technologies Inc.,—researchers at Harvard University and the National Institute of Standards and Technology (NIST) to develop a nanopore-based sequencing by synthesis (NanoSBS) system that will accelerate the use of

## ELMER L. GADEN

[continued from page 43]  
journal *Biotechnology and Bioengineering*, which he edited for more than two decades. In 1988 he received the Founders Award from the American Institute of Chemical Engineers and, in 2009, was honored with the prestigious Fritz J. and Dolores H. Russ Prize for his foundational research.

During 25 years on the Columbia Engineering faculty, the Brooklyn-born Gaden was a beloved teacher, researcher, mentor, and friend. He founded the School's program in biochemical engineering, served as chair of the Department of Chemical Engineering, and earned Columbia's Great Teacher award. In 1974, the same year he won admission to the National Academy of Engineering, Gaden left Morningside Heights to become dean of the College of Engineering, Mathematics and Business Administration at the University of Vermont. He concluded his career at the University of Virginia, retiring in 1994, but always nurtured a warm relationship with his alma mater.

Gaden received Columbia Engineering's Egleston Medal in 1986. He died in 2012, at the age of 88, but his spirit lives on in the Elmer L. Gaden Lectureship. Founded by the Department of Chemical Engineering in 2007, the annual series hosts leading researchers and scientists who uphold Gaden's legacy of innovation and excellence.

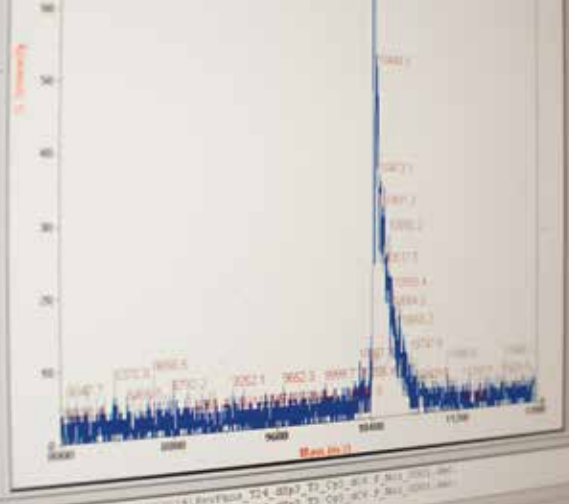
Ju co-invented the fluorescence energy transfer labeling technology for DNA sequencing that was widely used to successfully complete the international Human Genome Project.

DNA sequencing for wide applications in clinical diagnosis and health care. This collaboration, supported by a \$5.25 million grant from the National Institutes of Health, focuses on the research and development of a single-molecule electronic NanoSBS platform combining three technological advancements: NanoTag sequencing chemistry developed in a collaboration between the laboratories of Ju at Columbia and Dr. John Kasianowicz at NIST; Genia's metal-oxide semiconductor integrated circuit; and the novel protein constructs from Professor George Church's laboratory at Harvard Medical School. Genia has licensed the NanoSBS technology, and the resulting single-molecule electronic DNA sequencer is expected to be faster, more accurate and cost-effective than current commercially available technologies in decoding the human genome. Recently, Roche, a leader in research-focused health care with combined strengths in pharmaceuticals and diagnostics, acquired Genia for \$125 million in up-front payment, plus up to \$225 million in milestone payments.

With the collaborative strength of the leaders in biotechnology and the pharmaceutical industries, the team's goal is to develop a leading platform for personalized medicine.

Because each human differs from every other human by millions of variations in their genomes, understanding each person's genomic blueprint could provide vital information for disease prediction and prevention, while treatment could be tailored to the individual's genome. The key to this amazing big-picture potential for personalized medicine is continued research at the molecular level to discover genetic networks and cellular functions, coupled with bioinformatics and computational biology. That's exactly where Ju is happy and excited to be working: "My colleagues and I are inspired to harness our efforts and interdisciplinary expertise to produce new technologies for human health," he says.

By Amy Biemiller






# MEET THE

A lightweight, inexpensive, brain-controlled robotic arm for people with full-body disabilities that Durrani built with a team at the Columbia Robotics Lab under the direction of Computer Science Professor Peter Allen (page 55).





Pictured from left to right: Haoqian Chen, Sahir Jaggi, Jonny Cohen, Jennifer Mahan, Andelyn Russell, Haris Durrani, and Henri Dwyer

# FUTURE

**THE BOLD  
& DYNAMIC  
STUDENTS  
OF SEAS**

**A**t age 12, Jonny Cohen came up with an idea for a revolutionary device that would directly cut the costly operating inefficiencies of school buses. Now a sophomore at Columbia Engineering, Cohen is not just a mechanical engineering student but also the founder and CEO of his own company, GreenShields Project, the maker of that environmentally friendly transportation device. Cohen is one of the many game changers and innovative thinkers who currently comprise the School's dynamic student body.

In the following pages, you'll get to know current students like Cohen, who are already making a difference in the world; like PhD candidate Haoqian Chen, who is researching ways to improve cell therapy for cancer treatment, hoping to reduce the need for patients to undergo traditional chemotherapy and radiation; and senior Jennifer Mahan, a devoted Engineers Without Borders volunteer who helped build a foot-

bridge in rural Morocco to give residents access to food and medical supplies when flooding and the lengthy rainy season cripples their region.

These students reflect a generation of budding engineers who may have tinkered with LEGOs as kids but cannot imagine a world without the Internet; whose life and likes are documented on social media sites everywhere; and who are embracing a renaissance in engineering where literally no field, industry, or sector has not been influenced by engineering in some shape or form. Here, *Columbia Engineering* magazine offers a cross-section of the School's exceptional student body, young engineers who are, right now, making their marks at Columbia Engineering, carrying on its legacy of innovation and excellence. The School's next 150 years and its promising future couldn't seem any brighter.

## HAOQIAN CHEN

PHD CANDIDATE, BIOMEDICAL ENGINEERING



**H**aoqian Chen MS'12 is on a mission to serve others. From volunteering to combat homelessness and AIDS in New York City, to getting hands-on in rural Nigeria to help set up a community-based ceramic water filter business, this PhD candidate is driven to participate in the community and give back. That personal engagement doesn't just fulfill the very large heart of a young researcher. It also serves to inspire her work in immuno-engineering.

"In giving back to my community I get inspired by my colleagues and collaborators, doctors and social entrepreneurs who live to serve the most disadvantaged," she states. "Their selfless dedication gives me the encouragement to push further in research."

That inspiration is helping to drive Chen's work in improving cellular therapy for cancer treatment. Chen is focusing her research on applying a patient's own immune cells, also called leukocytes, to fight cancer, which could reduce the need for traditional chemotherapy and radiotherapy treatments that can kill cancer cells but also harm healthy cells.

"Almost everyone knows someone affected by cancer," she says. "I'm drawn to cellular immunotherapy because it harnesses the patient's immune system to target the cancerous cells directly. It's an exciting and burgeoning area of study and represents an area with much potential to help society."

Chen is diving deep into this innovative science, studying the process in which the body's healthy leukocytes, specifically T lymphocytes or T cells, are triggered. T cells are the natural defense to infections, and Chen hopes to gain fuller understanding of how the body kick-starts their development. By doing so, she expects to learn how to make these cells even more effective in fighting cancer.

"I am studying how the Lck protein (lymphocyte-specific protein tyrosine kinase), which is involved in the signaling process of certain T cells, activates

a cascade of biochemical signals that initiates T-cell activation and multiplication," she explains. "I am focusing on how external cues change the dynamics of Lck activity."

Her current goal is to develop a biosensor, a novel synthetic molecule that reports the activity of Lck in real time.

"By deepening our understanding of how Lck—and to an extent, cellular activation—responds to external cues, we hope to immuno-engineer and manipulate T cells for greater clinical efficacy," she says.

Chen's work in this innovative field caught the attention of the National Science Foundation (NSF), which awarded her its Integrative Graduate Education and Research Traineeship as well as its Graduate Research Fellowship.

"I feel really honored to receive this support from the NSF and am thankful to my advisers and mentors who cultivated my interest in research," she adds.

Chen's passion for translational research that can improve the human condition can be exhausting. "In lab work you have to maintain your optimism that someday your experiments will yield good results," she says. When she needs to pump up that optimism, Chen takes a break and volunteers with an organization that mobilizes New Yorkers to make a difference in their communities.

"I'm in the process of getting my puppy, a Shetland sheepdog named Leukocyte, trained and certified as a therapy dog," she reveals. "Once he's trained, we'll participate in sessions that encourage literacy by allowing children to practice their reading by reading aloud to their canine buddies."

*By Amy Biemiller*

*Pictured, left: Haoqian Chen uses the circular silicon wafer, with micro-scale patterns, to control the spatial cues that T-cells experience. By understanding how Lck activity—and by extension, cellular activation—changes under different spatial conditions, she hopes to immunoengineer T-cells for specific applications.*

## SAHIR JAGGI

SOPHOMORE, BIOMEDICAL ENGINEERING

**H**ailing from Upstate New York, Sahir Jaggi knew he wanted his college experience to include an urban environment with a free enterprise edge, but he also craved more.

“I’m very interested in start-ups and entrepreneurship. I’m able to learn engineering-related subjects in school, and the best way for me to learn business-related things is in an environment outside of the classroom,” says Jaggi, a biomedical engineering sophomore.

Jaggi found his entrepreneurship stride early on at Columbia. During his first month, he was introduced to Engineering School Dean Mary Boyce during a dinner where they began discussing the new Columbia Makerspace (page 58), a physical working area where students can bring their coding, programming, and creative DIY ideas to life while working in a collaborative environment. Jaggi quickly became the student lead on the project and delved right in by first surveying students about their interest level.

He soon spearheaded the student movement around everything from safety to logistics and supplies. There’s now a student council that oversees Makerspace, which opened this semester.

“Beyond resources for projects, the Makerspace provides an environment that is conducive to collaboration, hands-on learning, experimentation, and a place open to everyone, regardless of academic standing or discipline,” he says.

In addition to his help on the Makerspace and his classroom and research endeavors, Jaggi is also working steadily on a first-year pre-orientation program that will be tailored to students interested in entrepreneurship. With a target launch of summer 2015 for the Class of 2019, the idea behind the program is to serve as a crash course in entrepreneurship and the New York start-up scene.



Sahir Jaggi shows mock-ups of an application he is designing, one of the small projects he and his friends are working on outside of coursework.

---

## SAHIR JAGGI [CONTINUED]

“We hope to enable students to explore their entrepreneurial interests from day one and, if they’re so inclined, help them stay on track with their progress,” he says.

Jaggi’s own go-getter attitude showed through even before he stepped foot on campus.


“I really wanted to go to a place where the course load and class style wouldn’t force me to focus only in one specific area but would allow me to take classes in, and even minor in, a few very different disciplines. Everything I knew I would find at Columbia I’ve found here,” he says.

Since he’s continually being exposed to various subjects through his course work at Columbia, such as biomedical and electrical engineering, computer science, architecture, and statistics, Jaggi said he’s curious to learn more about the actual applications of the projects he works on. To that end, even before arriving for his first year at Engineering, Jaggi secured himself a research assistant spot in the Sia Lab, run by Samuel Sia, associate professor in the Department of Biomedical Engineering and a faculty entrepreneur. Jaggi noted that his three-year high school stint in a lab gave him the basic skills necessary to work in the Sia Lab, which focuses on molecular and micro-scale bioengineering.

“I am very excited and motivated by Dr. Sia’s philosophy, his approach to research, and his work in general,” Jaggi says. “He has a close affinity to entrepreneurship as well and has opened my eyes to what engineering really can do.”

Jaggi’s own enthusiasm seems to be on the right track for long-term engineering entrepreneurship success.

*By Janet Haney*



“Columbia Engineering is the perfect climate for fostering the entrepreneurial aspirations of its students because it provides an incredible education, its professors are remarkably supportive and accommodating, and it’s located in a major city, where, if you try hard enough, you can meet almost anyone.”

## JONNY COHEN

### SOPHOMORE, MECHANICAL ENGINEERING

A student entrepreneur on the move, Jonny Cohen was a featured speaker at TEDxRedmond, which highlights the unique inspiration, activism, and drive of young people. He was named to the 2013 and 2012 Forbes 30 Under 30 Energy List for his work in green technology, and also serves as CTO at Ecoviate, a green tech start-up.

**A**lthough Jonny Cohen, a sophomore at Columbia Engineering and founder and CEO of GreenShields Project, is the father of an environmentally friendly transportation innovation, in many ways he is still stuck in grade school. That's because his invention identifies and solves a major problem with which all school districts are faced—the costly inefficiencies of operating school buses.

Cohen's creation, GreenShields, resembling a yellow shark fin affixed to the upper front portion of a school bus, is an aerodynamic device that has been tested and shown to improve the gas mileage of school buses by 10 percent. Those results are attributed to GreenShields' unique shape, which redirects air pressure at the top of buses to reduce fluid separation and lower the coefficient of drag. As a result, buses require less energy and fuel to move through space.

"GreenShields are painted yellow, but there's a reason why they're actually green: If every bus in America adopted this technology, atmospheric carbon emissions could be annually reduced by 1.8 million tons!" Cohen exclaims. "Furthermore, schools in the United States would collectively save nearly \$300 million each year."

What makes Cohen's creation even more impressive is the fact that it was first imagined when he was just 12 years old. "I was walking home from school one day in seventh grade and I was thinking about a Saturday enrichment class I was taking on aerodynamics," he recalls. "I noticed a box-shaped school bus parked in front of my junior high and I thought its design could be improved." Since then, GreenShields has undergone several remodeling phases. Now in its fourth iteration, the fiberglass and epoxy resin device is nearly market ready.

"Regulatory restrictions have definitely delayed the production process, but I'm confident that GreenShields will be able to appropriately address regulations and persevere, as great progress has already been made," explains Cohen. "Although

GreenShields are not yet commercially available, we expect the cost to be somewhere around \$500 per unit. At that projection, for buyers, each unit would pay for itself in less than a year."

His innovation captured the attention of the Helen Diller Family Foundation, which awarded him \$36,000 this year for tackling global issues and creating lasting change.

In addition to his responsibilities as a student and an entrepreneur, this year Cohen attended meetings as a Youth Advisor to the USA Science and Engineering Festival. He is also keeping himself busy by managing consumer demands. "Each day, my email fills up with requests for GreenShields, so I'm doing my best to get them on buses as soon as possible." With so many duties, Cohen admits that it can be difficult to balance the demands of school and business, but he humbly confirms that there is no place he would rather be to face those challenges.

"Columbia Engineering is the perfect climate for fostering the entrepreneurial aspirations of its students because it provides an incredible education, its professors are remarkably supportive and accommodating, and it's located in a major city, where, if you try hard enough, you can meet almost anyone," he says. "I am very lucky to be a part of such an amazing university."

*By Dave Meyers*

## JENNIFER MAHAN

### SENIOR, CIVIL ENGINEERING AND ENGINEERING MECHANICS

Jennifer Mahan's visits to Morocco through the School's Engineers Without Borders (EWB) chapter and time as a Columbia Engineering student have brought her closer to a key goal: making a societal difference through her love of engineering.

"Before I got to Columbia I was really interested in finding a balance between engineering and community service," says Mahan, who has already traveled to Morocco three times as an active EWB volunteer. "Columbia encourages engineers to see the bigger picture, not just the equations and the problems, so that we also . . . understand the larger social, political, and topical issues that we'll be working on in that environment."

Mahan, a senior in Civil Engineering and Engineering Mechanics, studied Arabic in Morocco on a State Department scholarship the summer before arriving at Columbia. The St. Louis native has since been heavily involved with EWB's suspension bridge building project in Ait Bayoud, a rural community in Southern Morocco.

"It was Engineers Without Borders and working on the bridge project that helped me decide on civil engineering as a major . . . and it pushed me further into structural engineering specifically," Mahan says.

The 210-foot suspension footbridge was built using synthetic cables—donated by adjunct professor of civil engineering and engineering mechanics and acclaimed bridge engineer Theodore Zoli—as a sustainable alternative to steel cables. The bridge was completed in June 2013, and Mahan remains the project's co-lead and heads maintenance and operations from her Columbia base. For Mahan, witnessing firsthand the direct impact of her actions as a volunteer in the community is significant.

"About 2,400 people can now use the bridge to get from one side of the market and back, get to the health clinic, and get to the school," she says. Without the bridge, people had difficulty access-

ing much-needed resources during the region's three-month, flood-prone rainy season.

Mahan's attraction to engineering started in high school when she took an interest in physics and engineering. Recent internships have given Mahan real-world experience and have helped further solidify her desire to make a difference through engineering. In the summer of 2013, she was a cost-estimating intern with Metropolitan Transit Authority (MTA) Bridges and Tunnels, right on the heels of Hurricane Sandy.

"It was really interesting being at the center of these construction projects and seeing how they were going about addressing the issues," Mahan says, referring to post-hurricane activities.

Her most recent internship was the exact opposite from the MTA. She was an intern at Gannett Fleming, a global infrastructure firm, where she had a more technical role, getting involved with the firm's structural projects.

This rising star and recent American Council of Engineering Companies scholarship recipient still finds time for extracurricular activities such as Columbia Youth for Debate and Columbia Faith and Action.

With all her hands-on and classroom involvement, Mahan pointed out that EWB is one of her most rewarding Columbia experiences to date.

"Working with Engineers Without Borders has validated my hope and belief that engineering can have a direct and positive impact on the lives of people around the world," Mahan says. "I like that we do more than provide a technical understanding of the project—that we actively engage in a dialogue with community members to find the best solutions to the problems as a team."

*By Janet Haney*

Below: A team of Columbia EWB students, professional engineers, and local community members in Ait Bayoud, Morocco, collaborated to complete the 210-ft foot-bridge in June 2013.





“Columbia encourages engineers to see the bigger picture, not just the equations and the problems, so that we also understand the larger social, political, and topical issues that we’ll be working on in that environment.”

—Jennifer Mahan

## ANDELYN RUSSELL

JUNIOR, OPERATIONS RESEARCH

It was a simple realization that propelled Andelyn Russell’s pursuit of engineering: the world is beautiful, and humans need to protect it.

Russell chose to pursue engineering because she was set on having a positive impact in the world. “Humanitarian topics such as food security and sustainable development are pressing issues, and I wondered how I could make a difference. Engineering was the answer I saw most clearly,” she says.

It was Russell’s humanitarian spirit that led her to Columbia Engineering, where she is studying operations research as an Egleston Scholar. Currently a junior, Russell has wasted no time embodying the University’s global mission. Last semester, she studied microeconomics, discrete mathematics, and statistics in Madrid. This summer she traveled to Fontainebleau, France, where she interned with INSEAD’s Social Innovation Centre as a visiting researcher. She was the only undergraduate student intern this summer. She credits her Engineering advisers and professors for providing the support and space to explore such worthwhile opportunities.

Russell’s intellect affords her the ability to be explorative in research topics. In France, she worked with a team to analyze the circumstances of vehicle accidents with the goal of reducing the rate of accidents within two years. In two previous summers she worked on projects at Northwestern University, in one case developing a simple model of the spread of HIV in a generic sub-Saharan African population under the guidance of a professor, in the other, assisting on a project seeking to find a cure for Parkinson’s disease. It is through these diverse and important research pursuits that Russell has nurtured her innate sense of responsibility.

Keen enough to recognize a thread between her course work at school and her passions, she understands the importance of the tools she’s currently honing for gathering statistical analysis, specifically due to the emotional nature



ANDELYN RUSSELL [CONTINUED]

of many of the issues for which she does research. And her inclination to give back to society is as deep rooted and innate as her scientific aptitude. “I always try and volunteer in some capacity,” she says, speaking fondly of experiences where she taught a Model United Nations elective in a Harlem high school or tutored students in Spain for their International English Language Testing System exam.

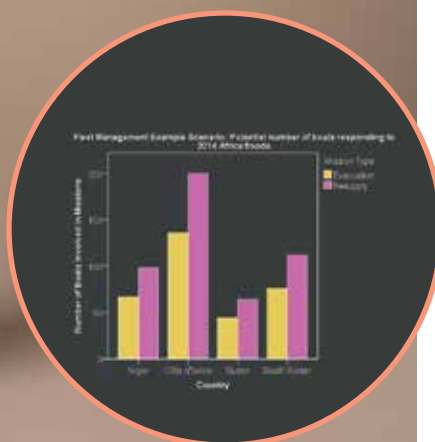
Fascinated with world cultures and the ways in which they interact, Russell has an anthropological inclination nurtured by Columbia’s strong global charge. But even with her desire to see the world and change it for the better, she loves her current home base being New York.

“New York City is the capital of individuality,” she says. “The environment promotes creative thinking and self-expression; despite the size, everyone can find their niche. Yet in following their dreams, New Yorkers work hard.”

It is apparent from Russell’s résumé, her near perfect GPA, her challenging course work, and her significant internship and research credits that she is indeed one of those hard-working New Yorkers. She seeks out difficult challenges in pursuit of a better world, tackling global issues with her uniquely capable intellect. Her work ethic and adeptness in cutting through complex problems will serve her well as she moves forward. Her educational aspirations include earning a doctorate; her professional goals include no less than bettering humanity by working with a humanitarian organization. And evidence indicates this is a goal Russell will achieve in vast and tangible ways.

*By Elaine Rooney*

*Pictured, left: This bar graph shows the hypothetical number of flood boats used in response missions in four countries experiencing floods in 2014. The graph conveys fleet management considerations in the humanitarian sector, and is merely illustrative of the type of work Russell focused on last summer.*





## HARIS DURRANI

SENIOR, APPLIED PHYSICS

Whether it's pioneering space law, writing science fiction novels, or fighting for the rights of disenfranchised communities, Haris Durrani's ambitions are as big and bold as his already stellar collection of achievements. His résumé boasts a list of heady accomplishments: award-winning author, editor, Egleston Scholar, cofounder and co-creator of the Muslim Protagonist Symposium, founder of a FIRST Tech Challenge Robotics Team, and the list goes on. Famous authors have lauded his work; he has been published and thrice interviewed on NPR's *The Takeaway*. He has received countless awards and honors, including a Creativity and Citizenship Award from the Center for Constitutional Rights and a National Gold Medal Portfolio from Scholastic Art and Writing Awards, and he was named a Minority Undergraduate Physics Major Scholar by the American Physical Society. To amass all this over the course of a lifetime would be duly impressive. But Durrani, a college senior, has not even graduated yet.

Durrani's passion for engineering and science stems from childhood, beginning with building with LEGOs and playing with science kits. In high school, he established his hometown's FIRST LEGO League and FIRST Tech Challenge teams in Westport, CT. Within three years he led the teams to first place finishes at the World Championship. He understood the power of robotics.

He knew early on what set engineering apart for him. "Most fields are fascinating in theory," he says. "Engineering is a field that I love from the meta to the nitty-gritty."

What is especially impressive about Durrani is his pan-disciplinary thirst for the interesting and his ability to let his various interests inform one another. An applied physics major at the School, Durrani also is a talented writer. He uses literature as an outlet for exploration—a vehicle to contextualize science, engineering, space—and a means to examine his identity as a Dominican, Pakistani American Muslim.

"Literature helped me understand that engineering and science exist in their social contexts and that an understanding of social, political, and moral implications is just as important—if not more important—as engineering formulae and methods."

It was this social consciousness that drew Durrani to Columbia Engineering. "SEAS had an emphasis on social responsibility and humanities that I didn't see elsewhere," he says.

Durrani is committed to the pursuit of social justice, and it underlines all he achieves. It was the impetus for his cofounding the Muslim Protagonist Symposium, with Barnard alumna Mirzya Syed, at Columbia to "use literature as an agent of social, intellectual, and spiritual change." It is also the catalyst for his interest in space law.

Last year, Durrani participated in an independent study with NASA astronaut and Columbia Engineering professor Michael Massimino BS'84, where he investigated the political and legal implications related to space debris and policy. "I believe that if we invest the time in forming the law now, we can make sure the final frontier is a feasible one. It's a field that I feel I can go into, helping to form its paradigms rather than merely improving what has already been done before." For Durrani, who is by nature a builder, whether of robots or of stories, being able to craft something from its infancy has always been an attractive prospect.

Fittingly, what's exciting to Durrani about his future isn't the realization of one particular goal but the sum force of all his passions being realized.

Sharing a quote of one of his favorite authors, fellow Columbian Isaac Asimov, Durrani says, "Knowledge is indivisible. When people grow wise in one direction, they are sure to make it easier for themselves to grow wise in other directions as well." Indeed, Durrani embodies this principle by looking for the connectivity in all he pursues.

*By Elaine Rooney*



A lightweight, inexpensive, brain-controlled robotic arm for people with full-body disabilities that Durrani built with a team at the Columbia Robotics Lab under the direction of Computer Science Professor Peter Allen. The team was a finalist for the Cornell Cup USA, presented by Intel in Walt Disney World.

## HENRI DWYER

### MS CANDIDATE, EARTH AND ENVIRONMENTAL ENGINEERING

As an undergraduate, Henri Dwyer studied quantum physics but now, as he works toward a master's in Earth resource engineering, he has been all consumed with something else entirely—trash. Turning waste to energy, to be exact.

“My ultimate goal is to start my own company, leveraging my technical and scientific skills in an innovative way to tackle our global energy challenges so we all become more efficient consumers of energy,” Dwyer says. “I believe waste to energy is a great pathway toward my goal.”

Dwyer, expected to graduate in December, spent one undergraduate semester running tests on river power, physically installing turbines near bridge pillars to see how they could increase power output. That experience instantly hooked him on waste-to-energy (WTE) research. A scholar in the NSF S-STEM Sustainable Engineering GradUatE (SEGUE) Scholars Program at Columbia, Dwyer is part of a small cohort of engineers focused on studying societal and environmental challenges, emphasis on water, energy, and infrastructure.

This opportunity was perfect for Dwyer, a dual French and American citizen who attended the famed Ecole Polytechnique in Palaiseau, France. He intends to complete his last year of Ecole Polytechnique's engineering program in conjunction with the completion of his master's program at Columbia Engineering.

Also a junior researcher on Columbia's Waste-to-Energy Research and Technology (WTERT) Council, Dwyer studies dioxins to see if rumored WTE and incinerator pollution fears are justified, concerns about the open-air combustion process that can produce dangerous pollutants. His analysis includes taking raw data from more than 90 percent of U.S. WTE plants to obtain dioxin emissions. He also works with Environmental Protection Agency (EPA) data calculating nationwide dioxin emissions. His goal: learning how the main dioxin sources' emissions have evolved over the years and WTE's role in that.

“Generally, waste to energy deals with converting municipal solid waste or household trash into electricity and heat,” Dwyer explains. “In the U.S., with little demand for hot steam, the focus is usually on electricity.”

According to a 2012 report by the EPA, the average American generates more than four pounds of trash a day, resulting in 251 million tons of trash for the year, most of which ends up in landfills.

Landfills' disadvantages, Dwyer notes, are residual air and water pollution, while leftover ash from the WTE process has a much lower volume than the original trash and can be cleaned and reused in cement or road pavement, for example. But the WTE method is not without controversy.

“There are two main blocks to wider adoption: initial costs and public perception,” Dwyer says. “A WTE plant can cost several hundred million dollars to build, so it can be difficult for municipalities or companies to raise enough capital. The second block stems from the history of waste to energy.”

Dwyer commented that over the last 20 years stricter regulations and better technology have turned the WTE industry into a much cleaner one, but its reputation lingers.

Roadblocks and lingering problems aside, Dwyer is up to these challenges. His preliminary results focusing on WTE and landfill nationwide dioxin emissions, along with health risks analysis, were recently presented at the 2014 North American Waste-to-Energy Conference. For many, garbage is just garbage; for Dwyer, it is a chance to make a difference in the environment and the world. So Dwyer plans to publish an article and his thesis using scientific sources proving WTE's claims of safety.

“Hopefully, my results will help convince opponents that their fears of dioxin air pollution are no longer justified,” he says. “I'm really excited about contributing to bettering our energy use and production.”

*By Janet Haney*

For many, garbage is just garbage; for Henri Dwyer, it is a chance to make a difference in the environment and the world.

Below: Shown here, dioxin emissions for four reference years, by sector and source. Each color represents a sector, and each box a source within that sector, with the area proportional to emissions.





## THE NEXT GENERATION



**M**arking the official start to the academic year, the Class of 2018 posed for a group selfie with Dean Mary C. Boyce at the School's annual Academic Assembly. The program, held in Low Rotunda August 26, served as an official welcome to the new class of first-year students, and an introduction to their exciting year ahead.

To an audience of approximately 300 new students, Dean Boyce said, "As you each have come to realize, engineering is critical to our world's future. The impact that each of us can have by bringing engineering solutions to the many key global challenges facing the world today has never been more important."

As a tradition, members of the Class of 2018 received a commemorative beanie to mark their entry into the Columbia Engineering community. Once a mandatory accessory at Columbia, the beanie is now a souvenir for incoming first-year students. This year's is slightly more special as it displays the School's 150th logo in honor of its sesquicentennial.



# ROOM FOR INNOVATION

All engineers need a place to tinker. At the newly opened Columbia Makerspace, students will be able to do that and more with a dedicated place on campus to collaborate, learn, explore, experiment, and create prototypes.

Located on the 12th floor of the Mudd Building, the Makerspace is equipped with a variety of hand tools and specialized tools, including an industrial sewing machine and a CNC embroidery system; a 3D printer, a laser cutter, and vinyl cutters; an extensive collection of woodworking tools; and electronics assembly and testing and debugging benches. Makerspace offers a central location for students to explore and create, whether their interest lies in woodworking and digital fabrication or textile arts and electronics. In addition to the work areas, the space also will serve as a place to host short seminars or student workshops.

Purely student driven, the idea for the space was brought on by a group of Engineering students who lobbied Dean Mary C.

Boyce last fall. The dean recruited a faculty steering committee to work with students on its formation and launch. Now, a leadership committee comprised of 10 students is in place and charged with setting the priorities and policies of the new space, and its operational structure.

Sophomore Sahir Jaggi (page 49) was one of the students instrumental in getting the Makerspace off the ground. He says, “Beyond resources for projects, a makerspace provides an environment that is conducive to collaboration, to hands-on learning, to experimentation, and is a place open to everyone, regardless of academic standing or discipline.”

The Makerspace, though housed at the Engineering School, is open to all Columbia undergraduates and their collaborators. And students are welcome to use the tools and the room whether or not they are working on a specific school-related project. As Ioannis (John) Kymissis puts it, “This is one distinguishing feature from



## SCHOOL OPENS NEW MAKERSPACE



other campus resources—the only requirement is that if they want to make something, then they can come and do it.”

Kymissis, associate professor of electrical engineering, was tapped in the spring to help direct the Makerspace. He works closely with the Engineering Student Council and both the faculty and student committees on managing its overall function, including overseeing key matters like safety and purchasing. Kymissis is a big fan of having this much-needed resource.

“Facilities like the Makerspace allow students to express their creativity and work on their engineering and artistic skills,” Kymissis says. “Students don’t always have access to certain tools or equipment that they might otherwise want to try out either for creative or practical reasons. They might want to monogram a jacket, fix their bike, or build a sculpture using laser-cut plastic pieces. The Makerspace lets them learn how to do this from their peers and provides the resources required to get projects done.”

So not only does the Makerspace serve as an actual space to build and work on projects and prototypes, it also spurs a sense of community. “What has also formed is a community interested in building, repairing, and trying new things—the sorts of things engineers love to do,” Kymissis adds. “I want to be sure that students can show up with an idea and walk out having made it in as many domain areas as possible.”

Jaggi is excited about the potential for also sitting in on classes and workshops that will be held at the new space. Having the Makerspace “allows us to cultivate a community of people interested in building things, and we can encourage more of a ‘maker’ culture at Columbia.”

*By Melanie A. Farmer*

# BIG DATA

# RESEARCH

## NEW GRANTS FUND INTERDISCIPLINARY DATA SCIENCE RESEARCH

Columbia's Institute for Data Sciences and Engineering is launching three groundbreaking research clusters at the interface of data science and the natural sciences. Funded in part by the Gordon and Betty Moore Foundation and the Alfred P. Sloan Foundation, the intensive collaborations chart new frontiers of biological oceanography, high-dimensional data analysis, and exploring the origins and destiny of our world.

Established in 2012, the Institute, a leading hub of cutting-edge interdisciplinary research, brings together over 150 affiliated faculty from nine University schools. The new research clusters expand the Institute's range of expertise, driving new advances and enhancing opportunities for doctoral students across disciplines to include a broader spectrum of questions and insights in their work.

"This support from Moore-Sloan is helping us achieve our goal for greater diverse interdisciplinary collaborations with the natural sciences at Columbia," says Institute Director Kathleen McKeown, the Henry and Gertrude Rothschild Professor of Computer Science.

One research cluster, "High Dimensional Data Analysis of Microscopy Images," is being led by Abhay Narayan, assistant professor of physics, and John Wright, assistant professor of electrical engineering. They will use modern techniques of data and image analysis to search and identify basic patterns making up a complex image of a material at the nanoscale. Identifying a material's basic building blocks will enable them to relate a material's structure to its functional properties.

"We are grateful to Moore-Sloan for supporting data-driven science," Wright says, "and for this program, already inspiring us to think about new computational models and tools, which should be useful both in microscopy and in other domains of science and engineering."

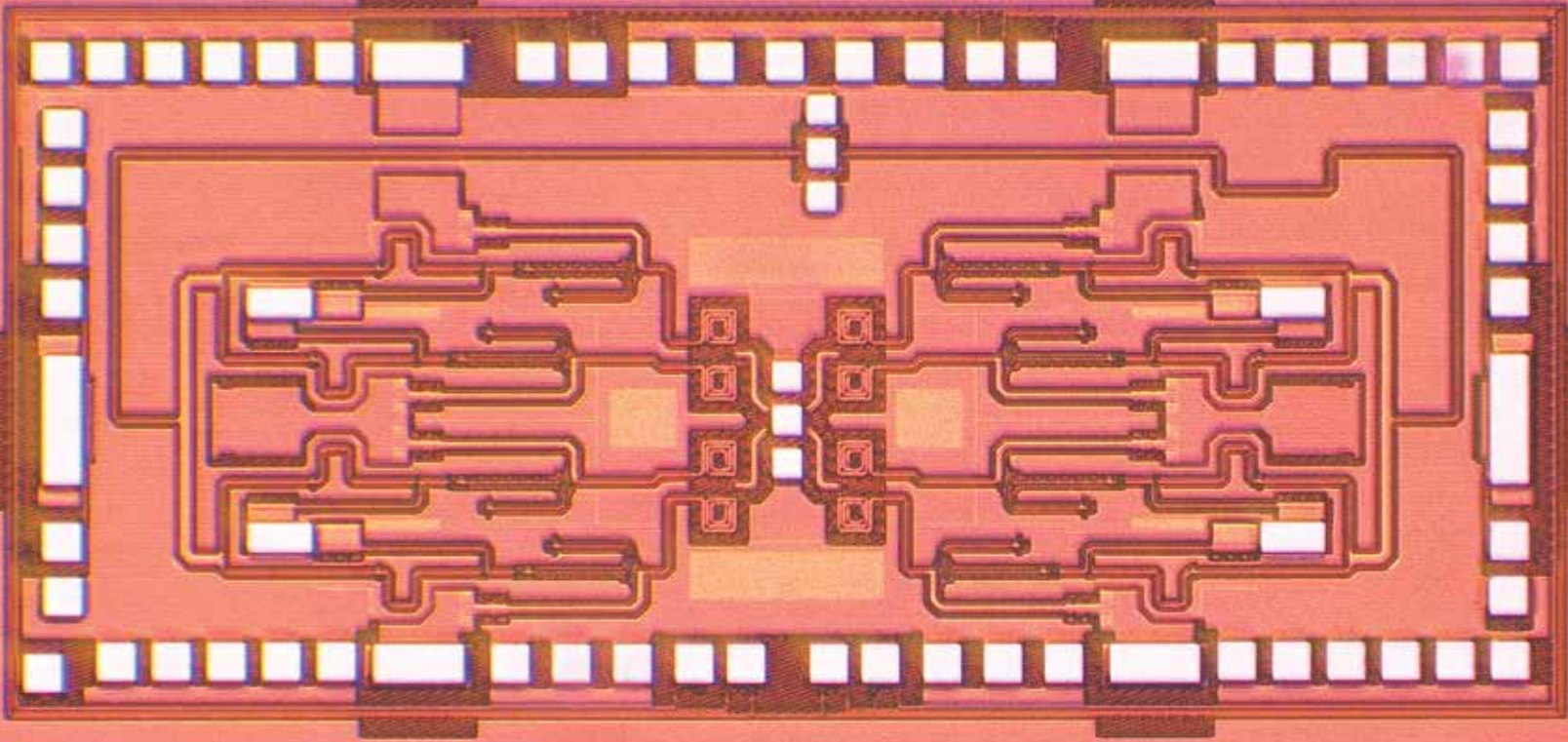
"The Birth of the Universe and the Fate of the Earth: One Trillion UV Photons Meet Stan," led by David Schiminovich, associate professor of astronomy, and Andrew Gelman, professor of statistics and political science, will examine the vast data set comprised of every photon observed and recorded by the Galaxy Evolution Explorer (GALEX) ultraviolet space telescope over 10 years. It uses a novel probabilistic modeling tool called Stan to unlock what the GALEX findings can reveal about dying white dwarf stars. "This project," Schiminovich says, "has the potential to transform the process by which astronomers confront models with their data."

The third project, "Mining an Ocean of Data: Application of Modern Statistical Methods for Addressing Biological Oceanography Questions," directed by Joaquim Goes, research professor at Lamont-Doherty Earth Observatory, and Rahul Mazumder, assistant professor of statistics, will analyze data from satellites and autonomous floats to deepen understanding of oceanic properties and identify phytoplankton from space.

"The oceans are vast, and extracting meaningful information for climate research continues to represent a huge challenge," Goes says. "This collaboration with statistical scientists essentially allows us to sail in uncharted waters."

Also this fall, the Institute celebrated another milestone. In addition to research proceeding on numerous fronts, it has received official approval for its new MS program in data science. The new degree is uniquely structured to provide the foundational education and real hands-on knowledge to address the shortage of data scientists across multiple sectors.

*By Jesse Adams*



# QUALCOMM

## INNOVATION FELLOWSHIP

### COLUMBIA ENGINEERING BOASTS TRIFECTA OF QUALCOMM FELLOWSHIP WINS

For three years in a row, Columbia University PhD researchers have beaten the odds to secure a coveted fellowship sponsored by a world leader in digital communication. It's a win for both the researchers and the company, which recognizes that finding better solutions that meet new requirements requires the sort of fresh thinking and creative approaches that aren't necessarily corporate grown.

Qualcomm Incorporated's Innovation Fellowship is open by invitation to students from a variety of top international schools. The competition annually awards a \$100,000 prize to pairs of students for research proposals that most impress the fellowship committee judges.

"We want to establish strong relationships with top research institutions, such as Columbia University, so as to expose our own researchers to the cutting-edge research being done in academia," says Aaron Klein BS'04, MS'05, PhD'10, staff engineer at Qualcomm Corporate Research. "One way we do that is through our Innovation Fellowship for PhD students."

The competition for the fellowships is fierce. This year there were nine winning teams selected out of 137 submitted proposals.

"Qualcomm inventions helped launch the mobile revolution and can be found in billions of devices around the world, from

smartphones and tablets to cameras and cars," explains Klein, who has been the fellowship point of contact for Columbia Engineering since 2012. "This fellowship program helps us continue to push the boundaries of possibilities and further research and development."

For Qualcomm, the program allows hardware, software, and systems engineers to get a deeper look into the research happening at leading universities and helps form collaborative relationships between Qualcomm and academia.

"I like to interact and have discussions around challenging topics with talented students and their professors," says Andrzej Partyka, a research and development engineer at Qualcomm and fellowship mentor. "I gain new insight and I also get to share my experience."

Being selected for a fellowship not only substantiates the winning students' research goals but adds prominence to the universities that are represented. *[continued on page 62]*

*Pictured above: This prototype is a Power Amplifier operating at 45GHz with a record output power of 0.5Watt and was developed in Prof. Krishnaswamy's research group as part of the DARPA ELASTx program. (Image provided by Anandaroop Chakrabarti)*

## QUALCOMM [CONTINUED]

“The Qualcomm Innovation Fellowship identifies research proposals of a fundamental nature that have the potential to revolutionize technological areas that are of interest to Qualcomm,” says Harish Krishnaswamy, assistant professor of electrical engineering at Columbia Engineering. “Consequently, it is simultaneously a validation of the innovative nature of the ideas proposed and of their usefulness to real-life applications.”

Krishnaswamy has firsthand knowledge of the value of that partnership: He is the PhD adviser to Anandaroop Chakrabarti who, along with Mehdi Ashraphijoo, advised by Xiaodong Wang, professor of electrical engineering, won the 2014 fellowship for their Massive Millimeter-Wave MIMO for 100G Wireless project.

Millimeter-wave technology refers to the use of frequencies for wireless communication that are an order of magnitude higher than what is used today in cellular phones and WiFi. Going to higher frequencies enables higher bandwidths and data rates. MIMO or multiple-input, multiple-output technology refers to the use of multiple antennas to establish many parallel streams of communication, further increasing bandwidth.

“This project proposes novel hardware and signal processing methodologies that will enable citywide wireless links supporting enormous data rates. This could form the backbone of future wireless networks that provide more mobile device capacity for users,” Krishnaswamy says.

That’s tech research that appeals to Qualcomm, which has been an industry leader in improving WiFi performance and creating new ways for WiFi networks to operate.

“This Columbia research is just the type of project we look for to contribute to our success in emerging research areas,” Klein says.

In the previous two years, Columbia electrical engineering PhD candidates Sunwoo Lee and Michael Lekas have won the fellowships for their proposals to use graphene devices to enable more versatile wireless circuitry and to make filters more flexible.

“These impressive showings three years in a row reflect Columbia Engineering’s consistently excellent quality of research and focus on innovation,” Klein says.

*By Amy Biemiller*



# IN FULL SWING

## ENTREPRENEURSHIP AT SEAS

### NEW CO-WORKING SPACE FOR YOUNG ALUMNI START-UPS, THE LATEST IN A STRING OF ENTREPRENEURSHIP ACTIVITY AT SEAS

Columbia Engineering’s thriving community of alumni entrepreneurs has a new home in New York City’s exciting tech start-up scene.

Located on the ground floor of the WeWork Soho West building on Varick Street, the new Columbia Startup Lab is home to 43 teams of Columbia entrepreneurs, including 24 seats devoted to Engineering alumni. The tenants represent a range of ventures, from sports and fashion to technology and health. In addition to discounted office space, the tenants receive practical business support, specialized training, and the opportunity to collaborate and network with fellow entrepreneurs. Each start-up team—representing not only the Engineering School but also Columbia Business School, Columbia College, and the School of International and Public Affairs—was selected through an application and interview process held in the spring. The qualified entrepreneurs have graduated from the University within the past five years.

The Columbia Startup Lab is just one of the many ways in which the School supports and promotes entrepreneurship. Offering a unique roadmap for its students, alumni, and faculty to pursue their innovative business ideas, the School hosts the Fast Pitch Competition, cohosts the Columbia Venture Competition, provides the Ignition Grants program, which funds ventures started by current Engineering students, and the Res. Inc. program, which is a residential community of engineering students interested in entrepreneurship. New this fall, the Columbia Makerspace, housed on the 12th floor of the Mudd





Building, is giving students a dedicated place on campus to collaborate, learn, explore, experiment, and create prototypes.

Announced earlier this year, 13 early-stage start-ups, led by SEAS students, have collectively received nearly \$135,000 in cFUND Ignition Grants out of a pool of some 70 applications. Grant recipients' start-up ideas ranged from new text-to-image software to innovative health care web applications and 3D sculpture reproductions brought directly to the user.

It is, indeed, an exciting time for budding CEOs at the Engineering School.

Ken Kruger MS'12 and cofounder Houtan Fanisalek say the unique opportunity to work in a shared space at the new Columbia Startup Lab has fueled their productivity. The duo's start-up, SideProjects, develops applications using a mobile framework for movement detection that utilizes sensors in wearable tech gear. Their dance app, TwerkMeter, popular among the 13- to 17-year-old female set, is a mobile dance game that directs users to perform specific dance moves as a song plays.

"Prior to working in the Columbia Startup Lab, I was working out of my bedroom," says Kruger, who earned his master's from the School in operations research. "The Columbia Startup Lab has provided two critical resources—a place to work and a sense of community. Since moving into the space, my productivity has skyrocketed. There's something about working around other hardworking people that makes a big difference."

The founders of NeuroScout, Jordan Muraskin BS'14 and Jason Sherwin, could not agree more. Even after just a few weeks in the Startup Lab, they were more energized about their company. Muraskin and Sherwin, under faculty adviser Professor Paul Sajda, have developed an applied brain-computer interface to track perpetual acuity while making rapid decisions.

"This is how innovation happens—it needs to be left alone in the right sandbox with access to the right toys. Columbia is doing that," Sherwin says.

"Working together with other start-ups is very motivating," adds Niran Shrestha, who cofounded GamePlan, the developer of cloud-based project management software for the construction industry. "During the early stage of bootstrapping and growth,

it is essential to maintain a focus and learn from the successes and failures of your peers. The Startup Lab is the ideal place for such inspiration."

At the official July 15 ribbon-cutting ceremony for the start-up lab, Dean Mary C. Boyce gave an overview of some of the Engineering alumni start-ups and underscored the School's dedication to innovation and entrepreneurship.

"In today's economy, inventors must also be entrepreneurs if their ideas are to become practical innovations in the marketplace," Boyce said. "So, in training tomorrow's leaders, at Columbia Engineering we firmly believe entrepreneurship education and support are essential." With the Startup Lab, "Columbia innovators now have a powerful home base for their businesses," she said. The School "is proud to be part of such a bold endeavor, and we look forward to seeing the products and services that will grow here in the years to come."

Teams from the Engineering School that have earned seats at the Startup Lab focus on innovations in mobile networking, social media development, restaurant management, and patient care, to name a few. They are co-working in the WeWork space with other like-minded entrepreneurs, and for one year, will have access to training and information sessions provided by Columbia faculty and alumni on topics including intellectual property and strategic planning. Networking opportunities and meetups with other Columbia entrepreneurs and alumni mentors will also be available to the start-up teams.

For many of these young entrepreneurs, joining the new facility marks a big step forward in achieving a lifetime goal.

"I always knew I wanted to run my own business," Kruger says. "I got into engineering because I like to build cool things. Building a business can be surprisingly similar to building a computer, but instead of arranging electrical components and wires, you have people and relationships. Combining engineering and business gives me a creative outlet, allowing me to express myself and share my work products on my own terms. And, really, it's just a lot of fun."

*By Melanie A. Farmer*

# CAMPUS



# CONGRATULATIONS GRADUATES

## CLASS OF 2014 ON TO NEW BEGINNINGS

“This really is the age of engineering. Every day we see how engineering solutions are meeting basic human needs—by increasing the productivity of agriculture; providing clean water, sanitation, mobility, and electricity in the developing regions of the world; or as we transform modern cities to smart cities; and as we strive to personalize medicine.”

—Dean Mary C. Boyce

FACULTY AWARDS WERE PRESENTED AS FOLLOWS:

**CEAA Distinguished Faculty Teaching Awards**

Alfred V. Aho, Lawrence Gussman Professor of Computer Science  
Ibrahim S. Odeh, lecturer in discipline in civil engineering and engineering mechanics

**Janette and Armen Avnessians Diversity Award**

Klaus S. Lackner, Maurice Ewing and J. Lamar Worzel  
Professor of Geophysics

**Edward and Carole Kim Award for Faculty Involvement**

Michael I. Hill, lecturer in chemical engineering design

“You are the most entrepreneurial generation in history. Thanks to your Columbia education, you are trained to see and solve problems differently, and you know better than most that life’s annoyances are just amplified opportunities, especially if you’re willing to risk seizing them.” —Jon Oringer MS’99

**1** Jon Oringer MS’99, founder and CEO of Shutterstock, was the Columbia Engineering Class Day Speaker.

**2** U.S. Army Capt. Keith Robinson got a last-minute leave from his Afghanistan tour to surprise daughter Ruby D. Robinson.

# NEW FACES AT SEAS

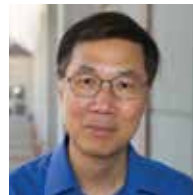
A WARM WELCOME TO THE FOLLOWING NEW FACULTY MEMBERS OF COLUMBIA ENGINEERING



## DAVID M. BLEI

Professor, Computer Science  
*PhD, UC Berkeley, 2004*  
*BS, Brown University, 1997*

David M. Blei's research includes statistical machine learning and Bayesian statistics, with wide applications in text, images, music, social networks, user behavior, and scientific data. Blei, who holds a joint appointment in Statistics, is currently teaching a PhD-level course, Foundations of Graphical Models. In the spring, he plans to teach an advanced seminar on inference from observational data.



## KAM LEONG

Professor, Biomedical Engineering  
*PhD, University of Pennsylvania, 1987*  
*BS, UC Santa Barbara, 1977*

Kam Leong focuses on the design of functional and nanostructured biomaterials for applications in nucleic acid delivery, personalized medicine, and regenerative medicine. Leong expects to teach the courses Direct Cellular Reprogramming and Biomanufacturing.



## QIANG DU

Fu Foundation Professor,  
Applied Mathematics  
*PhD, Carnegie Mellon University, 1988*  
*BS, University of Science and Technology of China, 1983*

Qiang Du's expertise is in applied and computational mathematics (multiscale modeling and analysis, numerical algorithms and simulations), with applications in areas of physical (superfluid, BECs, complex-fluid); biological (bio-membrane); materials (phase transitions, superconductivity); and information sciences (data, image). Du plans to teach Principles of Applied Mathematics in the spring, and in the near future, he hopes to teach courses on mathematical models and computational algorithms for various scientific and engineering applications.

“What makes the School attractive is the opportunity for the growth of applied and computational mathematics in an interdisciplinary research and training environment that is very unique both within the School and across the whole University.” —Qiang Du

“I chose Columbia Engineering for the excellence, diversity, and multidisciplinary research environment. I am very excited about the opportunities for collaborating with colleagues, students, and postdoc researchers.” —Agostino Capponi



**MICHAEL J. MASSIMINO**

Professor of Practice, Mechanical Engineering  
*PhD, MIT, 1992; ME, MIT, 1990*  
*MS, Mechanical Engineering, MIT, 1988*  
*MS, Technology and Policy, MIT, 1988*  
*BS, Columbia Engineering, 1984*

Michael Massimino’s research focuses on human-machine systems, space robotics, and human space flight. A former NASA astronaut, he twice fixed the Hubble Space Telescope and is pursuing partnerships in space-related research and technology development between NASA and Columbia. Last spring, he debuted a new course at the Engineering School on human space flight and plans to teach it again this academic year. Massimino is currently teaching The Art of Engineering with David Vallancourt, senior lecturer in Electrical Engineering. In the spring, Massimino will again teach Introduction to Human Space Flight.



**AGOSTINO CAPPONI**

Assistant Professor, Industrial Engineering and Operations Research  
*PhD, California Institute of Technology, 2009*  
*MS, California Institute of Technology, 2006*  
*BS, University of Rome, La Sapienza, 2001*

Agostino Capponi’s work focuses on financial engineering with an emphasis on counterparty risk, systemic risk, and dynamic credit investment. He develops probabilistic models to measure, control, and hedge these risks. The outcome of his research provides guidance toward the design of regulatory policies aimed at controlling and stabilizing financial markets. Capponi will be teaching Continuous Time Finance and Term Structure Modeling.



**MICHAEL BURKE**

Assistant Professor,  
Mechanical Engineering  
*PhD, Princeton University, 2011*  
*BS, The Pennsylvania State University, 2005*

Michael Burke’s primary research interests are in mixed-experimental-and-computational investigations of advanced combustion and energy systems that utilize multiscale modeling, automation, and data sciences. This fall, Burke is teaching Introduction to Combustion.



**MATEI CIOCARLIE**

Assistant Professor, Mechanical Engineering  
*PhD, Columbia Engineering, 2010*  
*MS, Columbia Engineering, 2004*  
*BS, Polytechnic University of Bucharest, 2003*

A roboticist, Matei Ciocarlie is interested in intelligent mechanisms that interact with their environment, hold their own in the real world, and perform useful tasks for people. He is looking to develop versatile robotic manipulators that leverage mechanical and computational intelligence and are able to assist people with motor impairments or make skilled workers more productive. This semester, Ciocarlie is teaching Introduction to Robotics. Down the road, he plans to teach more in-depth robotics-related courses such as Dexterous Manipulation, Human Robotic Interaction, or Artificial Intelligence.



---

**DANIEL ESPOSITO**

Assistant Professor, Chemical Engineering  
*PhD, University of Delaware, 2012*  
*BS, Lehigh University, 2006*

Daniel Esposito concentrates on solar energy conversion, solar fuels, catalysis, high-throughput screening of materials, interfacial phenomena, and in situ micro/nanoscale analysis techniques. Esposito is teaching Advanced Chemical Kinetics and in spring 2015 plans to teach an elective course in solar energy conversion.

**YANIV ERLICH**

Assistant Professor, Computer Science  
*PhD, Cold Spring Harbor Laboratory, 2010*  
*BSc, Tel-Aviv University, 2006*

Yaniv Erlich is interested in devising new algorithms to extract genetic information that is embedded in social media and Web 2.0 databases, map vulnerabilities to genetic privacy, and understand the contribution of repetitive elements in the genome to the predisposition of common diseases. Erlich will begin teaching next year; his course load is still being determined.

---

“Robotics is by definition multidisciplinary and the School of Engineering at Columbia can enable researchers from all the needed areas (mechanical, electrical, computational, biomedical, etc.) to come together and work on the most important problems in the field. Strong collaborations with Columbia University Medical Center can also enable us to advance important domains such as assistive and rehabilitation robotics.” —Matei Ciocarlie

**JAVAD GHADERI**

Assistant Professor, Electrical Engineering  
*PhD, University of Illinois at Urbana-Champaign, 2013*  
*MASc, University of Waterloo, 2008*  
*BS, University of Tehran, 2006*

Javad Ghaderi's research interests are broadly in the analysis, design, and management of large-scale networked systems. He draws upon mathematical tools from control, optimization, information theory, algorithms, and stochastic processes to study communication networks, wireless systems, social networks, and data centers. This fall, Ghaderi is teaching Communication Networks, and in the spring, he plans to teach Network Algorithms and Dynamics, a new course offering.

**CATHERINE GORLÉ**

Assistant Professor, Civil Engineering and Engineering Mechanics  
*PhD, University of Antwerp and Von Karman Institute for Fluid Dynamics, 2010; MSc, Delft University of Technology, 2005, BSc, '02*

Catherine Gorlé's research focuses on the development of predictive flow simulations of the natural and built environment through the integration of a variety of computational tools and experiments within a probabilistic framework. Specific topics of interest are turbulence models for uncertainty quantification and quantifying uncertainties related to the inherent variability of boundary conditions. Gorlé will be teaching Fluid Mechanics initially and expects to teach more, including Computational Fluid Dynamics.



**IOANNIS  
KOUGIOUMTZOGLOU**

Assistant Professor, Civil Engineering  
and Engineering Mechanics  
*PhD, Rice University, 2011, MS, '09; Dipl.Eng.,  
National Technical University of Athens, 2007*

Ioannis Kougioumtzoglou primarily focuses on stochastic mechanics with applications in civil and mechanical engineering. He is interested in mathematical modeling/analysis of complex stochastic systems; computational stochastic mechanics; nonlinear stochastic dynamics; uncertainty quantification methodologies; and signal processing techniques. In the spring, Kougioumtzoglou will teach an updated version of the existing course, Random Processes in Mechanics.



**KYLE MANDLI**

Assistant Professor, Applied Mathematics  
*PhD, University of Washington, 2011  
MS, University of Washington, 2005  
BS, University of Wisconsin, 2004*

Kyle Mandli's research involves the computational and analytical aspects of geophysical shallow mass flows such as tsunamis, debris flow, and storm surge. This also includes the development of advanced computational approaches, such as adaptive mesh refinement, leveraging new computational technologies, such as accelerators, and the application of good software development practices as applied more generally to scientific software. Mandli is currently slated to teach the undergraduate course on partial differential equations.

---

“I was drawn to Columbia Engineering because of its vibrant and intellectually stimulating environment made possible by collaborations with world-class institutes, such as the Lamont-Doherty Earth Observatory, the amazing faculty in the Applied Physics and Applied Math Department, and, of course, the fantastic students.” —Kyle Mandli



**ANTONIUS “TON” DIEKER**

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

Ton Dieker's research focuses on computer simulation techniques (algorithm design and analysis), stochastic networks, and modeling of service systems. He is an associate professor at Georgia Tech, where he has been on the faculty since 2008, and his honors include the Goldstine Fellowship from IBM Research, an NSF CAREER Award, the Erlang Prize from the Applied Probability Society of INFORMS, and a Fouts Family Early Career Professorship at Georgia Tech. In the spring, Dieker will teach a PhD course on sampling methods and algorithms and an additional course yet to be determined.



**ZORAN KOSTIC**

Associate Professor of Professional  
Practice, Electrical Engineering  
*PhD, University of Rochester, 1991  
MS, University of Rochester, 1988  
Dipl.Eng., University of Novi Sad, 1987*

Zoran Kostic's expertise spans mobile data systems, wireless communications, signal processing, multimedia, system-on-chip development, and applications of parallel computing. His work comprises a mix of research, system architecture, and software/hardware development, which has resulted in a notable publication record, three dozen patents, and critical contributions to successful products. He serves as director of the MS Electrical Engineering Program. This academic year, Kostic is teaching Electrical Engineering Practice, Signal Processing and Communications on Mobile Processors, and Wireless Communications.



**ROBERT G. BOZIC  
LTC USA (RET)**

Lecturer in Discipline, Chemical Engineering  
*PhD, Columbia Engineering, 2008*  
*MS, University of Florida, 1999*  
*BS, U.S. Military Academy, 1989*

Robert G. Bozic's work is primarily in electrochemical engineering, with a focus on electrochemical sensors and fuel cells. The sensor work is directed toward detection of munition constituents in groundwater. Microbial fuel cell research has been at the forefront of the fuel cell work. This fall, Bozic will be assisting with Chemical Engineering Design.

“I am absolutely thrilled to join the Columbia University family and the Department of Civil Engineering and Engineering Mechanics in particular. It is one of the very few departments with such a strong focus on engineering mechanics where so many brilliant people conduct research of the highest caliber.” —Ioannis Kougoumtzoglou



**ELENI DRINEA**

Lecturer in Discipline, Computer Science  
*PhD, Harvard University, 2005*  
*MS, Harvard University, 2005*  
*BS, University of Patras, Greece, 1999*

Eleni Drinea's research is in the areas of information theory and randomized algorithms, with a focus on characterizations of channel capacity, reliable communication over wireless networks, and the network coding paradigm for network optimization. She was a research associate from 2007 to 2009 at the School of Computer and Communication Sciences at Ecole Polytechnique Federale de Lausanne (EPFL). Drinea is currently teaching two sections of Algorithms for Data Science. In the spring, she plans to teach Analysis of Algorithms and Data Science Capstone and Ethics.



**KATHERINE REUTHER**

Lecturer in Discipline,  
Biomedical Engineering  
*PhD, University of Pennsylvania, 2014*  
*BS, The College of New Jersey, 2009*

Katherine Reuther's current research interests include soft tissue biomechanics, engineering education, and pedagogy. She will be working on developing new instructional tools and programs to enhance graduate education in the Department of Biomedical Engineering. Previously, her research focused on determining fundamental relationships and mechanisms of tendon and ligament injury and repair, with a particular emphasis on the shoulder. Reuther will be assisting this semester with Biomedical Engineering (BME) Senior Design, Computational Modeling of Physiological Systems, and Tissue and Molecular Engineering Laboratory. She is working on developing a graduate-level design course for the spring.



**S**eldom have the celebratory imperatives of an institution's birthday and the realities of its recent history been so exactly aligned as here, on the 150th anniversary of Columbia Engineering. To be sure, at its 25th birthday in 1889, the then School of Mines was flourishing, its first dean (1864–1897) and Columbia's best known scientist, Charles F. Chandler was in charge of the School's administrative affairs. Electrical engineering had just then been added to the School's programs in mining, applied chemistry, and civil and mechanical engineering. Enrollments matched and often exceeded that of the much older School of the Arts (aka "The College"); its graduates dominated New York City's engineering ranks. Still, the recent death of Frederick A. Barnard cost the School its first and most vigorous presidential advocate.

And so it went. By the 50th anniversary of the School (now the Schools of Engineering, Chemistry, and Mining) in 1914, a just introduced Trustee-mandated 3/3 plan would limit the capacity of the School to grow by reducing its recruitment pool to undergraduates who had completed at least two years in Columbia College. Increased graduate enrollments only partially made up for the shortfall in undergraduates, and Columbia ceded its earlier place among America's largest producers of engineering graduates. The 75th birthday in 1939 occurred with the Depression ongoing and war again imminent.

The centennial, in 1964, was unfolding just as Dean John Dunning had been relieved of his administrative duties by the Trustees, while

the School operated at 50 percent full capacity. In addition, New York City had lost—temporarily, it now seems—its attraction for a generation of postwar suburban-bound students and faculty. Departmental rankings, at the start of the decade easily in the top 10, by its close had slipped into the double digits.


By its 125th birthday in 1989, the School had effected an impressive recovery from the early 1970s, thanks in part to the turn-around deanship of Peter Likins (1976–80) and the programmatic updating, especially in applied physics, computer science, and bioengineering, that marked the deanship of Bob Gross (1981–89). Yet Gross's deanship ended with the School broke and in debt due to what Gross's critics called wasteful spending on the Center for Engineering and Physical Science Research (Schapiro CEPSR), a building that has since come to be seen as absolutely crucial to the future of engineering at Columbia. Only with the revival of New York City's fortunes in the early 1990s and the installation of Zvi Galil as the School's 13th dean in 1996 did the School achieve the sustainable takeoff that has propelled it to its present state of historically unparalleled institutional well-being.

To what can this current well-being be attributed? I suggest five factors. First, a 40-year period where the School has enjoyed almost continuously effective and imaginative administrative leadership. Second, although if not with the personal care Barnard accorded to his fledgling School of Mines, every Columbia president since William McGill in the 1970s has acknowledged the role of the School

# COLUMBIA ENGINEERING AT 150

## AN ENGINEERING RENAISSANCE





Robert A. McCaughey is the author of *Stand, Columbia: A History of Columbia University in the City of New York, 1784–2004* (Columbia University Press, 2003), and *A Lever Long Enough: A History of Columbia's School of Engineering and Applied Science Since 1864* (Columbia University Press, 2014). Images courtesy of Columbia University Archives

of Engineering and Applied Science as a major contributor, first to the University's academic and financial recovery and second, to its current flourishing. Third, the SEAS faculty in the 1980s placed the right bets on areas of engineering that were most likely to transform the profession, not just on broad subjects like computer science and bioengineering, but in subfields and interdepartmental initiatives such as cyber security, nanotechnology, neural engineering, financial engineering, and data science. Fourth, recruited faculty and students now coming to SEAS are drawn to it in large measure because they see the School not as a marginal appendage but an integral part of a great university, one long known for its excellence in the humanities and the social sciences, from which its famed Core Curriculum is drawn. They also see it as the site of extensive collaboration among its scientific departments, its famed medical school, and its engineering school, with the last more often than not serving as the matchmaker and administrative overseer of these cross-campus collaborations. The Institute for Data Sciences and Engineering, under the direction of Professor Kathleen McKeown, is a case in point.

And then there is a final factor that influences the state of engineering education throughout the United States, if not beyond, but which is especially telling here at Columbia. It is what historian of science Paul Forman has characterized as “the abrupt reversal of cultural ascribed primacy in the science-technology relationship—namely, from the primacy of science relative to technology prior to circa 1980, to the primacy of technology relative to science since that date.” At few major universities did its scientists—long housed here in their own Faculty of Pure Science—command so much of the institutional high ground as at Columbia, while leaving its lowly engineers, as the Columbia psychologist Eugene Galanter caricatured the once-prevailing Morningside mindset, “to construct dongles and dohickeys.”

In retrospect, it is a wonder that Columbia engineers even survived—and

without disruption—in such a technology-skeptical institutional environment. (Harvard and Yale engineers have enjoyed no such historical continuity.) Columbia's engineers did so in no small part by, as the poet Kipling put it in a riff on the Biblical sisters of Lazarus, Mary and Martha, in “The Sons of Martha,” by assigning to themselves the subservient role of Martha, ceding to Columbia's scientists “the better part.”

No longer. Martha has left the kitchen. Whether one attributes the privileging of solutions-driven technology over curiosity-driven science to the end of the Cold War, the “biological turn,” or the ubiquity of the computer, today's Columbia engineers and applied scientists have been its principal beneficiaries. Faculty in the nine SEAS departments now teach more undergraduates, train more graduate students, award more PhDs, and secure more research grants than do the faculty in the six cognate departments in the Faculty of Arts and Sciences. Yet Columbia's engineers actively seek out areas for fruitful collaboration with colleagues in physics, chemistry, biology, mathematics, and environmental science, but also, in the instance of the Institute for Data Sciences and Engineering, with professional-school colleagues in law, business, international and public affairs, journalism, and—who would ever have thunk it?—in English and history! If the name of the game at Columbia for the foreseeable future is, as its last four presidents have said, encouraging cross-fertilization in both teaching and research, who better to take on the role of Columbia's Johnny Appleseed than its engineers? Happy Birthday!

*By Robert A. McCaughey  
Professor of History and  
Janet H. Robb Chair in the  
Social Sciences, Barnard College*

# DEPARTMENTS

## LETTER FROM THE ALUMNI ASSOCIATION PRESIDENTS

Dear Fellow Columbia Engineers,

It's hard to believe, but another academic year is well under way. This fall, Columbia Engineering welcomes the undergraduate Class of 2018 and a new crop of graduate students. We're excited to continue working alongside Dean Mary C. Boyce, now in her second year at Columbia Engineering.

It's truly an exciting time at Columbia Engineering. Whether it's the growth of the new Institute for Data Sciences and Engineering or the interdisciplinary collaborations occurring in the Northwest Corner Building, every day sees groundbreaking and remarkable happenings at the School. Also, our alumni community has never been more vibrant—alumni from around the globe are reconnecting with the School and with each other through events and programs organized by CEAA, CEYA, and our partners in the Columbia Alumni Association. If you haven't yet become involved with the School, now's the time! Regardless of your location, you can access the global Columbia network to make new connections, reconnect with classmates, or support the School.

Lastly, as you know, 2014 marks the 150th anniversary of our School's founding as the Columbia School of Mines. In February, during Engineering Week, Dean Boyce, students, alumni, faculty, and staff put on a number of commemorative activities—both on and off campus—to kick off the yearlong anniversary celebration. Spring events, such as the Senior Design Expo, Class Day, and Reunion, were also 150th themed and filled with heightened excitement as a result. This fall, the celebration will culminate with marquee events around Founder's Day on November 15. But, between now and then, there will be more events to engage you with the School and the greater University community. In the meantime, please update your contact information in the alumni directory ([engineering.columbia.edu/alumni-directory](http://engineering.columbia.edu/alumni-directory)) so you will receive invitations to these events and other communications.

We look forward to seeing you during the fall semester as we kick off another academic year and wrap up the 150th anniversary celebration of Columbia Engineering!



### HITOSHI TANAKA

BS'63, MS'65, EngScD'76

President

Columbia Engineering

Alumni Association



### WHITNEY GREEN

BS'10, '13TC

President

Columbia Engineering

Young Alumni



COLUMBIA | ENGINEERING  
Alumni Association



COLUMBIA | ENGINEERING  
YOUNG ALUMNI

## CLASS NOTES: UNDERGRADUATE ALUMNI

### 1937

**Theodore Korol**, who will turn 100 this coming May, has just completed a chronicle of his life and work, which spans service during World War II as well as engineering and drafting for a number of companies and projects after his tour of duty was complete. His granddaughter, Rebecca Jay, writes, "Along with the rest of his family, I am very proud of him. This latest project he has completed is another testament to the active mind and creative soul that continues to marvel and inspire me every day."

### 1945

**Class Correspondent:**  
**Gloria Reinish**  
[reinish@verizon.net](mailto:reinish@verizon.net)

### 1946

**Jerold M. Lowenstein** has written a new novel, *And Now a World*, based on his experience as a U.S. Navy officer and physicist at Bikini and Los Alamos, NM. As a naval officer, he participated in Bikini atomic bomb tests. He worked as a nuclear physicist at Los Alamos and then with the Federation of American Scientists in Washington, DC. His first novel, *The Dark X: a Medical Mystery and African Adventure*, was published in 2010.

### 1951

**Class Correspondent:**  
**Ted Borri**  
[tjb63@columbia.edu](mailto:tjb63@columbia.edu)

### 1952

**Class Correspondent:**  
**Peter Mauzey**  
[p.mauzey@ieee.org](mailto:p.mauzey@ieee.org)

1953

**Class Correspondent:**  
**Don Ross**  
rossd@jbb.com

1955

**Class Correspondent:**  
**Leo Cirino**  
lc550@columbia.edu

1956

**Class Correspondent:**  
**Lou Hemmerdinger**  
LHemmer@aol.com

**Lou Hemmerdinger** writes, “Accolades go to our classmate **Stanley Manne** and his wife, Fern, who were honored on June 4 by the Ann & Robert H. Lurie Children’s Hospital of Chicago (affiliated with Northwestern University’s Medical Center), for giving a transformative gift wherein the Research Center will now be renamed the Stanley Manne Children’s Research Institute. Our best wishes for Stan and Fern.” Stanley is chair of the Manne Family Foundation, and the gift will provide funding to help sustain and further enhance pediatric medical research at Lurie Children’s.

1959

**Class Correspondent:**  
**Betsey Altman**  
bmeca@comcast.net

**Ralph W. Wyndrum Jr.** ’78BUS writes, “First let me thank all those at Columbia who put so much effort into the Reunion and Dean’s Day. It was a very pleasant and informative affair. Meta and I have taken to relaxing a bit in the spring and summer, a lovely period here on the NJ Shore. We live on the Navesink estuary beach, which provides protected docking for boats and a bit of protection from storms like Sandy. I retired in 2000 from AT&T Labs, having spent 37

years there and at Bell Labs until the breakup of 1996.

“In the fall semester, I teach at Rutgers University. During the rest of the year we serve as Eucharistic ministers at a local nursing home, and I serve on the Fair Haven Planning Board and the Environmental Commission. Earlier this month, Meta and I flew to Athens, stayed with **George Enepekides** (MBA’60BUS), then cruised up the Adriatic, visiting western Greece, Croatia, and Italy. We then stayed in the north of Venice at a small but beautiful hotel. Behold, it was a few doors away from a 15th C church (Madonna dell’Orto Venezia), which counted the famous 16th C painter Tintoretto as one of their early parishioners. Tintoretto created more than 40 magnificent paintings for them, and they have hung in the church ever since. It rivals or even overshadows such other venues where his work appears, such as the Rijksmuseum and our own National Gallery in Washington.”

1962

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

**Mickey Greenblatt** writes, “Life has been busy for the Greenblatts. Nancy and I were in Europe for four weeks (Germany on business, Switzerland and France on vacation). A company on whose board I served for 19 years, Solar Outdoor Lighting, merged into a larger corporation, so I have less responsibility. Nancy’s garden design business continues to take her time, but she loves the work. She recently left the board of a local private school but continues to write the newsletter for the local Master Gardener organization. My sons are doing well: Drew’s metal bending business has been featured in *The New York Times* and other publica-

tions, and he is on the executive committee of the National Association of Manufacturers. Rob is CFO of the largest home services company in the Washington metro area. Mark has written a book, *Valor*, about U.S. military heroes in Iraq and Afghanistan in his spare time as a lawyer for the Department of Commerce. They have given us, together with Nancy’s three, eleven grandchildren who laugh at my jokes more than our own children do. Hmmm. They all live nearby, so life is a series of babysitting, carpooling, dinners at Five Guys, as well as soccer games, field hockey games, and swim meets.

“I am in touch with **Mike Clark** (Chemical Engineering), who received his PhD from UC Berkeley after leaving Columbia. In his words, ‘We purchased a new home in Tucson, AZ, and are happily spending the six winter months in Southern Arizona, mostly playing golf and enjoying the wonderful hiking the area has to offer. Last December/January, we took a monthlong holiday cruise around the tip of South America, which included six days ashore in Antarctica and four days on South Georgia. The wildlife was spectacular! I continue to do a lot of global fly fishing and really enjoy fishing the streams of Patagonia, Kamchatka, and Alaska. In fact, Joanna and I leave in late July to spend a week fishing for trophy rainbows in the waters of Katmai National Park. Joanna continues to work as a volunteer in the cancer infusion facility for the Tucson Oncology Center; being a cancer survivor and a nurse herself means she brings a great deal of knowledge and empathy to the patients as they go through the difficulties of their treatment regimes.’ The Clarks live in Reno, NV, the rest of the year.

“**Vin Godino** (Civil Engineering) reports that he is retired after 16 years on the design of nuclear-powered submarines at Electric Boat and some years at other engineering companies doing the same. He has been married to Rusty for 52 years. They have five children and six grandchildren, all doing well. Their grandson Nicholas finished his freshman year at UCONN with high honors. Oldest daughter Trish just turned 50 (which caused him to write ‘OMG’). Their youngest son Matt will begin teaching in a Montessori school in Cambridge, MA.

“We hope to hear from you other grads: keep us posted on what you are up to.”

1963

**Class Correspondents:**  
**Chuck Cole**  
ccole6250@att.net  
**Mark Herman**  
mnh18@columbia.edu

1964

**Class Correspondent:**  
**Tom Magnani**  
tm421@columbia.edu

**Tom Magnani** writes, “This year’s Reunion, our 50th, saw almost 40 of us return to campus, some with family members, others on their own. Even the weather cooperated by not raining and by not being too hot. New Hall, now known as Carman, is still as we remember it, concrete block walls and all. The School’s staff, Nick Mider and Jane Lowry, worked tirelessly to ensure that everything went off as scheduled.

“A major accomplishment by our class was the creation of a Class of 1964 Scholarship Fund, which now stands at over \$100,000 without the dean’s match of \$50,000 and various corporate matches. Once the University completes its paper-

## CLASS NOTES

work, this will be an ongoing fund to which we can continue to contribute.

“Here are links to several photo albums: One for Reunion in general and one for the Thursday night Welcome Dinner in Low Library: [https://www.facebook.com/myceaa/photos\\_stream?tab=photos\\_albums](https://www.facebook.com/myceaa/photos_stream?tab=photos_albums). The other, in Dropbox, to all photos, our class and others, from Friday night at the Russian Tea Room: <https://www.dropbox.com/sh/6ov88r6xwam3i6d/AAD0Oz35v9yjQGWm2IU010V4a>.

“It was great seeing those of you who were able to attend and the committee members also had a great deal of fun talking to as many of our classmates as we were able to find.”

### 1965

#### 50th Reunion

To take an active role in your Class Reunion activities, please contact Nick Mider at [nm2613@columbia.edu](mailto:nm2613@columbia.edu) or 212-851-0734.

**Bill Bozarth** writes, “I joined IBM out of school and worked for them for 28 years, first in New York, then in Atlanta, with a four-year international assignment in Germany. Subsequently, I also worked for a start-up IT company and ran my own business before capping off my working career as executive director of Common Cause Georgia from 2002 to 2010. I came out of retirement late last year to step up and run as an Independent candidate for the Georgia General Assembly. I am currently fully engaged in that race, looking forward to winning the November election. I have four grown children ages 25 to 45 and five grandsons. I live with my wife, Judy, in the Buckhead section of Atlanta.”

**Richard Friedman MS’66, EngScD’73** writes, “I’m looking

forward to our 50th Reunion next year. I was employed as a senior engineer and structural fatigue and fracture tech specialist for 30 years and as a private consultant. I am married to my wife Susana with two ‘children’ and four loving grandchildren aged six months to 11 years, and living as a snowbird on Long Island and in Florida by the sea.”

#### **Bill Lupatkin MS’66,**

PhD’70GSAS recently retired from his pediatrics practice after 35 years. He writes that he is enjoying “free time and the absence of night call.”

**Harvey Rubin** writes, “I thought this might be a good way to say ‘hi’ to all my classmates, to let you know what I have been up to since I last sent an update, and to dwell for a moment on our upcoming 50th Reunion anniversary.

“In my last note, I told you of my retirement from Bell Laboratories at the end of 2011, after working in the telecommunications industry for 47 years. My retirement did not last long. By the end of January 2012, I was doing consulting work for a start-up company involved in designing improvements to wireless networks. I’ve been working with them ever since. I am enjoying the challenge of coming up with novel approaches to solve some sticky problems, but we are still a long way from getting these ideas into a commercial setting. Getting over the start-up hump is difficult, taking time, patience, and perseverance. Working with good people makes the difficult parts more bearable, and I also get a chance to extend my involvement with telecommunications into a 50th year.

“That involvement leads me to remark on our upcoming 50th year Reunion, scheduled for the last week of May 2015. I volunteered to be on the organizing committee, so many of you can

expect to receive a phone call or an email from me reminding you to attend if possible. There are many interesting events scheduled for the Reunion weekend, and some of them are specifically targeted to the 50th anniversary class. Next year, that’s us. It should be a lot of fun and wildly interesting, and of course, give us all a chance to get together again on campus. If you want to participate in the Reunion organizing activities, please send me an email at [harveyrubin43@gmail.com](mailto:harveyrubin43@gmail.com).”

### 1966

**John P. Anselmo** was recently elected vice chair of the Coastal, Oceans, Ports & Rivers Institute (COPRI) in the New York area. Also, his novel, *The Newsstand*, is doing well. It is a “coming of age” novel that deals with a Columbia Engineering student who learns to “fit in” to his two worlds: the tough streets of New York’s Little Italy of the 1960s and the Ivy League.

### 1969

**Class Correspondent:**  
**Ron Mangione**  
[Ronaldm@archeng.com](mailto:Ronaldm@archeng.com)

### 1970

#### 45th Reunion

To take an active role in your Class Reunion activities, please contact Nick Mider at [nm2613@columbia.edu](mailto:nm2613@columbia.edu) or 212-851-0734.

**Ken Dubuque** retired from a 30-plus-year career in banking, culminating in his serving as CEO of a midsized regional financial institution based in Texas, after an eight-year stint at the Port of New York Authority. He was on the board of the Financial Services Roundtable and the American Bankers Association CEO Council. He also started and chaired two

statewide small business loan funds, chaired a local chapter of the American Cancer Society (he is a cancer survivor), and was a member of several other nonprofit boards involving at-risk kids, education, and community reinvestment in Pittsburgh, the Washington, DC, area, and Austin. Ken and his wife of 30 years, Eileen, have returned to New York City and enjoy having their daughter Claire close by. While he has done some financial services consulting and deal making, Ken spends most of his time in the arts and volunteering: doing a bit of acting and voice-over, landscape painting, and writing, as well working with Earthwatch expeditions (concerning koalas in Australia, pandas in China, and wildlife in Malawi) and Global Volunteers projects (at the Crow Reservation in Montana and the Takitumu School in the Cook Islands). He also gardens in Central Park and serves on his co-op board. He enjoys the City with his family and friends, plays much tennis, builds a model train, and continues to travel (now up to 140 countries).

**John Wallace** writes, “My son and I thought we would contribute to the fantasy world of physics that Columbia has been trying to take a lead in by writing a new book that will be out shortly called *The Principles of Matter*, subtitle, *Reworking Quantum Mechanics*. The book centers on a couple of loose ends in physics, which became evident in my freshman physics courses of 1966–67. What is interesting is that these problems were brought up by another student and not the faculty.”

### 1971

**William D. Hooper MS’73,** MBA’74BUS graduated in May 2014 from The Barnes Foundation’s three-year Art and Aesthetics Program in

Philadelphia. His thesis topic was “The Barnes Foundation: A Case for Teaching Its Novel Art Curriculum to Enhance Thinking Skills Essential to Innovation in Business and Technology.” In the same month he was also appointed to the board of the Plant a Seed, Inspire a Dream Foundation, and he continues to serve on the board of the Heritage Dance Foundation, a performing and visual arts organization. William is also a mentor in Columbia’s Entrepreneurship Program. He is retired from Citigroup, after working previously for American Airlines and Andersen Consulting. Today, he consults in business development, continues his photographic artwork, and advocates for visual arts education.

#### 1975 40th Reunion

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

**Michael S. Katz** MBA’77BUS and his wife Susan were blessed with their seventh grandchild, a beautiful, healthy boy named Idan Katz, who arrived on May 30, 2014. Mike, who currently serves as vice president and on the executive board of the International Myeloma Foundation, recently received the Partners in Progress Award from the American Society of Clinical Oncology for his extensive involvement as an educator, developer of clinical trials for new drugs, and patient advocate. He also serves on the executive committee of the Eastern Cooperative Oncology Group.

**1976**  
**Kenneth Clark MS’79** was awarded the Department of the Army Achievement Medal

for Civilian Service in April, in recognition of his contribution to troop exercises between January and March.

**1978**  
**Class Correspondents:**  
**Peter Luccarelli**  
[peter.luccarelli@plioplaw.com](mailto:peter.luccarelli@plioplaw.com)

**Curtis A. Johnson** writes, “Recently I was elected president of the Board of Trustees of the Newark School of the Arts, a community music school in Newark, NJ, which enriches the lives of its students and the community through instruction and performance opportunities, primarily after school and on weekends. We provide a unique combination of access and excellence by maintaining a high level of instruction while accepting students of all ages and ability.

“I am a partner at the law firm of McCarter & English, specializing in debt financing and equity raising transactions in various areas including renewable energy and other impact investments. I recently served as an adjunct professor at Seton Hall Law School, where I taught the commercial law survey course on sales, payments, and secured lending. I was a coauthor of a treatise with respect to revised UCC article 9 as enacted in New Jersey. My wife, Melissa Hager (Barnard 1978), is the general counsel at the Richard Stockton College of New Jersey. I have two daughters who are, respectively, graduates of Syracuse in 2008 and Columbia College in 2012.”

**Peter Luccarelli Jr.** recently formed the law firm of Luccarelli & Musacchio LLP in Red Bank and Morris Plains, NJ. The firm specializes in patents, trademarks, copyrights, and related legal services. He resides with his wife, JoAnne, in Parlin, NJ, but remains a frequent Columbia campus visitor. Peter served on

the Department of Mechanical Engineering External Advisory Board from 2006 to 2013. He still serves on the alumni board of the Fraternity of Phi Gamma Delta Omega Chapter, where he counts among his brothers his sons, Peter III ’07CC and Christopher ’16CC. Chris serves as operations director for Columbia EMS (CAVA). Son James Luccarelli is a student at the Harvard Medical School MD/PhD program. Peter remarried in 2007. He and his wife, JoAnne, live in Sayreville, NJ.

**Albert McGovern** and his wife Mary Jo celebrated 32 happy years of marriage in May. Their son Sean, a CPA in law enforcement, married Caitlyn in September of 2013, in Cleveland; they reside in Westlake, OH. Their daughter Erin, a University of Iowa graduate, is a hospice nurse in Denver. Their daughter Kelly graduated from FIT and will be working for Atelier Jean Rousseau as they open their first U.S. store in the Big Apple. Al is approaching five years at Shure Incorporated, where he is now responsible for the mechanical engineering and industrial design activities worldwide (Chicago, China, Denmark, and Mexico). He is enjoying the 150-year Engineering School celebration activities, albeit from afar in Chicago.

**Kevin J. Roy** writes, “I am just completing a two-year contract position; my team configured and installed computer-based physician order entry (CPOE) in 70 hospitals across the country for Community Health Systems. I am relocating from New York City to Los Angeles this July to assume a full-time position as the manager of clinical informatics for Southern California Hospital at Culver City (formerly Hollywood Community Hospital).”

**1979**  
**Class Correspondent:**  
**Stewart Levy**  
[srlevy@att.net](mailto:srlevy@att.net)

**1980**  
**35th Reunion**  
To take an active role in your Class Reunion activities, please contact Star Sawyer at [ss3858@columbia.edu](mailto:ss3858@columbia.edu) or 212-851-2402.

**1981**  
**Class Correspondent:**  
**James Reda**  
[jfreda@jfreda.com](mailto:jfreda@jfreda.com)

**Michael Brochstein MS’82,** MS’14SCE recently graduated from Columbia with an MS degree in sustainability management. He writes, “This program is cosponsored by the Earth Institute and is housed at the School of Continuing Education. I am now spending the summer as an Environmental Defense Fund Climate Corps Fellow, working at the United Tribes Technical College in Bismarck, ND, on helping the College to improve the energy efficiency of their buildings. These are the first steps in a career transition that I am now making from a long career in IT to one in sustainability.”

**Ying T. Tao MS’82,** **ProfDeg’94** writes, “My son Jeffrey has completed his sophomore year at Columbia Engineering, majoring in computer engineering. My daughter, Kimberly, recently entered Columbia Engineering as a member of the Class of 2018.”

**1982**  
**Class Correspondent:**  
**Dan Libby**  
[kd126@columbia.edu](mailto:kd126@columbia.edu)

**Bo L. Hung Tran MS’83** writes, “I recently (June 2014) became a board member of Asian Human Services in Chicago.

## CLASS NOTES

AHS provides medical, including psychiatric and dental, services to underserved communities in the area. We also operate a charter school and provide job placements. Persons of all races and backgrounds are welcome. Our staff is multilingual, including some African languages.”

### 1983

#### **Michael Aghaganian Hagan**

writes, “I am currently senior director, Global Outcomes & Epidemiology Research, at Takeda Pharmaceuticals International. I’ve relocated to Chicago and am enjoying everything this vibrant, culturally diverse city has to offer. I was profoundly saddened by Mort Friedman’s passing. He was a good man and an inspiration to me.”

**Jay Mehta** writes, “My wife and I, along with a friend, invested in an Indian Premier League cricket team, the Kolkata Knight Riders, a couple of years back. Our team won its first championship in 2012 and was a winner of the Indian Premier League championship again this year.”

**Vincent Wu MS’88** writes, “It is exciting that my daughter Kylie will attend SEAS this fall as part of the Class of 2018. She will be majoring in computer science or computer engineering. I guess I will be back up to New York (from North Carolina) and see some of our friends.”

### 1984

**James Pastoriza** writes, “Presently I run a venture capital fund in Washington, DC, and San Francisco. We invest in early stage technology companies focused on telecom, media, technology, and software.”

### 1985

#### **30th Reunion**

To take an active role in your Class Reunion activities, please contact Star Sawyer

at [ss3858@columbia.edu](mailto:ss3858@columbia.edu) or 212-851-2402.

**Avishay I. Mazor** writes, “My youngest son Jacob will be attending the University of Chicago this coming fall, planning on majoring in physics/math.”

### 1986

#### **Michael Martinkat MS’89**

welcomed the birth of his third child, Caileen Anne Martinkat, on September 27, 2013. She joins her brother, Ryan, and sister Bridget, both nine years old.

### 1988

#### **Class Correspondents:**

**Caryn Frick**  
[carynfrick@gmail.com](mailto:carynfrick@gmail.com)  
**David Shofi**  
[dshofi@atmi.com](mailto:dshofi@atmi.com)

**Steven F. Carollo MS’92** writes, “I am now director of special projects at AutosplICE and leading an ERP implementation of software by IQMS.”

**Elaine Zacharakis Loumbas** is a corporate and regulatory health care attorney ([www.zacharakislaw.com](http://www.zacharakislaw.com)) living in suburban Chicago. She is an adjunct professor for Loyola Law School’s Beazley Institute for Health Law & Policy and at John Marshall Law School’s Center for Information Technology & Privacy Law.

**Dennis Mahoney** writes, “My oldest daughter Meaghan will be following in my wife (Karen Mahoney ’88CC) and my shoes and attending Columbia [College] in the fall. We are very excited that she chose Columbia and for all that she has achieved.”

### 1989

#### **Class Correspondent:**

**Shreese Roy**  
[Shre.roy@att.net](mailto:Shre.roy@att.net)

### 1990

#### **25th Reunion**

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

**Class Correspondent:**  
**Laura Cordani Christopher**  
[zchristophers@gmail.com](mailto:zchristophers@gmail.com)

### 1991

#### **Class Correspondent:**

**Radhi Majmudar**  
[radhi@majmudar.org](mailto:radhi@majmudar.org)

### 1992

#### **Class Correspondent:**

**Janneth Ignacio Marcelo**  
[jannethmarcelo@gmail.com](mailto:jannethmarcelo@gmail.com)

### 1993

#### **Class Correspondent:**

**Herbert Kreyszig**  
[Hek7000@gmail.com](mailto:Hek7000@gmail.com)

**Scott Genzer** writes, “I changed careers and moved to Norwich, VT, last fall and now run my own business (Genzer Consulting) doing educational data analysis and other education-related consulting with schools based in the U.S. and abroad.”

### 1995

#### **20th Reunion**

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

### 1996

#### **Class Correspondent:**

**Enrico Marini Fichera**  
[em75@columbia.edu](mailto:em75@columbia.edu)

### 1997

#### **Class Correspondent:**

**Kelly Lenz**  
[kal23@columbia.edu](mailto:kal23@columbia.edu)

### 1998

**David Yeung**, founder of Green Monday, has been named to The Purpose Economy’s list of 100

top global pioneers from Asia. David founded Green Monday, a social enterprise that promotes healthy and environmentally friendly living in Hong Kong. His company has partnered with thousands of restaurants and schools to promote vegetarian menu options and has collaborated with numerous organizations to help reduce carbon emissions and promote a greener lifestyle among individuals.

### 2000

#### **15th Reunion**

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

#### **Class Correspondent:**

**Daisy Chow**  
[daisy@caa.columbia.edu](mailto:daisy@caa.columbia.edu)

### 2001

#### **Class Correspondent:**

**Catherine Marcinkevage**  
[marcinkevage@gmail.com](mailto:marcinkevage@gmail.com)

**Cho-Nan Michael Tsai** writes, “I’d like to share some exciting news with the School. First, that my wife Cindy gave birth to my son Kyler in March. Second, I started a charity tech project that provides solar-powered e-readers for children in developing countries. Please visit our site at [www.sunnybook.org](http://www.sunnybook.org) for more information. I also want to announce a business I’m working on with a group here in LA. It’s called WeCram, and it is an academic coach in your pocket. Details at [www.wecram.com](http://www.wecram.com).

### 2002

#### **Class Correspondent:**

**John Morris**  
[jpm53@columbia.edu](mailto:jpm53@columbia.edu)

**Candice Snyder** nee **Barnes** writes, “This July I am getting an honorable discharge after serving

seven years active duty as a pediatrician for the Navy, attaining the rank of lieutenant commander. My physician husband and I have two-year-old boy girl twins Jacob and Charlotte, and just added another little girl, Ellie, to the mix this spring. We will be relocating to the North Shore area around Boston this summer. We enjoy reading through our *Columbia Engineering* magazine!”

### 2003

**Class Correspondent:**  
**Amar Doshi**  
abd19@columbia.edu

**Gareth Eckmann** is working for EastBanc, a developer in Washington, DC, as construction project manager on two mixed-use projects in the District. One project includes a new DC public library and residential and commercial uses, the other includes a new fire station for DCFEMS and residential and commercial uses. Gareth and his wife Maggie O'Donnell '04CC welcomed their daughter Alessandra Eckmann into the world on March 21 and visited campus with her for Maggie's 10-year reunion this June.

### 2004

**Class Correspondent:**  
**Eric Rhee**  
eric.rhee@gmail.com

### 2005

#### 10th Reunion

To take an active role in your Class Reunion activities, please contact Jonathan Whitford at jw3091@columbia.edu or 212-854-2317.

**Class Correspondent:**  
**Devang Doshi**  
devang.doshi@gmail.com

**Devang Doshi** writes, “Class of '05! Our 10-year anniversary is around the corner, so make

your plans for 2015 accordingly, because we hope to host you back on campus in June. In the meantime, please keep sending us your updates!”

### 2006

**Class Correspondent:**  
**Nick Jennings**  
nfv2003@caa.columbia.edu

**Hilary Libka** has joined the Boston Patent Counseling & Prosecution practice group at Cooley LLP, where her practice focuses on domestic and international patent procurement and portfolio management. She also counsels clients regarding litigations, freedom-to-operate/ due diligence analyses, and transactional agreements relating to patents and other forms of intellectual property. Hilary is registered as a patent attorney with the U.S. Patent and Trademark Office, admitted to practice before the Court of Appeals for the Federal Circuit, and a member of the Volunteer Lawyers for the Arts of Massachusetts. Prior to joining Cooley, Hilary was a senior associate at the Boston office of Wilmer Cutler Pickering Hale & Dorr LLP and a consultant for the World Intellectual Property Organization Office of Legal Counsel in Geneva, Switzerland.

### 2007

**Class Correspondent:**  
**Tamsin Davies**  
tamsin.davies@gmail.com

**Steven Leung** writes, “I currently work at the HK SFC, which is the securities regulator in Hong Kong. I have been in this job for the last three and a half years.”

### 2008

**Class Correspondent:**  
**Amy Lin**  
seas2008.engineeringnews@gmail.com

**Laurene Aigrain** writes, “After five years overseas, I recently moved back stateside, specifically to Houston, where I work on major capital projects for the oil and gas industry as a facilities engineer. I am traveling as much as I can and seeing old Columbia friends more often since moving back.”

**Eash Cumarasamy** and **Christine White** were married on May 3 at Columbia University. A Hindu wedding ceremony was performed in Low Rotunda and a Catholic ceremony was held at St. Paul's Chapel. For their honeymoon, they went to the Maldives and Japan. Christine is a second-year surgery resident in urology, and Eash is the vice president of corporate development for an oil and gas company. They live in Manhattan.

### 2009

**Class Correspondent:**  
**Ramya Pratiwadi**  
ramyap@gmail.com

**Tzvi Karoly** writes, “My wife and I had a baby boy, Adi, on April 29, 2014.”

**Mary Theresa Pendergast** writes, “I completed my PhD in civil and environmental engineering, focused on membrane science and technology for water treatment, at UCLA in 2014. I recently joined a Boston-based company, Oasys Water (oasyswater.com), where we are developing low-energy forward osmosis membrane systems for treatment of challenging waters.”

### 2010

**5th Reunion**  
To take an active role in your Class Reunion activities, please contact Jonathan Whitford at jw3091@columbia.edu or 212-854-2317.

**Class Correspondent:**  
**Michelle Madejski**  
michelle.madejski@gmail.com

**Aaron Hochberg** has been promoted to consultant at Mars & Co., a global management consulting firm specializing in business strategy and operational improvement for major corporations. Aaron joined the firm's New York City area office as an associate consultant in 2011. Since joining Mars & Co., he has worked as a generalist consultant with many of its high-profile clients in a broad array of industries. His experience ranges from beverages to financial services and from retailing to consumer durables. Aaron has helped clients with manufacturing strategies, labor cost optimization, growth strategies, and many other strategic and operational issues. He is also involved in the firm's professional recruitment efforts.

### 2011

**Class Correspondent:**  
**Justin Merced**  
jmm2238@columbia.edu

### 2012

**Class Correspondents:**  
**Rebecca Frauzem**  
rfrauzem@sbcglobal.net  
**Hannah Cui**  
hannah.cui@gmail.com

Jibon Health Technologies, cofounded by **Mikail Kamal** and **John Esau**, has recently been awarded a \$250,000 grant from Saving Lives at Birth (SLAB), a health advocacy group that works with the Bill & Melinda Gates Foundation. The biotech start-up is the maker of a low-cost, low-tech device that aims to reduce postpartum hemorrhage (PPH) in mothers delivering in rural communities and developing countries where PPH persists. The device will soon be tested in two hospitals in Bangladesh.

## CLASS NOTES



Pictured from left to right: Arthur Epley III, Dean Mary C. Boyce, and Vic Revenko at Columbia Engineering Reunion, May 2014

### VICTOR REVENKO TO ENDOW NEW CHEMICAL ENGINEERING PROFESSORSHIP

For Victor J. Revenko '63CC, BS'64, MS'68, his 50th Reunion from the School became more than an opportunity to reconnect with old friends. Vic, a consistent donor to the Engineering Fund, found the experience of working with his classmates at reunion so engaging that he desired to do more. During the summer, Vic and his wife Maggee formalized a \$3 million bequest to Columbia to establish the Victor J. Revenko and Family Professor of Chemical Engineering, a move they had been contemplating for some time.

Following reunion, Vic decided that completing his planned gift for the professorship was the logical next step. A native New Yorker who attended Stuyvesant High School before coming to Columbia, Vic earned his BS and an MS, both in chemical engineering. He later earned an MBA from University of California at Berkeley. After graduating from the Engineering School, Vic moved to California where he joined Chevron, enjoying a long career in a series of business, technical, and executive positions.

Now retired, Vic is a former president of the Chevron Retirees Association (and still a member of its nominating committee), a member of the board of trustees of the Institute of International Education, a former president and a board member of the Commonwealth Club of California, a former president of the International Diplomacy Council, and chairman and president emeritus of Internal Management Consultants. He currently serves on a California Supreme Court committee that helps nominate state bar court judges.

Vic has designated Columbia as a beneficiary of an IRA. This type of planned gift has the advantage of maximizing tax savings for the donor. In some cases, naming a charity like Columbia as an IRA or 401(k) beneficiary can mean that more assets are available for the donor's heirs.

*By Timothy P. Cross*

**David Mills** married Arielle Victoria Allen, now Arielle Victoria Mills, on June 21.

**2013**

**Class Correspondent:**

**Mary Byers**

**mbyers2202@gmail.com**

**2014**

**Class Correspondent:**

**Victoria Nneji**

**vcn2101@columbia.edu**

**Peter Xu** writes, "I have recently begun my job as an IT developer/engineer at HP. I am a backend developer on the Mobile App team in the Next Generation Supply Chain Architecture and R&D Group."

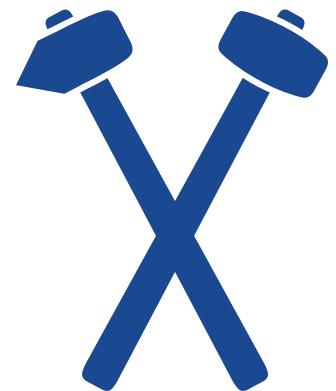
**Save the Date!**

**Reunion:**

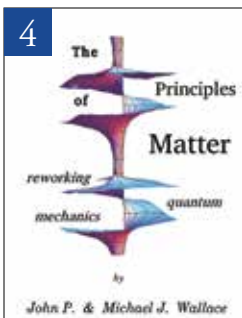
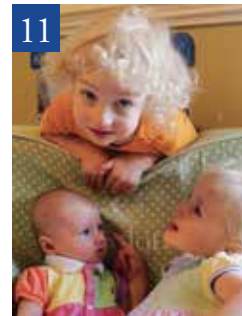
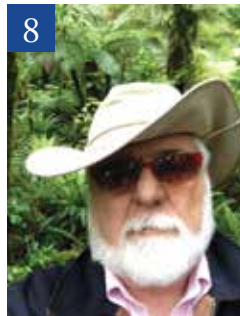
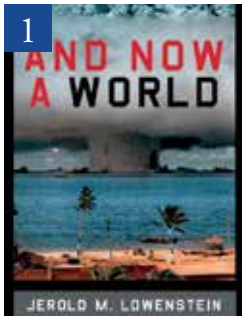
May 28–May 31, 2015

**Dean's Day:**

May 30, 2015







1 Jerold Lowenstein's '46 novel

5 William Hooper '71, MS'73

9 Jay Mehta '83 and cricket team

13 Tsvi Karoly '09 and family

2 Ralph Wyndrum '59 and family

6 Curtis Johnson '78

10 Cho-Nan Michael Tsai's '01 son

14 David Mills's '12 wedding day

3 Bill Bozarth '65

7 Albert McGovern '78 with family

11 Candice Snyder's '02 three kids

15 Peter Xu '14

4 A new book by John Wallace '70

8 Michael Hagan '83, New Zealand

12 Eash Kumarasamy '08 and Christine White '08 wed

**PROGRAM NOTES:  
GRADUATE  
ALUMNI**

**CIVIL ENGINEERING AND  
ENGINEERING MECHANICS**

**Eleni Chatzi PhD'10** writes, "Since my graduation in 2010, I have been an assistant professor, holding the chair of structural mechanics at the Department of Civil, Environmental and Geomatics Engineering at ETH Zurich. I am the principal investigator of a group of PhD students and postdoctoral researchers focusing on the development and implementation of methodologies for the monitoring and life-cycle assessment of structural systems. Our work deals with the observation of large-scale infrastructure components such as bridges and buildings, and the extraction of metrics that relate to their way of deforming and correspondingly to their condition, strength, and potential weaknesses or deterioration. I am very happy to be in a position that offers the benefit of daily interaction with young minds whom I aim to serve through innovative teaching and research."

**Kira (Schiavello) Larson MS'09** and her husband Preston are incredibly excited to welcome their daughter Kaylen Marie to the world! Kaylen was born on July 3, 2014 (one day before their three-year anniversary) at 11:11 a.m., weighing 8 lbs., 2 oz. The family is currently living in Morristown, NJ, with their two dogs, Shelby and Ruger. Kira is a bridge engineer at HNTB, and Preston is a regional account director for the Lexus account at Team One. They look forward to bringing Kaylen to her first Columbia Homecoming game this fall, where she will be decked

out in Lions gear to represent the Class of 2036!

On March 14, 2014, **Michael Lubin-Novosielski MS'12** and **Jaya Singh MS'12** were married in New York. Michael is a senior consultant with Oliver Wyman Financial Services, while Jaya is a product manager with Alcoa.

**COMPUTER SCIENCE**

A team from the Center of Computational Learning Systems (CCLS), which includes **Apoorv Agarwal MS'09** as the entrepreneurial lead and Manoj Pooleery as the PI, was recently awarded an NSF I-Corps grant. Apoorv writes, "The main purpose of I-Corps is to encourage researchers to step out of the building and talk to real customers to understand how the research being developed in labs may be commercialized to solve real-world challenges." The grant runs from July 2014 through December 2014.

After graduation, **Maria del Pilar Molina Lopez MS'14**, who goes by Pilar, joined Walt Disney Animation Studios as assistant technical director. She writes, "I moved from New York City to Los Angeles right after I graduated. It was an amazing opportunity to work for Disney. At Columbia, I was fortunate to work with Professor Eitan Grinspun in the Columbia Computer Graphics Group. I really enjoyed working there and I'm sure it gave me skills and knowledge to develop my work at Disney. I am currently working on technology for Disney's next animated feature films and loving every minute of it!"

**EARTH AND  
ENVIRONMENTAL  
ENGINEERING**

As of July 1, **Claudine Ellyin MS'12** has been R&D manager at Sustainable Waste Power Systems (SWPS). SWPS has the

first high-performance on-site wet waste gasification system, patented as the Garbage In Power Out (GIPO) process. Its first commercial product is called the Modular Core (ModuCore). SWPS will have the GIPO ModuCore systems in commercial operation this fall 2014 at Tuthilltown Spirits in Gardner, New York. The ModuCore unit destroys the wet grain waste in a clean and effective manner leaving only clean water and fertilizer grade mineral ash. The process of waste destruction will provide nearly all of the heat required by the distilling process while eliminating energy and cost associated with waste dewatering and disposal. Claudine writes, "SWPS continues to partner with breweries, distilleries, and wineries to install the GIPO ModuCore systems to process distillation mash waste and provide heat to the processing facility. It is also currently targeting the agricultural waste industries since in the U.S. alone, animal farms generate more than a billion tons of waste each year. In addition, SWPS has donated the prototype of the system to the City College of New York, which will result in the creation of a center of excellence around wet gasification technology."

**ELECTRICAL  
ENGINEERING**

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

Earning my master's degree in electrical engineering at Columbia University in New York City, I focused on methods and approaches in signal processing, machine learning, and computational neuroscience."

After working several years in software development in the U.S. and Italy, **Thomas J. Re MS'95** studied medicine in Rome and just completed his radiology residency at the University of Milan in July. He is currently performing a Schlaefer Foundation Research Fellowship in Pediatric Neuroradiology at Boston Children's Hospital of Harvard Medical School.

**INDUSTRIAL ENGINEERING  
AND OPERATIONS  
RESEARCH**

**Dimitri Mongeot MS'08** writes, "After trading USD interest rates swaps in New York with ING Financial Services for three years and Societe Generale for one year, I moved to London for a year and then to Hong Kong, where, since September 2013 I've traded USD/AUD and NZD interest rates swaps as well as U.S. Treasury notes."

**Lawrence Spokony MS'83**, MBA'86BUS is currently serving as corporate director of Mergers & Acquisitions for Huntington Ingalls Industries (HII).

**Don Sutaria (ProfDeg'70)** is founder and president of CareerQuest, located in New York and New Jersey. Also known as Career Doctor Don, he is a consultant to individuals and corporations offering executive coaching and career management services. He is the author of *Career and Life Counseling from the Heart (Your Career Is a Pathway to Your Soul!)* and has been quoted in numerous publications including the *Wall Street Journal*, *New York Times*, *Working Smart*, and *Fortune*.

Don is also a member of Columbia Career Coaches Network. His areas of expertise are career assessment, job search strategies, changing careers, résumés and cover letters, salary negotiation, executive coaching, reentering the workforce, work/life balance, self-employment, and age issues. His specialties also include counseling of international professionals, Generation X and Y, people over age 40, mid-career executives, career changers, freelancers, and consultants. His portfolio of clients includes a broad spectrum of professionals in various age groups.

Prior to starting CareerQuest in 2001, Don served for 35 years in various ascending positions in engineering and management in the pharmaceutical, fine chemical, food, beverage, and brewing industries, in companies such as Pfizer, Hoffman-La Roche, CPC International, and Schaefer Brewing. He also worked internationally in engineering, design, construction, and consulting firms.

**MECHANICAL ENGINEERING**

**Vito Agosta PhD'59**, writes, "This year I received an award

for the most innovative patent for energy and environment—Long Island Technology Hall of Fame, 2014 Most Innovative Patent Award for U.S. Patent No. 8,495,974 Fuel System and Method for Burning Liquid Ammonia in Engines and Boilers. I was pleased in that it contained 26 claims, all awarded. Presently I am working on the use of urea as a fuel in diesel engines. I am 91 and wonder how long I can continue this work which I enjoy."

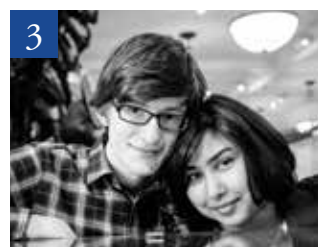
**Wilmouth Elmes MS'80** writes, "Last summer I had a wonderful and rewarding opportunity to sit on the SEAS committee that reviews senior Engineering students' design projects. As associate vice president of MEP Engineering & Technical Services here at Columbia University's Manhattanville group, there are always engineering analysis and studies that I am interested in pursuing or evaluating, but unfortunately do not have the time to undertake due to scheduling limitations. Professor Robert Farrauto of the Environmental Science Department asked if I had any studies that students could help with, so they could

gain real-world experience and add to their CVs. I jumped at the opportunity. As a 68-year-old this past April with over 47 years of professional engineering expertise, and as a Columbia alum with an MS in mechanical engineering now pursuing a professional degree in mechanical engineering here at Columbia, the experience with the students is one that I will always cherish. I can honestly say without any reservation whatsoever that it was the highlight of my career (imagine that). These engineers (men and women) were some of the most talented individuals I have had the pleasure to collaborate with." Some of the projects the students worked on involved evaluating the feasibility, capital cost, greenhouse gas reductions, and annual energy savings for developing a large solar farm consisting of panels on Manhattanville buildings' roofs and south facades, and comparing the results to the current Manhattanville energy plant that uses hydrogen carbon-based fuels. Another project, for example, involved evaluating the feasibility, capital cost, and energy savings for developing a

wastewater treatment plant that would treat local groundwater for use in site irrigation, plumbing in future Manhattanville housing projects, and building cooling towers."

Wilmouth adds, "Each of the student teams visited Manhattanville to closely collaborate, and each team formally presented final reports to me and the Engineering committee. Their work was so professionally done that no one would be able to guess that these were graduating seniors. Bottom line: what a great way to go when nearing the end of your professional career here at Columbia."

**Yi Zheng PhD'14** writes, "I was a PhD candidate supervised by Professor Arvind Narayanaswamy in the Department of Mechanical Engineering and defended my doctoral dissertation in the summer of 2014. Currently, I am a tenure-track assistant professor in mechanical engineering at University of Rhode Island. My research falls into the area of thermal science. It seeks to discover the nature of enhanced thermal transport phenomena and to develop novel techniques to investigate energy and



- 1 *Eleni Chatzi PhD'10*
- 2 *Kira (Schiavello) Larson MS'09 and her husband Preston welcome baby girl*
- 3 *Michael Lubin-Novosielski MS'12 and Jaya Singh MS'12 wed last spring*
- 4 *María del Pilar Molina Lopez MS'14*
- 5 *Claudine Ellyin MS'12*
- 6 *Wilmouth Elmes MS'80*





Sibylle Delaporte MS'10  
(Mechanical Engineering)  
at the launch pad

momentum transfer at micro/nanoscale length scale.”

**Sibylle Delaporte MS'10** joined ArianeSpace right after graduation. She writes, “My work was essentially to manage the mechanical assembly of launch vehicles at the European Space Center located in Kourou and to launch them. Who could imagine a more interesting assembly line with such great fireworks at the end? I love the experience of seeing the rockets that I help assemble ascend through the atmosphere and into space, and the release of tension when the mission is successful. I also participated in the preparation of the Soyuz rocket at the Russian cosmodrome in Baikonur, Kazakhstan. Russians have a different working style, but cooperation between space partners always prevails over difficulties in order to achieve the common goal of access to space and space exploration for peaceful purposes.”

In 2012, Sibylle moved to Kourou to be a combined operations manager, which makes her the liaison between the spacecraft manufacturer and the launch team for preparing and carrying out the combined launcher/payload operations. She also coordinates all the teams working on the assembly, integration, and testing of the upper part of the launch vehicle.

Sibylle writes, “Launching rockets to space is not routine. All launch campaigns have their share of technical challenges; success is based not only on extensive engineering and cutting-edge technology but also on the professionalism and dedication of many people. What I really enjoy is the chance to work in a multicultural environment with satellite teams coming from all continents. For me, launching satellites into space is above all a human experience.”

## IN MEMORIAM

**MORTON B. FRIEDMAN**

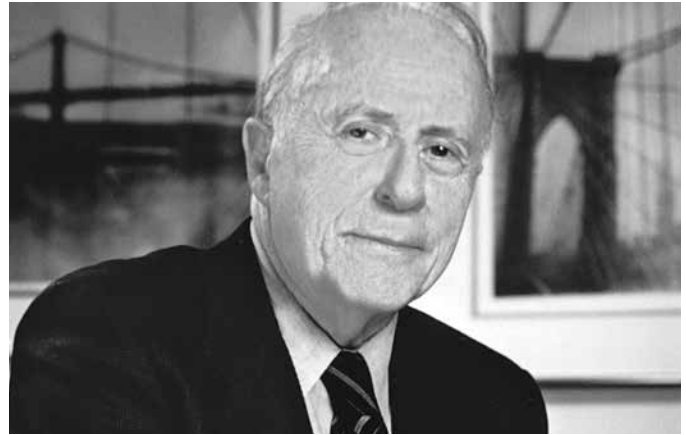
Distinguished and Devoted SEAS Professor and Senior Vice Dean

Civil Engineering and Engineering Mechanics Professor and Senior Vice Dean Emeritus Morton B. Friedman died June 3, 2014, in Canaan, CT. A longtime Columbia Engineering faculty member and dedicated senior administrator, Professor Friedman was 86 at the time of his death.

Professor Friedman, known as Mort to everyone at the School and at the University, joined the Engineering faculty in 1956 and spent the next seven decades becoming the heart, soul, and collective memory of the School. An aerospace engineer and mathematician, he received his BS, MS, and EngScD degrees from New York University. After a brief appointment at NYU as a research associate, he joined Columbia Engineering, where he advanced through the academic ranks in the Department of Civil Engineering and Engineering Mechanics, appointed as full professor in 1966. In 1995, he was appointed vice dean, senior vice dean in 2010, and senior vice dean emeritus in 2012.

George Deodatis, chair of the Department of Civil Engineering and Engineering Mechanics, remembers Professor Friedman as the first person he met at Columbia when he arrived as a graduate student in August 1983. At that time, Professor Friedman was the chair of the Department. "I was pleasantly surprised that the chair would be willing to see a new graduate student without a formal appointment," Professor Deodatis said. "He was spirited and jovial and, from the very first moment, he succeeded in making me feel comfortable and welcome. He continued to be exactly like this for the next 31 years! He was a brilliant mathematician, a very funny person, an endless source of knowledge for all things related to Columbia, but most important of all, always genuinely caring."

During his career at Columbia, Professor Friedman founded the Division of Mathematical Methods, the precursor to the applied mathematics component of what is now the Department of Applied Physics and Applied Mathematics, where he held a joint appointment. One of his earliest students in this program was Nobel laureate Robert C. Merton BS'66. A groundbreaking mathematician, Professor Friedman made major contributions in the development of accelerated quadrature methods of linear integral equations, accelerated spectral analysis of compact operators, accelerated projection methods, and uniform asymptotic solutions of differential equations with an almost periodic coefficient. He and his students were the earliest developers of the boundary element method that has since found widespread application in many engineering and applied science disciplines. His research was supported by the National Science Foundation in variational methods for fluids, by NASA in the SST sonic boom, and by DARPA in large scaled computations. He had been a consultant to North Star Construction, Hudson Institute, and Computer Usage Corp. for numerical analysis; Weidlinger Associates and Christensen Inc. for applied mechanics; and Inference Corporation for artificial intelligence software.



As vice dean, Professor Friedman was in the vanguard of engineering education leaders and helped shape the curriculum for many decades, from bringing engineering education into the first-year curriculum with project-based design and discipline-specific professional courses to creating a minors program at the School in more than 20 liberal arts subjects, and from encouraging service learning to providing research opportunities for undergraduates with junior and senior faculty. He also diligently served as mentor for a long line of faculty in various departments, a service of major importance to the School.

From 1981 to 1995, he served as chair of the Department of Civil Engineering and Engineering Mechanics and, from 1980 to 1991, also held the post of associate dean for instruction and research. In addition, he chaired the Executive Committee of the University Senate for several years. In carrying out this role and others at the University level, he gained wide respect for his insight, for his caring nature, and for providing wise counsel on navigating the many complexities of a university.

A former Fulbright Professor in applied mathematics and Field Instrumentation Scholar for the American Institute for Physics, he was recognized for his outstanding teaching by the Society of Columbia Graduates, which honored him with its Great Teacher Award in 1978. In 2012, Professor Friedman was honored for his lifelong devotion as a professor and senior vice dean at the School's Annual Faculty Excellence Awards program, and the meeting space on the fifth floor of the S.W. Mudd Building, where he led so many meetings, was dedicated as the Morton B. Friedman Conference Room.

Professor Friedman is survived by his devoted and treasured wife of 58 years, Sandy; his loving children, Robert (Linda) and Lori (Jim Goldfinger); and three beloved grandchildren, Chason, Asher, and Daden Goldfinger.

The family has established the Morton B. Friedman Memorial Prize for Excellence, to be awarded periodically to an undergraduate or graduate student in The Fu Foundation School of Engineering and Applied Science who best exhibits Professor Friedman's characteristics of academic excellence, visionary leadership, and outstanding promise for the future. To contribute to the Prize, please contact Zachary Howell in the Columbia Engineering Office of Advancement at 212-851-4023 or zh2134@columbia.edu.

Xinyue “Cindy” Wang  
'18SEAS (left) and  
Jiahui “Teddy” Liu  
'17SEAS, Columbia  
Engineering’s Z. Y. Fu  
Memorial Scholars



# FU MEMORIAL SCHOLARSHIP HONORING THE MEMORY OF Z. Y. FU

In 1998, Chinese businessman Z. Y. Fu, founder of the Tokyo-based Sansiao Trading Company and brother-in-law of Professor of Applied Mathematics John Chu, made a gift of \$26 million to the School. At the time, this gift was the largest single donation ever given to Columbia by a single benefactor.

At Columbia, Fu is probably best known for this gift, which gave the School its official name. But it was hardly his only act of generosity. In 1993, he created the Fu Scholars Program to allow exceptional students of Chinese origin to attend the Engineering School or the College. In total, 46 students attended Columbia during the 1990s and early 2000s because of his generosity.

Fu passed away in 2011, but his spirit lives on, not only in the School that bears his name but also in the Z. Y. Fu Memorial Scholarship Program. Established by a group of former Fu Scholars, the Fu Memorial Scholarship honors him in a way that he would truly understand and commend—providing four-year scholarships so that deserving Chinese students can study at the School.

So far, two Fu Memorial Scholars have matriculated at the School. Last fall, Jiahui “Teddy” Liu '17SEAS, originally from Chengdu in southwest China, became the first Fu Memorial Scholar. She is currently planning to major in computer science, with a minor in applied mathematics. This fall, Xinyue “Cindy” Wang '18SEAS, the newest Fu Memorial Scholar, began her first year at the School. Cindy hails from Nanchang and attended the Jiangxi Normal University High School.

Cheng Wang BS'04, now executive director at UBS in Hong Kong, was one of the original Fu Scholars. As a student, he was “surprised that a foreign university would offer a foreign student this opportunity.” At the time, a typical Chinese family could not have afforded to send a child to Columbia, “but Columbia

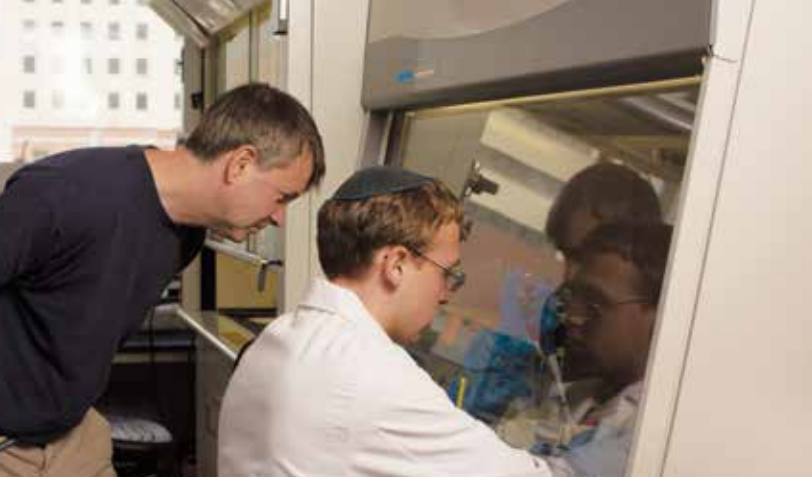
gave us this opportunity,” and he felt “we should carry on Mr. Fu’s will.” Former Fu Scholar Donglei Zhou BS'00 praised the new scholarships for continuing “Mr. Fu’s legacy of devotion to education.”

Wang and other former Fu Scholars had a chance to meet Cindy at a dinner hosted by Dean Mary C. Boyce in Shanghai on June 24. The dinner also was an opportunity for the dean to meet the Fu Scholars for the first time. Wang and the other alumni shared their Columbia experiences with Cindy. Other guests at the dinner included Mike Haiyun Ren '04CC, Helen Hailin Lou '99CC, Andrew Ma BS'05, and Yan Lou '99CC, '05BUS. (The School welcomed Teddy with her own dinner in June 2013 before she arrived at Columbia.)

Dean Boyce noted that “so many great things at our School during the last two decades can be traced directly to Mr. Fu’s generosity.” And she praised the donors to the Fu Memorial Scholarship for “giving a new generation of Chinese students the same opportunity to study at Columbia that Mr. Fu had given them.”

One Columbia Engineering couple, Shen Li '02 and Angela Liu '02, have special reason to support the Fu Memorial Scholarships. “Angela and I are excited to see a new Fu Memorial Scholar joining Columbia in September,” he says. “Without late Mr. Fu’s generosity, my education would not have been possible, and we would not have met. Our efforts to form and contribute to the Scholarship are a way to give back, to extend his generosity to the next generation of talents who would otherwise not have access to Columbia education, and to let Mr. Fu’s legacy live on.”

*By Timothy P. Cross*



Student opportunities. Discoveries.  
Championship athletics. Global  
programs reaching new heights.  
This October, what will **YOU** do?



## Change Lives and Change The World

On October 29, join Columbians around the globe for 24 hours of giving back, connecting, live events, and chances to win matching funds for your favorite school or program.

Join us!

[givingday.columbia.edu](http://givingday.columbia.edu)

#ColumbiaGivingDay   

Mark your calendar. Spread the word.  
Rally your classmates. Pay the  
**Columbia opportunity** forward.  
Columbia Giving Day 2014.



**150**  **COLUMBIA | ENGINEERING**  
The Fu Foundation School of Engineering and Applied Science  
1864-2014

Mail Code 4714  
500 West 120th Street  
New York, NY 10027

NON-PROFIT ORG.  
U.S. POSTAGE  
PAID  
N READING MA  
PERMIT NO. 121



**JOIN US!**  
REUNION WEEKEND  
MAY 28-31, 2015