THE FUTURE.
WE’RE WORKING ON IT.

CANCER-DETECTING BACTERIA
ENDING CYBERATTACKS
SELF-AWARE ROBOTS
Cover: An image of a mandala created by cancer cells is part of an art-science series, Colonies, by collaborators Tal Danino and artist Vik Muniz. Danino, assistant professor of biomedical engineering, engineers bacteria to detect and treat cancer. The Colonies series contains prints of beautiful, complex patterns from living bacteria, cancer cells, and cells infected by viruses. (HeLa Cell Pattern 1, print of cancer cells, courtesy of Vik Muniz Studio)
The Class of 2020 gathered together for the first time this fall at Academic Assembly. One of our Columbia Engineering alums, Ky Harlin BS’08, spoke of his journey at Columbia and since graduation—about his career and his first position, which was in the then-unknown field of data science. He remarked that data science as a career didn’t even exist when he majored in applied mathematics and minored in philosophy at Columbia Engineering, just ten years ago. Yet this foundational education prepared him for an emerging career path.

It was a timely reminder that we are preparing our students to contribute their creativity and ingenuity to a world that is rapidly evolving, one that will be vastly different from what it is today. In this issue of Columbia Engineering, we focus on that future, with a closer look at some of our faculty’s work in robotics, imaging and sensing, cybersecurity, and molecular engineering—all areas where exciting and rapid progress is being made, both on fundamental and applied research.

Sunil Agrawal has made great strides in his pioneering efforts in robotics, bringing new rehabilitative approaches to children with gait impaired by cerebral palsy, while Matei Ciocarlie is advancing the dexterity of robots and a better understanding of how artificial mechanisms can interact as skillfully as biological organisms. Peter Allen is exploring how to build complex human behavior, such as emotions and intent, into robots, while Hod Lipson is striving to create technology that is self-aware and conscious—what he calls, “the ultimate challenge.” (Read about their work beginning on page 7.)

Andrew Laine has been on the leading edge of imaging since his early work that pioneered digital mammography systems worldwide. Today he is applying his imaging techniques to pulmonary emphysema. Christine Hendon is developing optical tools so that in the future an optical biopsy of the heart, for example, will replace more invasive versions and provide surgeons with real-time data as they operate. (Learn more about their research on page 15.)

Keeping ahead of cyberattacks is the future-oriented research that Simha Sethumadhavan and Junfeng Yang have undertaken. Yang seeks to automate the detection of software bugs, while Sethumadhavan focuses on mitigating risk in hardware, in part by quashing malicious code that enters through “backdoors.” (See story on page 21.)

Yaniv Erlich and Tal Danino are working on molecular engineering research that holds great promise in medical and nonmedical areas. Erlich is harnessing crowdsourced DNA databases to probe the genetic basis of disease. Danino is programming the DNA in bacteria to make diagnostic and therapeutic molecules to attack cancer from inside the tumor. He also ventures into bio-art, collaborating with artist Vik Muniz, who uses actual bacteria to “paint” the images, including the one shown on our magazine cover. (Follow their work on page 25.)

As important as making discoveries is bringing these discoveries to real-world challenges. Read about the programs we have put in place to foster entrepreneurship and support startups, and meet Sidney Perkins, a student whose work with Engineers Without Borders took him to Uganda last summer for field research with Neopenda, a startup that our recent graduates are building to bring monitoring of infant vital signs to low-resource areas.

I invite you to visit the future in the pages of this issue, and to see the many ways our faculty, students, and researchers are working on it.

Mary Cunningham Boyce
Dean of Engineering
Morris A. and Alma Schapiro Professor
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Opposite page: Christine Hendon’s research group developed automated algorithms to analyze fiber organization within various organ structures, including the heart and cervix (shown). Story on page 15. Below: Videos by Jane Nisselson

engineering.columbia.edu/fall2016video

IC CIRCULATOR
Professor Harish Krishnaswamy and PhD student Negar Reiskarimian showcase their devices that will double WiFi capacity in the future.

3D FOOD PRINTING
Professor Hod Lipson accesses a new food space via 3D food printing with a team of robotics students, industrial designers, and International Culinary Center chefs.

SENIOR DESIGN EXPO
This year we tour the Senior Design Expo with former NASA astronaut Mike Massimino.

COLUMBIA NANO INITIATIVE
With techniques that range from formulas that predict material properties to super atoms mixed in a test tube, this center is producing a new periodic table of designer materials.
THE FUTURE. WE’RE WORKING ON IT.

CANCER-DETECTING BACTERIA
ENDING CYBERATTACKS
SELF-AWARE ROBOTS
A large field-of-view image, 2 cm in length, of mucinous carcinoma, a type of breast cancer, imaged with a custom-made, ultrahigh resolution optical coherence tomography system by Christine Hendon’s group. This project is done in collaboration with Hanina Hibshoosh, MD, and Sheldon Feldman, MD, at Columbia University Medical Center. (Image courtesy of Christine Hendon)
ROBOTICS

(Photo by Jeffrey Schifman)
Pushing the Limits of Robotics

Robots have been working behind the scenes in manufacturing for years. Now, researchers are focusing on the technology that could imbue robots with capabilities to interact with people and employ skills in the everyday world. That could mean a future where robots work side by side with people, take over mundane tasks at home, do dangerous work like firefighting and disaster response, and help us advance science and improve the human condition.

Critical to this next juncture in advanced robotics is a collaborative research effort. Engineers are not only thinking about our future with robots, but also aiming to solve the problems that are top of mind in robotics: how to make robots that are able to understand and respond to the environment; how to give them the capability to connect with each other and solve problems; and how to make their parts more humanlike, with the adaptability and flexibility we typically take for granted.

Discovering How to Make Robots Curious and Creative

There is no doubt that, in the future, robots will have a higher profile in everyday life than they do now. What intrigues roboticists, though, is developing the technology so that tomorrow’s robots will act and respond more like humans; to, in effect, be self-aware enough to be resilient and adaptive.

“Our ultimate goal is to create curious and creative machines: robots that ask questions, propose ideas, design solutions, and create those solutions, including other robots,” explains Hod Lipson, professor of mechanical engineering at Columbia Engineering and director of the Creative Machines Lab. “Creating technology with self-awareness and consciousness is the ultimate challenge in engineering.”

And, highly futuristic. Imagine a robot that can self-replicate or self-reflect. For Lipson and his lab, the collaborative nature of academic research is proving to be the perfect birthplace for that genesis.

“In academia we have the rare and precious license to work on very long-term goals. We can explore wild ideas that will only bear fruit decades from now.”

Lipson’s “wild ideas,” which include machine self-replication and programmable self-assembly, may not be so futuristic. Years ago, he took the concept of 3D printing to a new dimension, envisioning robotic printers that can create customized food. And while 3D printers that create pastries and confections are already in the marketplace, Lipson sees the technology expanding to create foods based on an individual’s biometrics, embedding in a food nutrients that are specific to the consumer, and then cooking it.

“Bringing software and robotics into something as basic as food prep and cooking means we
That insight will also bring humankind one step closer to answering an age-old question, he surmises. “If we can create self-awareness in machines, we will begin to understand life itself.”

Designing Robots to Help Overcome Effects of Neurological Disorders

Many children are fascinated by robots, and those who recently tried out a new robotic technology in Sunil Agrawal’s lab are no different. But these children have cerebral palsy, and the robotic technology they tested helped improve their balance and mobility.

Because cerebral palsy impairs muscle tone, it can cause some children to toe walk, a condition that affects quality of life and adds to the risk of falling and sustaining serious injury. Agrawal’s Tethered Pelvic Assist Device (TPAD), a cable-driven robotic system, applies downward forces to a child’s pelvis to improve impaired walking patterns after their training with the device.

“The children underwent 15 sessions of training over six weeks with our TPAD device and consistently showed improved force interaction with the ground that enabled them to walk more stably at a faster speed and with a larger step length,” says Agrawal, professor of mechanical engineering at the Engineering School and director of the Robotics and Rehabilitation (ROAR) Laboratory and Robotic Systems Engineering (ROSE) Laboratory. He recently received the Machine Design Award from the American Society of Mechanical Engineers for his innovative contributions to robotic exoskeletons design.

Agrawal focuses his work on rehabilitative medicine, developing robotic devices and interfaces that help adults and children move better or retrain their bodies to recover their lost function.

“In our work, we use robotics to help enhance human performance by melding machine action with the human body,” he says. To accomplish that, he takes a collaborative approach to the designs of these robotic devices, working with physicians from Columbia University Medical Center as well as with researchers in mechanical engineering and robotics.

“Our robotics research requires a close interaction with clinicians, therapists, and

open access to a new food space,” he says. “With robotics we can control nutrition and create novel foods you can’t make any other way.”

To push the idea of advanced robotic systems further, Lipson looks to natural biologic processes for inspiration.

“I’m fascinated by robots as an imitation of life—both body and brain,” he says. “Can we make robots that ask questions, propose ideas, design solutions, and make them—including other robots? That’s an exciting challenge.”

Taking cues from evolution, Lipson leverages inspiration from biological processes to program robots to simulate themselves, thereby getting closer to the day when robots are self-aware and demonstrate curiosity and creativity.

“To get there, we have to understand the biological process of thinking and reasoning. What we learn not only forwards the evolution of robots, but also brings new insight to the complexity of natural systems and engineering design automation,” he says.
The dreaded queasiness or nausea can occur in a car, on a ship, or on a plane: motion sickness. The cause is conflicting messages received by the brain from the eyes and ears. If you’re reading a book, say, or checking the messages on your phone, your eyes perceive that you are stationary. At the same time, the vestibular system of your inner ears detects motion. The simplest solution is to look out a window so your eyes, too, perceive motion.

Virtual reality (VR) can induce the same discomfort—but in reverse—called VR sickness. Your eyes, through which you travel within a virtual landscape, perceive motion; your ears perceive only that your head is tilted as you slouch in your chair while wearing a head-worn display, such as an Oculus Rift or HTC Vive.

Ajoy S. Fernandes MS’16 and Steven K. Feiner have devised a way to combat VR sickness. In a March 2016 paper, Fernandes and Feiner, professor of computer science at Columbia Engineering, director of the Computer Graphics and User Interfaces Lab, and codirector of the Columbia Vision and Graphics Center, described their technique, which uses virtual soft-edged circular cutouts to narrow the VR user’s field of view (FOV): It automatically decreases the FOV when the virtual motion is likely to cause discomfort, then restores the FOV when discomfort is less likely. Participants in their study reported significantly less discomfort, but most didn’t notice the FOV changes. “And those who did notice them,” says Feiner, “said they’d prefer to have them in future VR experiences.”

Feiner has also done pioneering work on augmented reality (AR), which overlays VR onto the real world interactively (can you say Pokémon Go). Mechanics, for example, can don lightweight eyewear that guides them through complex tasks, showing them which machine parts and tools to use.

Then there’s what one might call “mix and match” AR. Feiner is pursuing hybrid user interfaces that can allow 2D, touch-sensitive, flat-panel displays to be used in tandem with head-worn and handheld displays that enable 3D interaction in the space around the panel.

By Ann Rae Jonas
medical professionals,” he explains. “We help them learn what our technology can provide and vice versa.”

By doing so, Agrawal is able to offer functional solutions using wearable rehabilitative robotics. His designs are lightweight, durable, easy to wear, energy efficient, and able to interface well with their wearers. He is currently starting work on a new, five-year, $5 million grant from the New York State Department of Health on further TPAD research.

Aside from the TPAD, Agrawal has other rehabilitation robotic technologies that are undergoing human testing. He has designed a robotic scoliosis brace to offer a novel platform for pediatric orthopedists. And he has just begun human testing of a robotic neck brace that is designed to treat patients with head drop (common in people with ALS) or the tremors experienced by people with cervical dystonia.

Key to the success of Agrawal’s assistive robotic technology is a deep desire to make this technology meet the personal needs of people. “Our designs are novel in the field of rehabilitative robotics and reflect the needs of patients,” he says. With this technology, he is providing the fundamental and applied knowledge necessary to advance human-robot interaction.

Making Robots Capable of Interacting with People
Science is enabling robots to be more helpful, from delivering room service to helping with housekeeping chores at home. But for robots to be truly effective assistants, a new dimension of shared autonomy must be explored, where
robots can better interact with humans and learn to adapt to new situations.

“Current technology is catching up with human need, but robots do not yet have the ability to understand complex human behavior such as nuance, emotion, and intent,” says Peter Allen, professor of computer science at Columbia Engineering. “Building these capabilities into robots is quite challenging and involves learning and understanding about humans as well as being able to write software that is up to this challenge.”

Allen and his research team are exploring the idea of shared autonomy in their quest to make robots more effective in helping people with severe motor impairments. For these people, even using a joystick or a keyboard to control an assistive device is difficult to nearly impossible. Instead, Allen and his team have shown how a special sensor placed behind the ear can connect a person’s desire for an action with that action being done by a robot. “This is science that has real meaning in people’s lives,” he says.

In trials, a test subject fitted with the sensor used his ear muscles to move a cursor on a computer screen, which, in turn, resulted in the robot picking up different objects using different types of grasps. “Even more amazing, the subject was at our collaborator Sanjay Joshi’s lab at UC Davis, and the objects were grasped and picked up in our lab at Columbia. We set up a virtual reality interface, so the subject could virtually see the robot and the choices for grasps and then select one he liked or actually choose his own grasping strategy,” says Allen. “We learned if you can off-load some of the task on the robot’s own intelligence, you can simplify the interface and have the human inject just enough of a control signal to get the job done.”

Because humans have such a highly developed control system in the brain, it makes sense to Allen to find a way to harness that power in order to make it easier for a person to guide and control a robot.

“We are now exploring the newly emerging area of Brain-Computer Interfaces (BCI) for
Walt Disney Animation Studios recently used Eitan Grinspun’s technology on its live-action remake of *The Jungle Book* to depict the motion of plants and trees—trees reacting to the wind, monkeys swinging on branches. Grinspun says he himself felt he was watching real vegetation when he saw the movie.

Most of Grinspun’s animation technology is used for supporting roles—and that’s fine with him. In *Tangled*, for example, Rapunzel’s hair was an important character in its own right. Disney used Grinspun’s technology for the clothes, to depict how fabrics draped and flowed—freeing up the artists to work on the hair. Grinspun’s technology was also used to model realistic hair and its motion for the hero characters in Disney’s forthcoming animated adventure, *Moana*.

“You don’t want the motion of the fabric to draw too much attention to itself,” says Grinspun, associate professor of computer science and director of the Columbia Computer Graphics Group. “Yet it needs to be responsive, realistic, and supportive of the artistic vision. If you can compute motion that’s realistic, and you can render it realistically, you can help the audience to become immersed in the world of the story, and that makes the experience all the more believable!”

Grinspun’s algorithms, which are based on the field of mathematics called “discrete differential geometry,” not only can simulate how materials bend and move, but also predict it. Working with Pedro Reis of MIT, Grinspun adapted code developed for animation to predict the coiling patterns of fiber-optic cables laid on the ocean floor. The computer code worked so well that it predicted things the scientists hadn’t even considered—which they then confirmed in the lab.

All of his work, says Grinspun, grows out of his interest in the geometry of physics. “That is what fascinates me,” he remarks. “Anything that is a geometric approach to physics—the intersection of geometry, physics, and computation.”

“I pursue this stuff for the beauty of the geometry and the physics,” says Grinspun, “but the larger fulfillment for me is in knowing that our code is being used on the big screen, by doctors in medical simulations, by biologists studying the motion of bacteria flagella.”

By Ann Rae Jonas
communication and information exchange between humans and robots,” says Allen. “This has promise to really improve human-robot interaction. By experimenting with a novel suite of noninvasive sensors, we are determined to develop techniques to recognize situational state, or user awareness. This will also allow the robot and human to actually learn about each other’s state and expectations.”

**Assistive Technology Leads to Autonomous Robotics**

Before robots become fully autonomous, they will need to have the ability to physically manage seemingly small but very complex tasks. For instance, there’s no robot now capable of the intricate movements the human hand uses to accomplish tasks.

“Dexterous, versatile manipulation is one of the big unsolved problems in robotics,” says Matei Ciocarlie, assistant professor of mechanical engineering at the Engineering School. “Today’s robots on assembly or manufacturing lines perform the same task again and again, grasping the same parts as they come down the line. The world where humans interact is not like that. There is a wide range of objects of all shapes and sizes that people effortlessly manipulate.”

No one knows that scenario better than a person who has had a stroke and can no longer effectively grasp objects. Ciocarlie, along with Joel Stein, chair of the Department of Rehabilitation and Regenerative Medicine at Columbia University Medical Center, has cocreated MyHand, a glove-like orthosis, to help stroke survivors regain hand function. By creating this portable, lightweight glove, the researchers have not only been able to help the person wearing it manage grasping and other hand movement; they have gotten closer to the goal of developing autonomous robots.

“Manipulation is an enormously complex skill, testing the ‘hardware’ (the hand) and the ‘software’ (the brain) in equal measure,” explains Ciocarlie. “Autonomous robots cannot yet approach humanlike performance, but, when controlled by the human user making the high-level decisions, a wearable device could enable the user to perform tasks that a stand-alone robot could not.”

Ciocarlie, Stein, and their team have been working with stroke patients for more than a year, testing the MyHand device, collecting patient feedback, adjusting the device, and testing again.

“We’ve gone from simple movement to testing pick-and-place tasks, and, quite recently, we have begun experimenting with methods that allow the users themselves to control the device,” he says. “The patients and the research physical therapists we have been lucky enough to work with give us very objective and practical assessments and don’t hold back when criticism is warranted.”

Ciocarlie often receives important encouragement from the patients he works with. “In most cases, as we wrap up a test, the user will tell us something along the lines of, ‘You know, overall, it’s so much better than last time.’ That’s what we like to hear,” he adds.

Even more encouraging are the most recent tests, when, for a moment, a patient is so absorbed in conversation with Ciocarlie and the research team that he or she simultaneously operates MyHand without thinking about it. “That’s where we’d like to get to: an assistive device you don’t have to think about, as it just enables you to do what you want,” he says.

> Curious about the programs and initiatives at Columbia focused on robotics? Learn more at robotics.columbia.edu.

By Amy Biemiller
IMAGING + SENSING
Erasing the Line between Imaging and Analyzing

As imaging and sensing technologies grow in both sophistication and accessibility, they do more than just gather data and produce images: They are research tools in their own right, providing scientists with the means to deepen our knowledge both about fundamental biological processes and about causes and progression of disease. Obtaining the images is only the first step. Significant research and clinical advances require new ways of analyzing the data.

Current biomedical imaging and sensing technologies include computerized tomography, magnetic resonance imaging, optical coherence tomography, spectroscopy, and ultrasound, to name only a few. These technologies are at the intersection of the physical sciences, mathematics, computer science, and engineering. Columbia Engineering is home to many imaging and sensing labs, some of which collaborate with labs at Columbia University Medical Center. Our researchers are using biomedical imaging and sensing to study everything from the development of artificial vision systems to bone biomechanics.

Sometimes they work in partnership with technology companies to develop new imaging and sensing techniques. In a constant feedback loop, faculty and researchers pursue technological advances to satisfy unmet scientific and clinical needs; the new technologies then open their eyes to further questions to explore.

**Developing Optical Tools for Surgical Guidance**

Early in her research career, Christine Hendon was drawn to biomedical optics; she was intrigued by this medical technology that did not rely on radiation. Today, her overall goal is to develop optical tools for surgical guidance.

“We want to develop optical tools that provide the surgeon with a clear understanding of the tissue,” says Hendon, assistant professor of electrical engineering. Her techniques primarily use near-infrared spectroscopy and optical coherence tomography (OCT), which has been dubbed “optical ultrasound.”

So-called optical biopsies would offer much higher resolution than current biopsy surrogates such as MRIs, PET tomography, and ultrasound. A potential advantage of OCT is that the surgeon would be able to image a wide area of tissue and, unlike with invasive biopsies, remove as little tissue as possible.

Currently, the main application of Hendon’s research is focusing on OCT in the treatment of heart arrhythmias, or irregular heart rhythms. A common treatment is ablation, in which the surgeon uses a catheter to detect abnormal electrical signals and then applies radio-frequency energy to remove scar tissue in the malfunctioning area.

Hendon is also using spectroscopy to provide real-time information during surgery. Especially important is the depth of a lesion—the ablated, or dead, tissue area. “Frequently,” says Hendon, “patients who have ablation return for a
An upcoming project focuses on the use of optical tools in breast cancer. Hendon is working with breast surgeon Sheldon Feldman and pathologist Hanina Hibshoosh at Columbia University Medical Center to identify tumors localized to the duct. Eventually, they will image lesions over time to determine which are likely to progress to cancer.

Hendon is also collaborating with fellow Columbia Engineering professor Kristin Myers on using imaging to assess the mechanical properties of the cervix in relation to preterm birth.

In late July, Hendon did the first in vivo testing of the spectroscopy catheter on an animal model.

Hendon’s group is building an atlas of OCT heart images. So far, the atlas includes 25 human hearts, with 15 volumes (600 images per volume) for each heart. Eventually, the atlas will be used to train cardiologists.

second procedure. We hope that the use of spectroscopy will reduce both procedure time and the number of repeat procedures.”

Above, middle: Custom-developed catheter integrates optical fibers with a therapeutic radiofrequency ablation probe to allow for real-time assessment of lesion depth by monitoring changes in the near-infrared reflectance spectra (Photo by Jeffrey Schifman)

Real-time changes in the heart’s reflectance spectra visualized during the creation of a radiofrequency ablation lesion (Images courtesy of Christine Hendon)

Below, top: 3D reconstructions of OCT volumes of human heart tissue images

Christine Hendon (left) and Xinwen Yao reviewing histology images of the heart to correlate with optical images taken with a custom-built, ultrahigh resolution optical coherence tomography imaging system

Below, bottom: 3D reconstructions of OCT volumes of human heart tissue images
Hendon is committed to encouraging STEM education among youth. At Columbia, she hosts campus visits by middle-school students—who leave with OCT images of their finger. “Middle-school kids are great,” she said. “They don’t hesitate to ask questions.”

Image Analysis for Both Diagnosis and Treatment Design

In the mid-1980s, Andrew Laine was a graduate student at Washington University, in St. Louis—and a whiz hacker. At the time, the three major manufacturers of medical imaging equipment used different encrypted (proprietary) codes for breast magnetic resonance imaging (MRI) scans. At his adviser’s prompting, Laine cracked the codes, so the data from the various machines could be integrated and the images compared and studied. “Later,” he says, “the federal government ordered imaging manufacturers to adopt a common standard, so images could be shared among VA hospitals.” The result was Digital Imaging and Communications in Medicine (DICOM).

International politics played a role in determining Laine’s next step. With the collapse of the Soviet Union, the U.S. army had a surplus in the defense budget, including $20 million for medical research on women’s diseases. Laine proposed a method to enhance mammograms, to address the problem of visible lesions being overlooked in screening. His technology was ranked the most promising in the program, and he received a $2 million grant for mammography research.

Laine, who is chair of the Department of Biomedical Engineering, with a joint appointment in Radiology at Columbia University Medical Center (CUMC), was the first to apply methods of multiscale “wavelet” representations to enhance subtle details in mammograms so they would not be missed. This not only produced better images, but also reduced the amount of radiation needed for screening. Today, the core algorithm he developed in 1992 is used in almost all commercial digital mammography systems worldwide.

Using a phased array ultrasound transducer, Laine was also the first to compute cardiac strain, which can be a precursor to a heart attack, in real time, from 4D (3D plus time) ultrasound. The 4D imaging can also detect abnormal wall motion of dead myocardial tissue resulting from a heart attack that has already occurred.

“Fostering the relationship between academia and industry,” Laine says, “is the fastest way to bring technical advances in imaging to clinical practice and improve patient care.” Laine spearheaded a partnership between Columbia and General Electric (GE) to foster translational research. It enables biomedical engineers, clinicians, and GE to jointly address unmet clinical needs that could benefit from
advances in MRI technology and other imaging methods.

Laine is also applying the wavelet technique he devised for mammography to pulmonary emphysema, a form of chronic obstructive pulmonary disease (COPD). Conventional computed tomography (CT) methods categorize a patient’s disease as one of three subtypes. In collaboration with Graham Barr, MD (CUMC), Laine’s lab is helping to reveal underlying disease stages of COPD by expanding the number of imaging phenotypes used as biomarkers.

By using 3D imaging of CT data and tens of thousands of CT lung scans, and tracking thousands of patients over a decade, Laine has discovered a richer set of 60–80 subtypes of emphysematic tissue.

Laine is also working with Professors George Hripcsak and Larry Schwartz at CUMC. Their research will allow clinicians to study a patient’s history using both text (electronic health record) and annotated findings derived from medical images. This collaboration adds the new dimension of imaging informatics—including radiomics (the extraction and analysis of quantitative features of images)—to precision medicine, furthering our ability to understand disease processes, create new therapies, and better predict patient outcome.

By Ann Rae Jonas

Above (clockwise from top right): This PET image sequence shows the progression of the amount of radio ligand (tracer) material within the brain, from initial injection, where it is “unbound” and flowing within the blood vessels of the brain, to a latter time, where the ligand has bound itself to specific metabolic site/target. The radioactive ligands appear as bright yellow spots within the image sequence. In the beginning, everything is diffused. After about 30 minutes, the ligand appears concentrated in yellow “bright spots” in the image as more becomes bound to metabolic targets within the brain.

Below, left: Laine’s imaging methods of multiscale enhancement have improved the detection/diagnosis of breast cancer for both types of mammograms shown (dense breast, far left, and malignant tumor). (Images courtesy of Andrew Laine)
Scientists attempting to decode the brain rely on high-speed recordings of individual neurons. Yet measuring enough neurons to understand how the brain drives behavior has remained a holy grail of neuroscience research.

Enter SCAPE, or swept confocally aligned planar excitation microscopy, a technique developed in the laboratory of Elizabeth Hillman, associate professor of biomedical engineering at Columbia Engineering. SCAPE enables 3D imaging of living tissues at very high speeds: 10–100 times faster than most in vivo microscopes. By imaging in 3D at such high speeds, SCAPE has the potential to transform neuroscience and biomedical research.

Another benefit of SCAPE is its simplicity. The technique requires no special preparation of samples and doesn’t require the user to move the sample or the microscope’s objective lens. As a result, SCAPE can capture real-time events in living animals, like the firing of neurons in a mouse brain or the beating of a zebrafish’s heart. SCAPE could also have clinical applications, providing doctors with a real-time 3D view of cells within a patient, for example, to guide removal of tumors.

Hillman, who is also associate professor of radiology at Columbia University Medical Center and a principal investigator at Columbia’s Mortimer B. Zuckerman Mind Brain Behavior Institute, first described SCAPE in a paper in *Nature Photonics* last year. She was subsequently awarded a $1.83 million, three-year grant from the NIH BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative to support her work on SCAPE.

Recognizing the significant commercial potential of SCAPE microscopy, in August 2016 Columbia entered into an exclusive, worldwide agreement with a leading microscope manufacturer to license SCAPE patents. The company plans to develop a commercial system, bringing the powerful technology to scientific laboratories around the world.

“We have received so much interest in SCAPE,” says Hillman, “we knew we needed help to get the technology onto the worldwide market as soon as possible. We are very excited to be entering this next phase and could not be more happy with our new partnership.”

By Ann Rae Jonas
The challenges of maintaining cybersecurity—from securing personal computers to protecting government, military, financial, medical, and corporate systems from malicious attacks and unauthorized access—are ever evolving. In July, thousands of e-mails from Democratic National Committee employees were hacked and, soon after, released by WikiLeaks. The damaging aftermath revealed controversial information tied to the U.S. presidential campaign and also resulted in the resignation of the DNC chair. It is no secret that hackers are becoming smarter and more sophisticated, always on the lookout for new attack surfaces and vulnerabilities.

The DNC e-mail hack is just one of several high-profile cyberattacks of late; large companies have been affected by data breaches in recent years, and, as a result, millions of people’s personal data—from credit card and Social Security numbers to sensitive health information—have been compromised. Worldwide spending on cybersecurity initiatives reached $75 billion in 2015 and is expected to rise dramatically in the coming years.

For a system to be truly secure, everything in that system must be safeguarded—the hardware, the software, the router, the computer’s configuration, and the users’ access to the system.

Computer scientists at the Engineering School are working to fend off breaches and attacks, and, here, two professors tackle that with two distinct approaches—one focused on software security and the other on preventing hardware hacks.

**Streamlining Software Security Processes**

“To err is human . . .” the famous quote begins. And that is the crux of software security issues. Error-prone humans design and implement the software that is ubiquitous in homes, industry, and government, necessitating a focused effort to quickly and efficiently identify flaws in its design.

“By exploiting software bugs, attackers can gain control of software and the devices controlled by it, as well as steal privileged information,” says Junfeng Yang, associate professor of computer science and codirector of the Software Systems Lab.

Software security presents an interesting engineering challenge, chiefly because software engineering is a human activity based on fallible human problem-solving skills. It’s that fallibility that is responsible for security gaps in technology like smartphones, computers, and printers that we use for common, daily tasks. It also puts large-scale and complex technology—like medical equipment, drones, power grids, and space technology—at risk.

“For now, the creation and administration of program logic requires human intelligence, so we’ll be stuck with software systems written and administered by humans for a long time. That means we will have systems that are not 100 percent secure,” says Yang.
Is it possible to efficiently and effectively compensate for the human factor that results in software security issues? Yang thinks so.

“My goal at Columbia Engineering is to build ‘self-driving’ technology for software engineering. I believe we can build intelligent tools to help detect and fix a lot of programming or admin errors, in order to increase reliability and security,” he explains. “The concept is similar to self-driving cars in which we program a destination and the car drives autonomously, safely navigates streets and highways, and gets us where we want to go.”

Yang is already making headway toward that goal. One of his earliest innovations tackled the problem of storage system errors in crash-recovery code. He employed an automatic verification technique called model checking to develop eXplode, a solution that makes it easy to find such bugs, even on complex storage stacks built from many different subsystems. Similarly, his team also examined the reliability problems inherent in multithreaded software programs commonly used in web servers. Testing, analyzing, and verifying multithreaded programs is notoriously difficult, leading to a greater probability for undiscovered bugs that can be exploited by attackers. His StableMT solution improves the analysis and testing of these programs and enhances reliability.

“It requires a lot of manual effort to detect bugs, so it would be great if we could automate much of this process using software to scan software,” he remarks. “We report potential bugs to the developers, and they create patches to their own software.”

Collaboration is key to identifying and solving the unique security and reliability challenges inherent in the multitude of software programs constantly in development. Along with his PhD student Younghoon Jeon, Yang has developed an automated solution to diagnose performance slowdowns in mobile apps. He’s also working with Yinzhi Cao at Lehigh University on machine unlearning—an automatic repair system that scrubs unwanted data injected in learning systems via malicious attacks or security breaches. Machine unlearning can also make learning systems forget users’ data for better privacy.

“There are many computer paradigms, and new ones on the horizon, each with potential security vulnerabilities,” he says. “The key to efficiently and effectively overcoming these security and reliability issues in both software and hardware is advanced computer science.”

A Firm Foundation for Security

In the world of cyberattacks, software is the low-hanging fruit that fraudsters typically exploit. But as software security becomes tighter, attackers are looking for opportunities to take advantage of weaknesses in hardware—the foundation for an entire computer stack. The prize is deeper control of systems and devices.

Computer scientists like Simha Sethumadhavan, associate professor of computer science and founder of the hardware security startup Chip Scan, are working hard to get ahead of these exploits and find fixes for this potential cybersecurity nightmare.

“Cybersecurity is a current, pressing problem, and the practical solutions can have a huge impact,” says Sethumadhavan. “With the world
“To achieve hardware-up security, his group works on nullifying hardware “backdoors,” malicious pieces of code placed in hardware that can be hard to detect and impossible to remove. “One type of hardware backdoor behaves like a ticking time bomb. One solution is to change attackers’ assumptions about hardware design, effectively elongating the fuse on these malicious pieces of code so the bomb never goes off,” says Sethumadhavan. His group’s solution is being evaluated by U.S. Air Force Labs to keep their supply chain safer.

Sethumadhavan’s lab has also found a way to make antivirus protection more effective and energy efficient. “The big engineering question was how to make antivirus protection better so that it could guard the device better but consume the lowest amount of energy possible,” he remarks. The solution? Bake the antivirus into silicon. “This antivirus in silicon can’t be easily turned off and uses less energy even though it runs continuously to protect the system.” That work has gained commercial notice and has influenced development of new, highly secure consumer products.

“In a couple of years from now, it is very likely you will be able to purchase a smartphone with an antivirus system embedded in it that is easier on battery life,” says Sethumadhavan. “That’s inspired by our work.”

By Amy Biemiller
MOLECULAR
ENGINEERING

(Photograph by Jeffrey Schimman)
body’s own immune system to fight disease, especially cancer. Developed in the late nineteenth century by William Coley, the “father of immunotherapy,” the approach fell out of use in favor of today’s familiar cancer treatments of surgery, radiation, and chemotherapy. Today, molecular engineering researchers at Columbia are making exciting advances toward the creation of immunotherapeutic agents, including synthetic vaccines against cancer and deadly viruses.

Molecular engineering also holds great promise in nonmedical areas, such as digital information storage, water purification, and agriculture.

**Bacteria: Engineering’s Newest Research and Clinical Collaborators**

“Being able to manipulate life.” That, in five words, is what drew Tal Danino to synthetic biology. And not just for the intellectual adventure, but as a way to engineer solutions to real-world problems.

Danino, assistant professor of biomedical engineering at Columbia Engineering and director of the Synthetic Biological Systems Laboratory, wants to put bacteria to work detecting and treating diseases such as cancer. The heart of his technology lies in programming the DNA in bacteria to make diagnostic and therapeutic molecules from inside the tumor.

Immune cells cannot enter the tumor’s center, called the “necrotic core.” Bacteria like the environment in the core: not only are they safe, but they also can feed on nutrients provided by dead cancer cells.

“Not only can we make certain small molecules,” says Danino, “but we can also make a lot of other things. We can make proteins and enzymes that cause holes in cancer cell membranes—that’s what bacteria do; they kill cells. We also can make small RNA molecules, to silence genes that are expressed in cancer.”

Danino has engineered a probiotic to detect liver cancer. When the proliferating bacteria sense the tumor environment, depending on which genetic circuit used, they produce a molecule that either changes the color of the urine or causes it to luminesce. Now his goal is to make probiotics that can get into tumors, sense the environment, and release a therapeutic drug in response.

**That’s Life: Engineers Make and Exploit Living Molecules**

Molecular engineering—at the intersection of the life sciences, engineering, and computer science—is about making new molecules. Researchers in this hybrid field seek to understand the fundamental processes of life; at the same time, they exploit that knowledge to modify and synthesize biological materials for solutions to real-world problems.

Columbia molecular engineers, particularly genomics researchers, are paving the way for achievements in radical new approaches to medicine, such as gene editing and gene therapy, that are still in their infancy.

Recent years have also seen a resurgence of interest in immunotherapy, which marshals the
In late July, *Nature* published a paper coauthored by Danino on recent work using attenuated, or less virulent, bacteria to treat liver tumors. He and his colleagues used the bacteria to deliver three different genetic circuits into liver tumors: one to produce a molecule that attacks tumor cell membranes, one to produce a molecule that causes cells to self-destruct, and one to produce a protein to stimulate the immune system.

In mouse tests, used alone the bacteria reduced tumor growth slightly, but combining the bacteria with a common chemotherapy drug, 5-fluorouracil, caused the tumor to shrink much more than when only the drug was used.

Danino also expresses his creativity through bio-art projects, recently in collaboration with Brazilian artist Vik Muniz. Some artworks consist of actual bacteria; others use a photo. In perhaps the most striking work, the bacteria are alive and growing while exhibited. For Danino, science and art are not mutually exclusive.

“It is all about exploration; about being comfortable with uncertainty and seeing where it leads you,” he says.

**Marshaling Millions of Web Collaborators**

Yaniv Erlich may have the largest research group of any scientist. His collaborators are the more than 20,000 people who have so far posted their genomes on the crowdsourced online genetic database DNA.Land. Site users upload genomes that they have obtained from one of three consumer genetic-testing companies—23andMe, FamilyTreeDNA, or Ancestry.com—providing Erlich and his colleagues with a wealth of data.

Erlitch, assistant professor of computer science at the Engineering School, with a joint appointment at the New York Genome Center (NYGC), started the site with fellow NYGC member Joseph Pickrell, adjunct assistant professor of biological sciences at Columbia. Erlich’s genomics research, including his cutting-edge gene-sequencing algorithms, motivated him to harness the resources of the online world as a way to obtain as many human genomes as possible, both efficiently and cost-effectively. Additionally, he liked the idea of giving people a way to be involved with his work.

No stranger to untraditional data-collection methods, in 2013 Erlich used genealogical data harvested from social media sites to create a family tree of 13 million people, going back to the 15th century.
Because each genetic-testing company tests for different genetic markers, DNA.Land uses a technique called “imputation” to infer genetic variants not included in a specific test. The technique is based on the phenomenon that certain markers are frequently inherited together.

“In return for their genomes,” says Erlich, “DNA.Land offers users more than just a sense of virtue for having contributed to science.” Users receive a “contribution badge,” showing points accumulated for answering questions.
When asked if he would have posted his genome on DNA.Land had he had a mutation linked with a serious late-onset disease, Erlich does not hesitate before responding. “Privacy is important but the whole point of posting genomes is to find solutions for serious diseases. If you have a serious mutation, would you not want the best science to understand it?”

By Ann Rae Jonas
J. Thomas Vaughan

Thomas (Tommy) Vaughan joined Columbia this spring as the University-wide director of Magnetic Resonance (MR) Research, a newly created position with joint appointments at Columbia Engineering, Columbia University Medical Center, and the Mortimer B. Zuckerman Mind Brain Behavior Institute. An expert in the field of ultrahigh field magnetic resonance techniques and technologies, Vaughan is overseeing a collaborative effort to build an MR Research Center at Columbia. This summer, as Vaughan settled into his new role and his new home in bustling New York City—a change from the suburbs of Minneapolis—he spoke to Columbia Engineering magazine about the future of MR research, delivering MRI to the masses, and that time, not so long ago, when he biked around the world.

“To bring MRI to the rest of the world requires a new way of thinking. We need to reinvent the current methods and technology.”

World’s first 9.4T human brain images in vivo, in the highest field strength yet acquired. Vaughan invented a multichannel transmit and radiofrequency shimming for MRI.

Q. How did you get into the MRI field?
A. I wanted to be an astronaut, but ended up as a civil servant for NASA on the Space Shuttle project. NASA’s contractors were doing the most creative work, so I moved to Texas Instruments to work on “a government project,” while going to grad school at UT Southwestern. I had studied biology and electrical engineering and, with my radar experience, it led me to an NMR course at UT. I was hired to build the first 2 tesla (2T) machine and then worked on the first 4T, 7T, 9.4T, and 10.5T MR systems, as the opportunities to work with more and more powerful magnets presented themselves.

Q. Columbia will be getting several state-of-the-art MR systems, some as part of a new partnership with GE. How will they be used?
A. For basic neuroscience, translational R&D, and technology transfer. Columbia will be purchasing six new GE 3T MR systems and a 7T system to be located in the Neurological Institute on the Columbia University Medical Center campus. An additional 3T MR system will belong to GE, along with a complement of half a dozen GE scientists, as part of a translational research agreement between Columbia and GE. The Zuckerman Institute will have two Siemens 3T machines, one 7T system, and a 9.4T Bruker preclinical system to be used for neuroscience. These 3T and 9.4T systems will be installed in the Zuckerman Institute by the end of October 2016.

Q. How is Columbia Engineering involved?
A. In the Columbia Engineering laboratory component of the University’s MR Research Center, we will explore new technologies and methodologies to develop new MRI systems. The World Health Organization’s data shows that only 10 percent of the world has access to MRI. In a sense, MRI hasn’t been delivered to the world. We need to find a way to do that.

We have NIH neuroscience seed money to test the feasibility of new kinds of MR. We are basically reinventing magnetic resonance—the magnet, the spectrometer, the imaging physics—to make it portable, operate anywhere in the world, delivered in the back of a bus or a pickup truck.
truck, and not dependent on the modern power grid or other infrastructure. And, of course, we hope it will be affordable.

At the other end of the spectrum, I have a 9.4T magnet in Minnesota that I want to bring to Columbia, one of five in the world. Currently wielding the most powerful field strength at which human images have been achieved, the 9.4T machine is like a Hubble Telescope for the human mind. You can see anatomy to 10 microns in-plane resolution, plus high-resolution metabolism and physiology, all in vivo and noninvasively. Being beyond the capabilities of commercial MR systems, our aim is to build a 9.4T human imager in-house at Columbia.

The many systems being delivered and used for research at the Zuckerman Institute and the Medical Center will require and benefit from new technologies and methods to improve existing approaches and to facilitate new ones in support of biomedical research.

These projects and more will fully engage Columbia Engineering faculty and students in an all-out engineering effort.

Q. How will having these machines enhance research?

A. MR is another set of eyes to the world. We will be using MR imaging (MRI) to observe anatomy. Magnetic resonance spectroscopy (MRS) will be used to measure metabolism in different tissues and organs. And functional magnetic resonance (fMRI) will be used to observe brain activity and, in the process, to better understand the human mind and behavior. These powerful and comprehensive MR tools and techniques will be developed in the engineering lab and deployed in the MR laboratories in the Zuckerman Institute and in the Medical Center to investigate the human mind and body, noninvasively, in states of health, disease, and therapeutic intervention.

Q. What is the future of magnetic resonance research?

A. MR will continue to be used for basic science, clinical diagnostics, and therapy tracking. One direction is using MR together with complementary modalities (CT, PET, ultrasound) to get a more complete picture. Another is toward more powerful systems using more powerful magnets that provide more signal-to-noise to give higher spatial and temporal resolution in our images. Yet another is making MRI accessible to the rest of the world.

To bring MRI to the rest of the world requires a new way of thinking. We need to reinvent the current methods and technology, not make just incremental improvements. For example,
current magnets need to be cooled in a helium bath contained by a large, heavy “Thermos bottle.” This new magnet and MR system require modern infrastructure including communications links, a reliable power grid, field service access, and a stable supply of increasingly scarce and expensive helium. But if you had a magnet of high-temperature superconducting ceramic material, weighing less than 1,000 pounds, that used liquid nitrogen from the air and could use a nonuniform field, the machine could be smaller, cheaper, and shorter. Think of an inner tube that you could put around the middle of a patient. We need to explore new magnet technology, imaging physics, and to revolutionize the MR system so that the MRI machine can be used anywhere in the world, even where there is no power. And to use a gamer’s laptop with a link to the cloud, so you can get information anywhere on the planet. This new system envisioned is now being developed in collaboration with the University of Minnesota.

Q. What will “success” look like to you, a year or two from now?

A. Organizing and funding a Center by 2018. This would give us an organizational structure that everyone can understand and peer-reviewed legitimacy. My biggest mission is to organize Columbia’s resources into a single MR Research Center.

Q. When you’re not busy in the lab or in meetings, how do you spend your time? Any hobbies or interests?

A. I moved and restored a pioneer log cabin in the North Woods on the St. Croix River, on the Wisconsin side of the Minnesota–Wisconsin border. It is kind of like Lake Wobegon. The cabin dates from 1880 and belonged to a bachelor dairy farmer from the community on which Garrison Keillor’s story was based. My son and I moved it to this off-the-grid location. Now that we are moving to New York, having this cabin in the Wisconsin woods will keep me connected to family and the outdoor activities I enjoy. Another interest is cycling. When I was in college I took two years off to ride around the world, visiting 57 different countries. This was a mission to see what the world had to teach as I was trying to decide my own life’s directions. I now enjoy biking the route along the Hudson, from the Morningside Heights campus, up to the Zuckerman Institute at Manhattanville, and on to the Medical Center at 168th Street and back. Cycling gives me my daily exercise, transportation, recreation, and my thought for the day.

By Joanne Hvala
The spirit of engineering was ingrained early on in Sidney Perkins’s life. He has fond memories of rushing home from soccer practice to watch NOVA on PBS with his father, a mechanical engineer. His mother, a calculus tutor in her spare time, would teach him math concepts he hadn’t yet covered in class. Social responsibility, too, was intertwined in his community life, as Perkins devoted hours to volunteering in a way that proved formative.

“I remember teaching swimming and sharing my love of the outdoors at a day camp for inner-city youth in the summer after my junior year. And I remember it was beyond gratifying.”

When considering which scientific discipline would provide him with the best vehicle for his altruism, Perkins decided on engineering as having the best potential to improve the world.

His quest to find an institution that embodied his values led him to the socially engaged community of SEAS, where he is currently a senior studying biomedical engineering. “The science of engineering is divorced from moral authority and constitutes the tools that we use to shape the world around us,” says Perkins. “This is technology: the ‘what’ of engineering. Equally, if not more, important is the art of engineering, which espouses serious ethical considerations for the implementation of engineering projects. This is the ‘where,’ ‘when,’ ‘how,’ and ‘why’ of engineering.” Perkins found this philosophy deeply rooted in the culture here.

He notes, “I saw a school that celebrates the importance of contextualized engineering: engineering for a purpose.”

For Perkins, nothing has more encapsulated this marriage of art and science than Columbia’s chapter of Engineers Without Borders, a group for which he has served as copresident, and which he describes as being a defining part of himself. He has gathered hands-on experience in design and leadership and, importantly, learned that, in engineering, the problem must always precede the solution.

His work with Engineers Without Borders continues to inform his experience. He took on field research this past August in Uganda, a trip facilitated by Senior Lecturer Aaron Kyle, for his senior design project. Before leaving, Perkins remarked he intends to conduct biomedical field research with a classmate and members of Neopenda—a startup by fellow Columbians aimed at providing neonatal care in low-resource settings. “The team is looking to identify 100 problems in the span of one week through extensive communication with clinicians, professors, and representatives of NGOs in-country,” says Perkins, describing what will ultimately become a senior design project with large potential for impact.

In the future, Perkins plans to practice as a physician and understands his engineering background will provide a robust toolbox for his aspirations to leave the world better than he found it.

Speaking about this, he says, “One of my biggest excitements about going into medicine with a background in engineering is that when I encounter inefficiencies in procedures, or needed medical devices, there is no reason that I could not fill those gaps. I’m particularly interested to see how this plays out in tissue engineering.”

As for his own contributions to altruistic achievement through science and technology, he intends to remain committed to keep questioning, challenging, and maintaining a problem-focused approach. As Perkins notes, “This is the engineer in me.”

By Elaine Rooney
For Christina Michaels, an engineering education is the engine that can power almost any career path. Michaels spent the summer interning for Pricewaterhouse-Coopers, in the cybersecurity and privacy group, where she worked on a third-party risk assessment, evaluating a client’s third-party relationships and the risk they pose to the client. Though that may not sound like a natural next step, she said, the job was actually a natural outgrowth of her chemical engineering studies.

“You might be wondering why, as a chemical engineering major, I’m working on cybersecurity,” she admitted with a laugh. “But in terms of cybersecurity, PricewaterhouseCoopers is growing the division, and it’s an exciting time to be with them—now’s a good time to get into the industry.”

And while her previous internship—at a nuclear power plant, where she worked on risk stratification—was a more traditional choice, Michaels said she’s happy to have both experiences under her belt.

“When I was venturing away from chemical engineering I was nervous, but I’m a lot more comfortable now—and the more diverse of a background you can have, the better,” she noted.

Back on campus, Michaels will still be working with Res.Inc., the Columbia Engineering residential entrepreneurship incubator where she lived and worked beginning freshman year (and last year served as the student coordinator), although she won’t be living on its floor.

“I still want to be a part of the program, and Res.Inc. likes to bring back former students, even if they haven’t graduated yet,” she said.

And, after a year of successes—Res.Inc. members took first and second prize at Columbia’s Fast Pitch competition last November, and another team made it to the final round in the Columbia Venture Competition last April—the program is “really blossoming,” she said. “We’ve had a lot of interest from prospective students.”

(Michaels has an even stronger tie to Res.Inc. to motivate her—her sister, Stephanie Michaels ’18SEAS, is an event manager for the program this year.)

Michaels said she’s going to spend her senior year shoring up her newly declared applied mathematics minor, as well as...
enjoying the chance to move beyond the chemical engineering requirements.

“I’ve been asking people what are the most useful skills you can gain from the last college year, and the answer seems to be that any coding experience you can gain is important, and that statistics is valuable too,” she shared. “So I’m excited to diversify within engineering.”

Michaels is also looking forward to the publication of research she worked on last summer at the University of Maryland under Professor L. J. Martinez-Miranda, whom Michaels met through SEAS Associate Dean Leora Brovman. “Modified Coffee Rings for Quasi 1D Interconnects,” on the self-assembly and conductivity of silver nanowires on glass gratings, is under consideration by a peer-reviewed journal.

Keeping the connection to her summer internship is another item on the to-do list, she said. “I know that PricewaterhouseCoopers doesn’t currently have the biggest presence on campus, so I want to approach both PwC and Columbia about being a student ambassador, and for them to be more present at career fairs and for general information,” she said. “Having had this experience, I think a lot of engineers would really enjoy it here.”

Michaels noted that her internship proved to her the value of an engineering education for her—or anyone else—in almost any field.

“I’ve been able to apply the skills I use in my engineering classes,” she said. “Engineering provides you with a logical, problem-solving methodology that can be applied to any professional situation.”

By Jennifer Ernst Beaudry

“When I was venturing away from chemical engineering I was nervous, but I’m a lot more comfortable now—and the more diverse of a background you can have, the better.”
Columbia Space Initiative (CSI), one of Columbia’s newest student clubs dedicated to all things space and space tech, is less than a year old, but it’s already seen success: The group presented a design for an asteroid anchor at NASA’s Neutral Buoyancy Laboratory and competed at NASA’s prestigious RASC-AL (Revolutionary Aerospace Systems Concepts – Academic Linkage) competition.

Founded by Julia Di ’18SEAS and Keenan Albee ’17SEAS, the Columbia Space Initiative is “totally dedicated to space technology and outreach,” Di said. As an umbrella organization overseeing a number of projects—“We call them missions, because we’re a space club,” Albee said, laughing—the group has members working on a number of things. In April, one team planned and launched a high-altitude weather balloon.

Another team—one that counts both Di and Albee as members—went to Houston in May for NASA’s Micro-g NExT challenge to present their design for Lion Claw, a tool that anchors an astronaut to an asteroid and was created with input from former NASA astronaut and faculty adviser Michael Massimino, who has first-hand spacewalk experience. Massimino BS’84 is professor of professional
practice in the Department of Mechanical Engineering and author of the just-released Spaceman: An Astronaut’s Unlikely Journey to Unlock the Secrets of the Universe.

Di and Albee said seeing the design they created in action in NASA's Neutral Buoyancy Lab—a 6.2 million gallon diving tank that contains full-scale models of International Space Station modules and equipment for other space missions—was an amazing experience. (The group livestreamed it on Facebook.)

In the tank, Lion Claw held at least 30 pounds of force—triple the amount the design brief had called for.

"The divers who tested the tools said that ours was one of the strongest designs of the day," Di remarked.

The CSI team, one of a small number of teams selected to test their astronaut tool designs in Houston, received grants from NASA, the Columbia College Student Council, the Columbia Engineering School Student Council, the SEAS Dean Travel Fund, and the Columbia Joint Council Co-Sponsorship Committee to work on their design and travel to Houston.

“We’re definitely planning to do the competition again this year,” Albee said.

A separate team was selected to head to the Kennedy Space Center in Cape Canaveral, Florida, in June to present their proposal for a crewed mission to one of Mars’s moons as one of the 12 finalists in NASA and the National Institute of Aerospace’s RASC-AL competition for university students.

And these adventures are all thanks to the film The Martian.

While Di and Albee, friends through Columbia’s Formula SAE racing team, had separately been mulling the idea of starting a group that reflected their interest in space, the plan crystallized at a talk, held at the University last fall, centered on the Ridley Scott film.

The discussion, the inaugural event of the Engineering School’s Extreme Engineering program, featured clips from the film and discussion with Massimino and NASA engineers.

Extreme Engineering, spearheaded by Massimino and Dean Mary C. Boyce, brings in speakers who reflect the incredible diversity of cutting-edge careers available to engineering students. The School has already cohosted several events under the new Extreme Engineering banner and launched a video series, hosted by Massimino, that showcases faculty and their “extreme” research.

“We were looking for things that would excite the students—not just in space, but things that are very cool in the engineering space,” Massimino noted.

So far, it’s working: CSI is proof.

After the panel last September, Di and Albee said they approached Massimino to ask if he’d help them launch the club as their adviser, and with that the group was off and running.

“They’re out of control—they’re great,” Massimino remarked of the 30-strong club. “I’m amazed at everything they do. Truthfully, I just try to stay out of the way.”

Di and Albee say that CSI has cemented their commitment to pursuing careers in space exploration and technology. Over the summer, several CSI members held internships at NASA's Jet Propulsion Laboratory, at Columbia's Lamont-Doherty Earth Observatory, and at SpaceX. Albee worked on the CST-100 Starliner design team for Boeing's Advanced Space Exploration group. Di interned at NASA's Marshall Space Flight Center, as part of the NASA Robotics and Space Hardware Academy, working on building a robotic arm that can electrostatically capture orbital debris.

This academic year, Albee noted, the group will continue advocating for an aerospace major/minor program at the School and have started talking with the student council and faculty members about possibilities.

They’re also looking to expand CSI’s impact beyond Morningside.

“We’re working with other universities and trying to create a college consortium for space in the Northeast,” he said. “Things like that are pretty exciting.”

By Jennifer Ernst Beaudry
The Engineering School has made promoting entrepreneurship in its students a top priority—and the results speak for themselves. Under Dean Mary C. Boyce, Columbia Engineering is laser-focused on teaching skills, encouraging collaboration, and giving students and recent grads a boost in the startup sector.

“A lot of students—even if they plan to take a traditional job after they graduate—will have in the back of their mind that they are building a skill set to take with them to build their own company,” said Ivy Schultz, associate director of Entrepreneurship Programs for Columbia Engineering. “I think people know they’ll change jobs, and the skills of entrepreneurship are transferable.”

“Dean Boyce is very much into supporting student initiatives and interests,” agreed Paula Anzer, director of Strategic Initiatives for the Engineering School. “And one of the things our students and faculty are passionate about is solving real-world problems and having a global impact.”

Combining the two is the name of the game with the Columbia Design Challenge, launched in 2014 with a focus on the Ebola crisis. For the second and latest edition, students were asked to bring their
most innovative ideas for addressing issues with urban water and sensing technologies. It was run in partnership with the Columbia Global Center in Rio de Janeiro; and on May 31, Columbia community members, including Dean Boyce and 22 students, traveled to Rio to present their design concepts, meet with colleagues, and tour facilities at partner school COPPE/UFRJ, Rio de Janeiro’s federal university. They saw firsthand how water and wastewater treatment affect the city and how using wireless sensing technology could have a great impact on the Rio environment.

“We weren’t thinking about it initially, but we realized that some of the ideas generated might be really viable as startups,” Anzer said. (In fact, one team who entered the Sensing and the City Design Challenge won an Ignition Grant from the School.) “There are some real opportunities for startups,” she added.

Two more key examples of fostering entrepreneurship are Fast Pitch and the Venture Competition, launched seven years ago. Bookending the academic year, Schultz said, the competitions give engineering students ways to...
meet like-minded collaborators, hone their pitches as well as their business development acumen, and potentially walk away with the critical funding (Fast Pitch awards $5,000 in grants; Venture Competition has a total prize pool of $250,000) that can help them take their ideas to the next level.

Schultz also hails Fast Pitch and the Venture Competition as a great way to connect students with the vast resources of the alumni group—and vice versa. By recruiting alums as judges for both competitions and as student mentors, students are tapping into a deep network of connections, advice, and resources. And alumni get a firsthand look into the creative ideas of the future.

Columbia Engineering endows Ignition Grants to the tune of $120,000 a year for ideas it thinks has potential. Judges can award different levels of grants, depending on project needs, with amounts ranging from $5,000 to $25,000. Some recipients and competition winners have used funds toward space at the Columbia Startup Lab, the dedicated coworking facility at WeWorks Soho West that provides heavily subsidized work areas for more than 40 Columbia startups from the Engineering School, Columbia College, and the Business School.

“Engineers are really a lot of the creative drivers behind new products,” Schultz said. “Developing your ideas is hugely risky, it’s time consuming and stressful, and for our alumni and very recent grads, it’s so important to give them ‘a soft landing’ to get something started,” she noted.

Columbia-born Neopenda is just one example of what the model can do.

Founded last year by biomedical engineering master’s students Sona Shah MS’16 and Teresa Cauvel MS’16, Neopenda started as a class project in Katherine Reuther’s biomedical design class. The result—a wearable vital-signs monitor designed for use on newborns in developing nations—got a huge boost after placing third in the Global Technology Challenge track at the 2015 Columbia Venture Competition. Shah and Cauvel used the $10,000 cash award to fund a two-and-a-half-week trip to Uganda, where the women visited nine different public and private hospitals in four different cities and met with NGOs and government entities to better understand the country’s newborn health priorities.

“What we had been missing was a deep understanding of conditions on the ground,” Shah said. “The trip was a turning point in realizing that there was a huge need, even in the most sophisticated hospitals. It was validation that what we were doing was appropriate and needed.”

In the year since, Shah and Cauvel have made huge strides. Following their first Uganda trip, they were accepted into the inaugural Relevant Health accelerator program in D.C.—the women took classes remotely and traveled back and forth to Columbia for five months while intensely focusing on moving Neopenda forward. They launched a Kickstarter campaign (raising $40,953) and kept pitching. In the past year, Neopenda took first place finishes in the 2016 Columbia University Women Entrepreneurs Pitch Competition, the Cisco Internet of Everything Challenge at the 2016 Rice Business Plan Competition, and the 2016 Vodafone Americas Foundation Wireless Innovation Project—and both Shah and Cauvel graduated.

This summer, they flew to Uganda for a second time to meet with partners—including members at their pilot hospital partner, St. Francis Hospital Nsambya, in Kampala—in preparation for their next steps.

“We can’t thank Columbia enough at this point,” Shah said. “The mentorship from Dr. Aaron Kyle and Dr. Reuther, who are on our advisory board, has been phenomenal. It’s where we started.”

Startup CarboCycle, which focuses on converting organic waste into palm oil substitutes, also attributes its recent momentum to its big win in this year’s Columbia Venture Competition.

“The biggest thing the Venture Competition did was turn our idea into a potentially viable business,” Shashwat Vajpeyi PhD’16 said.
VidRovr, an innovative video management and processing platform developed by PhD students in Columbia Engineering’s Digital and Multimedia Lab, was recently named among the Publicis90, a select group of startups to receive funding and mentorship from Publicis Groupe, one of the world’s leading advertising and PR firms.

A jury of executives and practitioners selected just 90 winners from more than 3,500 applicants spanning 141 countries. VidRovr placed an overall 12th in the global competition, which aims to support digital entrepreneurs with major business potential in the industry.

Cofounders Joe Ellis and Dan Morozoff, doctoral students in electrical engineering and biological sciences respectively, created VidRovr to enable real-time processing of large video collections to extract meaningful information, index clips, and help clients intelligently leverage content. With Professor Shih-Fu Chang as adviser, they devoted several years to patenting foundational research in machine learning and multimodal information processing, designing algorithms to process and learn from vast amounts of information.

Making up more than 80 percent of online traffic, video is the fastest-growing and most profitable space for advertisers. VidRovr helps partners monetize content with systems to help index, search, and recommend videos automatically. The company was selected to participate in the NYC Media Lab’s startup incubator, The Combine, and consulted extensively with industry experts to address clients’ needs.

After graduating from The Combine, VidRovr executed a licensing deal with Columbia Technology Ventures (CTV) for the core patents and software developed in Chang’s lab with collaborators Brendan Jou, Hongzhi Li, and Svebor Karaman.

“In years to come we hope that, through VidRovr, the technologies for video understanding that we developed at Columbia will allow users to be more informed and entertained online by making relevant, beautiful, and important content readily accessible and available,” Ellis said.

By Jesse Adams

Vajpeyi is CEO of CarboCycle, first-place winner in the 2016 Venture Competition Global Technology Challenge track. Now that most of its members have finished their degrees, Vajpeyi remarked that CarboCycle is focusing on launching a pilot program to collect food waste for conversion—possibly even at Columbia. (CarboCycle is currently in talks with the University, among other potential clients.)

“Even besides the Venture Competition, the School has been very supportive, helping connect us to lawyers and other resources,” he said. “Especially for us, who had no idea about how to develop a [business] plan, it’s very helpful.”

By Jennifer Ernst Beaudry

“I think people know they’ll change jobs, and the skills of entrepreneurship are transferable.”

—Ivy Schultz, Associate Director, Entrepreneurship Programs, SEAS

Above, left: A prototype for a cooling management system using sensors, made by an undergraduate team that participated in the sensing design challenge (Photo by Timothy Lee Photographers)
last year, Columbia Engineering researchers were the first to invent a technology—full-duplex radio integrated circuits (ICs)—that can be implemented in a nanoscale CMOS (complementary metal-oxide semiconductor) chip to enable simultaneous transmission and reception at the same frequency in a wireless radio. That system required two antennas, one for the transmitter and one for the receiver. Now the team, led by Electrical Engineering Associate Professor Harish Krishnaswamy, has developed a breakthrough technology that needs only one antenna, thus enabling an even smaller overall system. This is the first time researchers have integrated a nonreciprocal circulator and a full-duplex radio on a nanoscale silicon chip.

“This technology could revolutionize the field of telecommunications,” says Krishnaswamy, director of the Columbia high-Speed and Mm-wave IC (CoSMIC) Lab. “Our circulator is the first to be put on a silicon chip, and we get literally orders of magnitude better performance than prior work. Full-duplex communications, where the transmitter and the receiver operate at the same time and at the same frequency, has become a critical research
area, and now we’ve shown that WiFi capacity can be doubled on a nanoscale silicon chip with a single antenna. This has enormous implications for devices like smartphones and tablets.”

Krishnaswamy’s group has been working on silicon radio chips for full-duplex communications for several years and became particularly interested in the role of the circulator, a component that enables full-duplex communications where the transmitter and the receiver share the same antenna. In order to do this, the circulator has to “break” Lorentz Reciprocity, a fundamental physical characteristic of most electronic structures that requires that electromagnetic waves travel in the same manner in forward and reverse directions.

“Reciprocal circuits and systems are quite restrictive because you can’t control the signal freely,” says PhD student Negar Reiskarimian, who developed the circulator and is lead author of the research paper published in April in *Nature Communications*. “We wanted to create a simple and efficient way, using conventional materials, to break Lorentz Reciprocity and build a low-cost nanoscale circulator that would fit on a chip. This could open up the door to all kinds of exciting new applications.”

The traditional way of breaking Lorentz Reciprocity and building radio-frequency circulators has been to use magnetic materials such as ferrites, which lose reciprocity when an external magnetic field is applied. But these materials are not compatible with silicon chip technology, and ferrite circulators are bulky and expensive. Krishnaswamy and his team were able to design a highly miniaturized circulator that uses switches to rotate the signal across a set of capacitors to emulate the nonreciprocal “twist” of the signal that is seen in ferrite materials. Aside from the circulator, they also built a prototype of their full-duplex system—a silicon IC that included both their circulator and an echo-cancelling receiver—and demonstrated its capability at the 2016 IEEE International Solid-State Circuits Conference this past February.

“Being able to put the circulator on the same chip as the rest of the radio has the potential to significantly reduce the size of the system, enhance its performance, and introduce new functionalities critical to full-duplex,” says PhD student Jin Zhou, who integrated the circulator with the full-duplex receiver that featured additional echo cancellation.

Nonreciprocal circuits and components have applications in many different scenarios, from radio-frequency full-duplex communications and radar to building isolators that prevent high-power transmitters from being damaged by back-reflections from the antenna. The ability to break reciprocity also opens up new possibilities in radio-frequency signal processing that have yet to be discovered. Full-duplex communications is of particular interest to researchers because of its potential to double network capacity, compared to half-duplex communications that current cell phones and WiFi radios use. The Krishnaswamy group is already working on further improving the performance of their circulator, and exploring “beyond-circulator” applications of nonreciprocity.

“What really excites me about this research is that we were able to make a contribution at a theoretically fundamental level, which led to the publication in *Nature Communications*, and also able to demonstrate a practical RF circulator integrated with a full-duplex receiver that exhibited a factor of nearly a billion in echo cancellation, making it the first practical full-duplex receiver chip and which led to the publication in the 2016 IEEE ISSCC,” Krishnaswamy adds. “It is rare for a single piece of research, or even a research group, to bridge fundamental theoretical contributions with implementations of practical relevance. It is extremely rewarding to supervise graduate students who were able to do that!”

The work has been funded by DARPA MTO (Microsystems Technology Office) under the ACT (Arrays at Commercial Timescales) and the RF-FPGA programs, and by the National Science Foundation.

By Holly Evarts
Liberal arts majors are increasingly skipping cursory computer science classes for the more rigorous ones meant for computer science majors. And for good reason. New methods in machine learning and text mining are turning texts into data that can be analyzed computationally—giving English majors studying literary works, history majors analyzing past records, and economics majors examining financial trends powerful new ways to change how their fields are studied.

In response, Columbia’s Department of Computer Science last year introduced a new class, Computing in Context, to teach computer science in a way that is both rigorous and relevant to specific liberal arts disciplines. Aimed at students who may not otherwise take computer science, Computing in Context is a hybrid course taught by a team of Columbia professors and is the first of its kind to combine lectures in basic computer science with lectures and projects applying those methods to multiple disciplines within the humanities and social sciences.

The class is the brainchild of Adam Cannon, who during 15 years of teaching introductory computer science at the Engineering School has seen the number of liberal arts students in his classes climb. “These students don’t want an appreciation of computer science; they want to apply computing techniques in their own fields. And they’re going to change those fields because they can think about them differently. This is the beginning of a revolution in liberal arts,” says Cannon.

First they have to think like computer scientists. At its core, computer science is about structuring a problem into individual component parts that can be solved by computer. It entails critical and abstract thinking that is by itself a powerful method of organizing and analyzing information. Computational thinking can be learned and is part of all computer science classes, but most focus on numeric, not text, processing, and projects may not be relevant to liberal arts students.

Cannon’s class introduces context. While teaching basic concepts—functions, objects, arrays—and programming in Python, it inserts modules, or tracks, each created by a humanities or social sciences professor to show how computing concepts apply to a specific discipline.

A track is taught live once, with the material digitized for future classes that adopt the flipped classroom approach: students digest the context-specific material online, aided by teaching assistants who lead discussions and active learning tasks.

Three tracks have been offered since the class was introduced—digital humanities (Dennis Tenen), social science (Matthew Jones), and economics and finance (Karl Sigman). This fall, Cannon is offering a new track for students within the School of International and Public Affairs. Taught by Gregory Falco, a Columbia adjunct professor with expertise in sustainability, the track covers computational concepts and coding in the context of solving policy problems.
The class debuted in spring 2015 with all 150 slots filled. The gender split was 50/50, unusual for a computer science class; 100 percent were liberal arts students. Reasons to enroll differed. “Even if you don’t do computer science, you will probably interact with people who are techy, so it’s important to communicate with programmers on their own level,” says student Christina Cheung, a recent School of General Studies alumna who studied economics-statistics and transatlantic relations.

Suzen Fylke had enrolled for computer science before but never followed through. “I didn’t feel programming was for me, so the regular class was a little intimidating. Computing in Context offered an easier entry point since half the class was analysis on topics I was familiar with. Maybe I wouldn’t be good at the computer science part, but I knew I could do the analysis part.” For her, the class has been life-changing. Fylke took it in spring 2015, just before graduating with a degree in American studies, and has since enrolled in Hunter College to study computational linguistics.

Demand for the class is expected to grow. Cannon hopes someday 90 percent of all Columbia undergraduates enroll in a computer science class. Says Cannon: “It’s exciting to think some students coming out of this course are going to be faculty in 10 years. And they are going to have the computational skills to change their disciplines. That’s when I’ll feel this class is really successful.”

By Linda Crane
Columbia Engineering has always taken a leadership position designing innovative, video-based classes, but this year Columbia Video Network (CVN) is pushing the boundaries even further, helping professors harness CVN’s technology to flip their on-campus classes, and launching their first Massive Open Online Course (MOOC) specialization on Coursera.

“The sky is the limit when it comes to what you can use these modules for,” said Ibrahim Odeh, the professor designing and teaching the new MOOC and the founding director of the Global Leaders in Construction Management (GLCM) program in the Civil Engineering and Engineering Mechanics Department.

CVN has been a part of Columbia since its establishment in 1986; where once the department would mail videotapes of lectures to students, today it streams lectures, hosts exams, and facilitates discussion for 300 students in as many as 60 classes each semester. CVN offers certificate programs and master’s degrees in almost every engineering discipline, including applied mathematics, materials science, and biomedical, civil, electrical, and chemical engineering. It awards doctorates in mechanical engineering, electrical engineering, computer science, and earth and environmental engineering; and there are 10 to 20 doctoral students enrolled at any given time. CVN entered the nascent MOOC market in 2013 with the introduction of three free, noncredit...
courses in operations research, natural language processing, and MOS transistors.

Operating out of two recording studios—including one lightboard studio that lets instructors use a glass “whiteboard” designed for video lectures—the department has been investing in new staff, equipment, and infrastructure to stay on top, according to Nancy Rubin, executive director of CVN.

“What we bring is the quality of the instructors and the production value, and the level of support for faculty and students differentiates us,” she said. “What really resonates with people is that they can get a fully online, graduate degree from an Ivy League school, and there is no distinction between doing the online degree and getting the degree on campus. That’s not true of other programs.”

CVN uses social media to let distance-learning students feel more integrated into the University, broadcasting events and relevant information, but also using it to talk directly with students. Many school events are livestreamed as well.

“Through chat, social media, e-mail, discussion boards, and video conferencing, people might think there’s less interaction, but really, there’s more,” Rubin noted.

CVN is also leveraging its expertise to help professors “flip” their classes and apply the distance-learning model to traditional courses. Filming lectures with CVN and distributing them to students before class meets lets instructors use class time for discussion, experimentation, projects, and deeper research, and Rubin said the model is growing in appeal.

“We get more and more inquiries from professors who are interested in flipping their classes,” she remarked. “It just gives them more quality time in the classroom.”

CVN’s latest project will bring the University’s video capabilities to a whole new audience. This fall, the School’s first specialization, or series of lectures, for education technology site Coursera—and the School’s first MOOC dedicated to civil engineering—went live.

The course, Construction Management, will mix lectures from Odeh as well as from top executives from the construction industry. This specialization will be able to serve and educate the architecture, engineering, and construction (AEC) industry—the biggest industry in the world, Odeh said—with the right fundamentals to help understand a crucial field of study such as construction management. Moreover, with such a unique approach, Odeh is aiming to bridge theory and practice by getting several individuals, pioneers in various CM topics, to build the new specialization with him for the thousands and potentially hundreds of thousands of students around the world.

“I’m very keen to show how we are collaborating with top leaders from the industry, who are excelling in a specific field,” he said. “We can take advantage of that to deliver to the online students and community what we are finding in our research and our studies.”

Rubin noted that MOOCs fill a critical role for the Engineering School—and one that serves the School’s goals on multiple fronts.

“They meet the need of the University to educate a broader population, which is part of our mission. They also serve a marketing purpose: We have great talent and this showcases that as well as the areas we can provide expertise in,” she said. “MOOCs are becoming more and more relevant: That whole space is something to watch, and it’s critical that we’re an active participant.”

By Jennifer Ernst Beaudry
Alan Willner PhD’88 has spent his illustrious career at the University of Southern California, but Columbia still has his heart.

“I have blood in my two arms—one flows red for USC, one flows blue for Columbia,” he said.

Willner, the Steven and Kathryn Sample Chair in Engineering at the University of Southern California and 2016 president of the Optical Society, was elected to the prestigious National Academy of Engineering earlier this year. An internationally recognized expert on optics and photonics, Willner will be formally inducted into the Academy at a ceremony in October.

“There were about eight elected from electrical engineering this year, including people from academia and industry,” Willner said. “What struck me is that I know so many truly excellent people who are better than I am but who aren’t in yet and should be. I feel very humbled by it.”

Willner joined USC in 1992, after doing postdoctoral work at Bell Laboratories in the Photonics Networks and Components Research Department and as a researcher at Bell Communications Research. His work with optical technologies, notably tunable fiber optic equipment, has helped to critically advance the communications industry—and has been recognized. His award history includes being named an International Fellow of the Royal Academy of Engineering in 2010 (one of four Americans to receive recognition that year from the U.K. body); a 1994 Presidential Faculty Fellows Award from the White House; and the 2014 IEEE Eric E. Sumner Technical Field Award in Communications. He is a prolific author and speaker: His resume lists more than 1,100 publications, including one book; 30 U.S. patents; 350 refereed journal papers; 21 book chapters; 23 keynotes or plenaries; and more than 220 invited papers and/or presentations.

But Willner said his success is a reflection of his incredibly good fortune.

“I’ve been blessed for 25 years at USC with wonderful students and colleagues. With my students, I give them resources and try to get out of the way. It’s amazing,” he said. “I’m the team leader, but they’re better than I ever was. I stand on the shoulders of giants, and they are my students. Fifty percent of them work harder than me, 75 percent of them are smarter than me, and 100 percent of them are nicer than me. I’m inspired by them.”

Born in Brooklyn, but having spent his teenage years in Baltimore, Willner came to Columbia after graduating from Yeshiva University with a degree in physics. And initially, he had a very different career path in mind.

“I applied to law school and got in, but I went to get my master’s in SEAS first because I thought I’d be interested in patent law,” he remarked. “After my first year, Professor [Richard] Osgood asked if I was interested in doing a PhD with him, and, after much soul searching, I said, ‘Yes.’ At some point, when my LSATs were no longer valid, I said, ‘Well, that’s it.’”
At Columbia, his relationship with Osgood, the Higgins Professor Emeritus of Electrical Engineering and Applied Physics, was transformative.

"Professor Osgood is the most fair-minded person I know: He has incredible intellectual integrity and personal honesty, and he taught me much more than how to be a researcher," he said. "I didn't realize until later how much I run my own group and treat my own students just like Professor Osgood did."

Willner's relationship with Columbia—he also serves as a visiting professor—will take on a new dimension this year. One of his sons is at SEAS this fall; a second has been accepted and, having deferred, will attend SEAS after spending a year in Israel. And Willner couldn't be more proud. "My wife, Michelle—whom I met when she was going for her doctor of musical arts at Columbia—and I are thrilled our kids will be there," he said.

"I have come to really appreciate more and more as the years go on what Columbia did and what Professor Osgood did for me—it was really the best years of my life as a student there," Willner added. "And even though Professor Osgood has now retired, I cherish my ongoing wonderful collaborations with several current, outstanding Columbia faculty. Roar, Lion, Roar!"

By Jennifer Ernst Beaudry
Jamey Barbas BS’83 is changing the face of New York City.

(Photo courtesy of Jamey Barbas)
As a Barnard student, she enrolled “across the street” for a bioengineering class and got hooked, she said. Barbas joined SEAS and after graduating with a BS in 1983, she started work at a transportation consulting firm.

Columbia, she remarked, gave her that first taste of the industry—and a closer look at the structures that shape New York City.

“My professors were amazing,” she said. “And they had some really interesting relationships with private contractor organizations. I remember going on a trip sponsored by the Moles organization, where they took us on a field visit inside the Archer Avenue tunnel while it was being built. Those experiences leave an impression.”

The New NY Bridge incorporates other unique features besides its financing and fast-tracking. The foundations and roadway were designed to accommodate a rail line, should one be desired down the road. The bridge also has embedded sensors that can give engineers feedback almost immediately if something isn’t right—what Barbas called, “the most comprehensive structural health-monitoring system for a bridge in the U.S.”

Barbas said the team is sensible of their responsibility to the public in another way: Building a bridge in a city that takes justifiable pride in its instantly recognizable structures is no small task. And as a native New Yorker, she’s got a personal interest.

“It’s the most amazing project in New York,” she added. “And I’m happy to lead a new major bridge project right in my own backyard.”

By Jennifer Ernst Beaudry

“I’ve always gravitated toward things that are difficult in structure and engineering, and innovative in procurement.”

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“The look of the bridge was important to the owner and the public. We knew we wanted to have a signature, or iconic, structure,” Barbas said.

The eye-catching, twin-span cable-stayed design (the new bridge is actually two bridges, one for each direction) is part of the equation—but only part, she noted.

“We do think about the public all the time—they’re the end users, and our neighbors too. So that’s the aim: to put something out there that will serve the public.”

That meant adding a pedestrian-shared space and a bike area (which the old Tappan Zee lacked), as well as lookouts with decor created by local artists.

Seeing that vision begin to rise up from the Hudson, Barbas said, is hugely gratifying.

“It’s the most amazing project in New York,” she added. “And I’m happy to lead a new major bridge project right in my own backyard.”

By Jennifer Ernst Beaudry

Above: Barbas addressed alumni and guests during Reunion Weekend 2016. (Photo by Timothy Lee Photographers)
For Chelsey Roebuck BS’10, it was a 2009 trip with Columbia Engineering to Ghana that planted the seed for ELiTE, his nonprofit education startup that has provided learning opportunities and mentorship for thousands of students across the globe. There, Roebuck and cofounder Clayton Dahlman BS’11 utilized grant funding to organize and operate a community-based education program called Piece It Together, the function of which was to provide hands-on learning experiences in STEM for secondary schools in underresourced neighborhoods. Through the success of Piece It Together, Roebuck and Dahlman were inspired to launch ELiTE in Ghana in 2011 and had expanded to three more countries by 2013.

The mission of ELiTE—an acronym for Emerging Leaders in Technology and Engineering, Inc.—is also to provide skills in STEM for middle and high school students in underresourced areas. ELiTE operates by using the classroom as well as out-of-school programming to provide practical lessons in STEM that Roebuck hopes will help students to achieve their goals—whatever they may be.

“My dream is to enable all students, regardless of who they are or where they come from, to have the opportunity to pursue their passions.”

This year Roebuck’s efforts with ELiTE were recognized, as he was named to the prestigious Forbes 30 Under 30 list, in its education category, a well-deserved honor to reward a most noble mission. Fittingly, when Roebuck received the news he was in a classroom in West Harlem, overseeing what he describes as one of ELiTE’s more challenging computer science classes. He is quick to credit his whole team for the success, and with an unsurprising lack of complacency, sees the recognition as inspiration for further improvement.

“Being named to the Forbes 30 Under 30 list has been an incredible honor for me, personally, and serves as validation for all of the hard work that our entire team has put in over the past few years. However, it also serves as motivation to keep pushing forward and raising the expectations for what is possible for me and for the organization.”

Roebuck credits his time at SEAS with providing him with tools crucial to ELiTE’s accomplishment: his work ethic, confidence, and the benefit of a network of what he refers to as “some of the smartest people on the planet.” Additionally, the rigor of his coursework instilled sufficient training in intellectual stamina. “Being an entrepreneur is hard,” he says. “But for me, completing my degree in mechanical engineering was harder.”

It is the culmination of these hard-earned lessons that Roebuck plans to continue to pay forward. “With the populations we serve,” he notes, “our primary goal is to instill the same traits and qualities that Columbia helped me to develop—grit, a strong work ethic, the confidence and humility necessary to accomplish their dreams, and a powerful network of peers and mentors invested in their continued success.”

By Elaine Rooney

(Photo by Timothy Lee Photographers)
RECONNECTING AT REUNION

From honoring some of Columbia’s most esteemed engineers to examining the future of STEM education, and from conversations among generations of alumni to explorations of interdisciplinary research across the University, there was something for everyone at Reunion 2016.

“Welcome home,” said Dean Mary C. Boyce at the June 2 awards dinner and Reunion kickoff in Low. “As the public increasingly recognizes the impact of science and engineering, Columbia has become the place for partnerships across fields, with incredible collaborations across schools, faculty, and students.”

The recipients of the Engineering School’s most distinguished honors exemplify the diverse contributions of Columbia engineers to advancing the frontiers of knowledge in engineering and beyond.

Ronald Breslow, University Professor and a pioneer in designing and synthesizing new molecules, and Paul A. Marks ’46CC, ’49P&S, president emeritus of Memorial Sloan Kettering Cancer Center and a longtime Columbia faculty member, each received the Michael Pupin Medal for their collaborations exploring new compounds to fight cancer and even potentially restore cancerous cells to normal. The Pupin Medal, which recognizes service of broad significance to society as a whole, had never before been awarded to two recipients in the same year since being established in 1958.

Rene B. Testa MS’60, EngScD’63, professor emeritus of civil engineering and president of the Columbia Engineering Alumni Association, presented the Thomas Egleston Medal to Sheldon Wiederhorn BS’56, an authority on the mechanics of stress and fracture whose work has contributed to a wide variety of products, including spacecraft windows. The Egleston Medal, named for a key founder of the School of Mines, honors distinguished achievements in the profession.

Testa also presented the Samuel Johnson Medal to Ralph Izzo BS’78, MS’79, PhD’81, CEO of Public Service Enterprise Group, Inc. (PSEG), and a thought leader on energy policy. The Johnson Medal recognizes outstanding achievement in a field other than engineering and the applied sciences.

G. Michael Purdy, Columbia’s executive vice president for research, noted: “Tonight we honor the curiosity and imagining
that are constantly expanding the bounds of human knowledge and bringing benefits to all life on the planet.”

Reunion continued with departmental luncheons, tours of the campus and neighborhood, gatherings with old friends throughout New York City, and sessions featuring Columbia faculty. Among talks examining literature, law, and the fine arts, Kristin Myers, associate professor of mechanical engineering, shared an engineering perspective on why preterm births occur.

Adam Cannon, senior lecturer in computer science, discussed a new course, Computing in Context, that he is continually developing with Columbia colleagues to help students harness the power of algorithms in other fields. (See related story on page 44.)

“The modern liberal education is about building the foundation for a lifetime of learning in a changing world,” Cannon said at the Great Teacher Lecture. “The next crop of faculty will be computationally empowered, and our students are going to lead the charge.”

Following a barbecue for alumni, Reunion-goers got an in-depth progress report from Jamey Barbas BS’83, project director of the new replacement for the Tappan Zee Bridge connecting Westchester and Rockland counties, detailing its design and ongoing construction. (See related story on page 50.)

“The proposal was selected based on the best value, shortest construction time, least dredging required, and studies suggesting no need for major structural repairs for 100 years,” Barbas said, noting that the bridge is designed to reduce congestion, offer paths for bicycles and pedestrians, and accommodate potential expansions of mass transit. “We’ve learned a lot from studying our long-span bridges.”

Reunion also included a range of receptions for the School’s diverse communities, convening veterans, alumni of color, LGBTQ engineers, and former athletes, among other affinity groups, as well as class dinners and a starlight reception on Low Plaza.

By Jesse Adams
With the appointment last spring of Thomas Theis as the inaugural executive director of the Columbia Nano Initiative (CNI), nanoscience research at Columbia continues to flourish. The University has long been a leader in this burgeoning field, and Theis—who brings a wealth of research and executive leadership experience that cuts across industry, government, and academia—comes at an opportune time. He will be key to bringing investigators together across campus and beyond.

“Many advances in nanofabrication have been motivated by applications in information technology—ever smaller transistors enabling ever faster, lower power, and less expensive IT systems,” says Theis. “But the uses of nanofabrication technology are expanding—supporting basic and applied research in diverse fields of science and engineering. Right now, Columbia faculty are exploring new ways of manipulating light for communication and computation; new materials with revolutionary mechanical, chemical, and electronic properties; new tools for biology and medicine; new devices for sensing and energy conversion; and more. CNI helps to attract and retain world-class faculty, and I’m excited about working with them to generate new research proposals and identify and implement new and unique capabilities for nanoscale fabrication and characterization.”

State-of-the-art facilities are essential to this multidisciplinary research effort, and Columbia Engineering has been supporting the addition of new CNI facilities as well as the expansion of existing ones, like the clean room on the 10th floor of the Schapiro Center for Engineering and Physical Science Research (CEPSR). The clean room, a critical facility for research that increasingly requires a contamination-free, controlled environment, is being fully renovated and will double in size, to about 5,000 square feet. Set to open this winter, the newly minted clean room will provide faculty, students, and researchers with access to cutting-edge nanofabrication and characterization capabilities with an improved supporting infrastructure.

“We expect the clean room will be used by many more researchers,” says CNI Facilities Director Nava Ariel-Sternberg. “The space is significantly larger, and we’ll have new and exciting technological capabilities—important new tools, as well as improved utilities—all necessary to accommodate innovative interdisciplinary nanotechnology research. We’ll be able to build all kinds of new devices in a clean and protected environment, working in nanophotonics, advanced electronics, microfluidics, and more, with novel materials like 2D semiconductors: graphene, transition metal dichalcogenides, and more.”

Among the new features of the clean room are improved temperature and humidity controls, better particle control, compressed air, nitrogen supply, and improved air handling units dedicated for the lab. There will be a host of new tools including a diffusion furnace for low-pressure chemical vapor deposition of several high-quality thin films, such as silicon (Si) oxide, Si nitride, and Si carbide; and two new plasma etchers, one based on fluorine chemistry and one based on chlorine chemistry, to assure the ability to etch a large variety of materials.

The Nanofabrication Clean Room is part of CNI’s shared labs, which also include a Shared Materials Characterization Laboratory and an Electron Microscopy Laboratory, both housed nearby in Havemeyer Hall. The Shared Labs Facilities offers a wide range of processing, characterization, and imaging instruments; and Ariel-Sternberg manages the labs.
Engineering has become a foundational field now, preparing for all other fields and shaping solutions to global challenges. Your Columbia education has prepared you for a bold future—stay true to your signature, and find your way to make an impact on the world.”
—Dean Mary C. Boyce

“I’ve never had a good idea that everybody thought was a good idea. . . . Judgments are the reaction of consensus thinking and hindsight, pollution in the atmosphere of your mind. . . . Wake up each day doing what you want, and brush the haters off your shoulders.”
—Jon Steinberg ’03BUS, CEO of Cheddar/Former President and COO of Buzzfeed (Class Day Speaker)

“The ability to transform this generation and all generations to come—that is the Columbia magic.”
—Linxi (Jim) Fan, Valedictorian

CONGRATS, CLASS OF 2016!
The Journey’s Just Begun

2016 Faculty Award Recipients:

Presidential Award for Excellence in Teaching
Adam Cannon, Senior Lecturer in Computer Science

Distinguished Faculty Teaching Awards
Jae Woo Lee, Senior Lecturer in Computer Science
Robert Farrauto, Professor of Professional Practice in Earth and Environmental Engineering

Janette and Armen Avanessians Diversity Award
Aaron M. Kyle, Senior Lecturer in Biomedical Engineering

Edward and Carole Kim Award for Faculty Involvement
Jeffrey T. Koberstein, Percy K. and Vida L. W. Hudson Professor of Chemical Engineering

serving the research community within and outside of Columbia University, as well as businesses and entrepreneurship ventures.

CNI was established at the University in 2014 to build upon and maintain Columbia’s strong and successful experiences with highly multidisciplinary and collaborative research programs in nanoscale science and engineering. The center supports multidisciplinary research in the Departments of Applied Physics, Chemical Engineering, Chemistry, Electrical Engineering, and Physics.

“The possibilities are just endless,” says CNI’s Science Director Keren Bergman, who is also Charles Batchelor Professor of Electrical Engineering. “The combination of our Columbia initiative together with national initiatives in nanoscience and nanotechnology is enabling us to pool all of our resources, and this is putting us in a place—in time and space—that’s unprecedented. We could not be more excited about the broad spectrum of opportunities emerging at the multidisciplinary intersections of nanoscale science and engineering.”

By Holly Evarts

Columbia Nano Initiative
engineering.columbia.edu/fall2016video
A team led by Shree K. Nayar, T. C. Chang Professor of Computer Science at Columbia Engineering, has developed a novel sheet camera that can be wrapped around everyday objects to capture images that cannot be taken with one or more conventional cameras.

The Columbia team, which includes research engineer Daniel Sims BS’14 and postdoctoral researcher Yonghao Yue, designed and fabricated a flexible lens array that adapts its optical properties when the sheet camera is bent. This optical adaptation enables the camera to produce high-quality images over a wide range of sheet deformations. Sims presented the work this spring at the International Conference on Computational Photography (ICCP) at Northwestern University in Evanston, Illinois.

“Cameras today capture the world from essentially a single point in space,” says Nayar, a pioneer in the fields of computational cameras, computer vision, and computer graphics. “While the camera industry has made remarkable progress in shrinking the camera to a tiny device with ever-increasing imaging quality, we are exploring a radically different approach to imaging. We believe there are numerous applications for cameras that are large in format but very thin and highly flexible.”

If such an imaging system could be manufactured cheaply, like a roll of plastic or fabric, it could be wrapped around all kinds of things—from street poles to...
furniture, cars, and even people’s clothing—to capture wide, seamless images with unusual fields of view. This design could also lead to cameras the size of a credit card that a photographer could simply flex to control its field of view.

The new “flex-cam” requires two technologies—a flexible detector array and a thin optical system that can project a high-quality image on the array. One approach would be to attach a rigid lens with fixed focal length to each detector on the flexible array. In this case, however, bending the camera would result in “gaps” between the fields of views of adjacent lenses. This would cause the captured image to have missing information, or to appear “aliased.”

To solve this problem, the Columbia Engineering team developed an adaptive lens array made of elastic material that enables the focal length of each lens in the sheet camera to vary with the local curvature of the sheet in a way that mitigates aliasing in the captured images. This inherent optical adaptation of the lens is passive, avoiding the use of complex mechanical or electrical mechanisms to independently control each lens of the array.

The researchers arrived at their passively adaptive lens array by optimizing its geometry and material properties. They fabricated their prototype lens array using silicone and demonstrated its ability to produce high image quality over a wide range of deformations of the sheet camera. The research was conducted in Nayar’s Computer Vision Laboratory and was funded by the Office of Naval Research.

“The adaptive lens array we have developed is an important step towards making the concept of flexible sheet cameras viable,” Nayar says. “The next step will be to develop large-format detector arrays to go with the deformable lens array. The amalgamation of the two technologies will lay the foundation for a new class of cameras that expand the range of applications that benefit from imaging.”

This is the latest innovation in the computational camera space from Nayar’s lab. In April, Popular Science named his self-powered camera to its annual list of top 10 inventions of 2016.

By Holly Evarts
Tweeting under the handle TyquanAssassin, Gakirah Barnes taunted and threatened rival gang members but sometimes expressed conflicting feelings of grief. “The pain is unbearable,” she tweeted in 2014, after Chicago police allegedly shot and killed her best friend. Two weeks after typing those words, Barnes was gunned down by a rival gang member. Just 17, she left behind an unusual legacy: more than 27,000 tweets, a modern equivalent of War and Peace tapped out in bursts of 140 characters or less. Starting the day she opened her Twitter account in 2011, and ending with her death, in April 2014, Barnes’s words give researchers a window on the emotions fueling gang violence in Chicago.

Though she broadcasted her thoughts to 2,500 followers, many of her messages read more like excerpts from a secret diary. “I was drawn to the variation—on one day her posts are highly aggressive, and the next, deeply emotional, as she mourned the loss of loved ones,” said Desmond Patton, an assistant professor at Columbia’s School of Social Work who studies gang violence in Chicago.

Patton was curious to see what more could be learned from Barnes’s Twitter feed. With the help of Chicago teenagers and social workers, he translated the lingo, and in February, published an analysis of her tweets.

Taking the work a step further, he recently teamed up with Columbia’s Data Science Institute to develop a violence-prevention tool that can detect highly emotional speech on Twitter.

A team led by Patton and computer scientists Kathleen McKeown and Owen Rambow has developed an algorithm that looks for grief- and aggression-themed posts social workers and violence-prevention workers can use to understand an underlying conflict and defuse it. McKeown, a pioneer in natural language processing, is Gertrude Rothschild Professor of Computer Science at Columbia Engineering and heads the Data Science Institute.

While gang violence has declined in New York and Los Angeles, it persists in Chicago’s poorest, most segregated neighborhoods. Barnes’s murder made international news, in part, because of her dual roles as victim and victimizer. The news photo of the gap-toothed girl in her graduation gown, handed to the media by her mother, stood in sharp contrast to the images of Gakirah Barnes brandishing her gun on YouTube.

To develop the algorithm, the team labeled a subset of Barnes’s tweets as “aggression,” “loss,” or “other,” and developed a program to tag the nouns, verbs, and other parts of speech. They also created a dictionary of Barnes’s vocabulary, including translations of the emojis she sprinkled throughout her writing. They used an “emotion” dictionary to rate words by how pleasant, intense, or concrete they were.

Training their algorithm on the labeled data, they developed a model to predict whether a post in a larger sample of Barnes’s tweets should be classified as aggression, loss, or other. They hope to next mine tweets Barnes exchanged with friends to see if they can develop a method for detecting underlying conversations. This would give prevention workers further context. “The people who intervene then know why the teenagers are upset or angry and how to defuse the situation,” said McKeown.

Eventually, they hope to set their algorithm loose on live Twitter and Facebook feeds and, potentially, other social media platforms. A Chicago-based nonprofit, Cure Violence, will take the lead on interpreting posts that are flagged and decide how to intervene.

By Kim Martineau

Far left: A team led by Desmond Patton (right), Kathleen McKeown, and Owen Rambow (not pictured) is building a tool that can identify Twitter posts that could lead to violence. (Photo by Kim Martineau). Left: Researchers have developed an algorithm to recognize grief- and aggression-themed tweets. In the top tweet, Chicago gang member Gakirah Barnes mourns the loss of her best friend. Below it, she vows to never snitch. Facemask emojis are code for “no snitching” and “100” means she’s serious. (Courtesy of Desmond Patton)
Columbia Engineering researchers, with colleagues from Disney Research and MIT, have developed a new method to control sound waves, using a computational approach to inversely design acoustic filters that can fit within an arbitrary 3D shape while achieving target sound filtering properties.

Led by Computer Science Professor Changxi Zheng, the team designed simulated acoustic voxels—small, hollow, cube-shaped chambers through which sound enters and exits—as a modular system that can be connected to form an infinitely adjustable, complex structure. Because of their internal chambers, they can modify the acoustic filtering property of the structure and alter the acoustic result.

“In the past, people have explored computational design of specific products,” says Zheng. “The general approach to manipulating sound waves has been to computationally design chamber shapes. Our algorithm enables new designs of noise mufflers, hearing aids, wind instruments, and more—we can now make them in any shape we want.” The team has also proposed using acoustic tags linked to specific items, opening the door to encoding product and copyright information in 3D printing.

Last year, Zheng’s team used computational methods to design and 3D print a zoolophone, a xylophone-type instrument with keys shaped like zoo animals that represented fundamental research into vibrational sound control.

This year, his team came up with an approach that would enable better manipulation of acoustic propagation for many products, such as automobile mufflers and instruments already mentioned. Their new algorithm enables them to virtually assemble acoustic voxels like Lego bricks into complex structures to produce targeted acoustic filtering properties.

“We are investigating some of the intriguing possibilities of ultrasonic manipulation, such as cloaking, where sound propagation can be distorted to hide objects from sound waves,” says Zheng. “This could lead to new designs of sonar systems or underwater communication systems. It’s an exciting area to explore.”
unique needs of researchers grappling with big data sets.”

Many of the group’s 30 members are already working on hardware and software solutions for handling big data. Nowick focuses on developing “networks-on-chip” to better organize complex data flows among dozens or hundreds of processors and memories running simultaneously within parallel computer chips, while Luca Carloni, associate professor of computer science, is developing embedded “systems-on-chip” featuring hardware customized for specific applications. Roxana Geambasu and Eugene Wu, assistant professors of computer science, are adapting software and databases to work with big data. On the application side, Chris Marianetti, associate professor of applied physics and applied mathematics, is working to solve tough equations in quantum mechanics to design better batteries. At Lamont-Doherty, Ryan Abernathey, assistant professor of earth and environmental sciences, is exploring NA-SA’s new groundbreaking simulation of ocean waves interacting with large-scale currents, which generates overwhelming volumes of data. Other members include neuroscientists, astronomers, physicists, biomedical researchers, civil engineers, and climate scientists.

Approved by the Institute’s board in May, the group hopes to establish a fully fledged center by next year.

OUR DRIVERLESS FUTURE
Hod Lipson, professor of mechanical engineering, is coauthor of a new book, Driverless: Intelligent Cars and the Road Ahead, with technology journalist Melba Kurman.

Published in September by MIT Press, the book explores how recent breakthroughs in artificial intelligence and robotics are bringing driverless cars from sci-fi to reality, particularly via deep learning software that gives cars rapid and accurate visual perception. Autonomous automobiles are expected to hit the world’s streets within the next decade and set off waves of transformative change in industry, public policy, and how humans live, work, and play.

The technology could unleash another “Apollo moment,” the authors write, if government, industry, and consumers can work together to achieve a safer, cleaner, and more convenient alternative to traditional driving.

Lipson, director of Columbia’s Creative Machines Lab, is an expert on self-aware and self-replicating robots, 3D food printing, and bioprinting. He uses primarily biologically inspired approaches to design, build, and maintain increasingly complex robotic systems, aiming ultimately for machines capable of designing and making other machines. (See related story on page 7.)


FACE OF THE FUTURE
A groundbreaking new technique developed by Gordana Vunjak-Novakovic, the Mikati Foundation Professor of Biomedical Engineering and professor of medical sciences, repairs large bone defects in the head and face with lab-grown living bone precisely tailored to the patient. The method uses autologous stem cells derived from a sample of the patient’s fat to, for the first time, grow living bone that precisely replicates the original anatomical structure.

“We’ve been able to show, in a clinical-sized living model of jaw repair, that this bone, grown in vitro and then implanted, can seamlessly regenerate a large defect while providing mechanical function,” said Vunjak-Novakovic, director of the Laboratory for Stem Cells and Tissue Engineering, codirector of the Craniofacial Regeneration Center, and director of the Bioreactor Core of the NIH Tissue Engineering Center. The study was published in Science Translational Medicine in June.

Her team, which included collaborators from Columbia, Louisiana State University,
and the Tulane University School of Medicine, fabricated a bone matrix scaffold and custom-designed perfused bioreactor chamber to provide a perfect anatomical fit, enabling bone formation in just three weeks. They discovered that lab-grown bone was gradually replaced by new bone formed by the body.

The researchers are now including a cartilage layer in the bioengineered tissue and conducting preclinical trials through Vunjak-Novakovic’s company, epiBone, as they prepare for clinical trials. “The need is huge, especially for congenital defects, trauma, and bone repair after cancer surgery,” Vunjak-Novakovic said. “This is a very exciting step forward.”

THE END OF PRIVACY?
With researchers at Google, a Columbia Engineering team led by Augustin Chaintreau, assistant professor of computer science, recently demonstrated that posts on just two social media apps are enough to link users’ accounts and identify them individually.

Privacy advocates have long cautioned that users can be identified in vast, anonymous data sets, from credit card to mobile phone records, but the new study demonstrates how easily individuals can be identified by app location data alone.

The team developed an algorithm that analyzes geotagged posts on Twitter, Instagram, and Foursquare and calculates the probability that the accounts might be connected. The method, which outperforms other algorithms, can also identify shoppers by matching anonymous credit card purchases to logs of mobile phone locations. The work was featured at the World Wide Web conference in Montreal this spring.

While location tracking provides directions and other services to users, it raises privacy risks that remain poorly understood. Without the right to privacy, experts warn, citizens may be less likely to speak freely. They also worry that sensitive information such as age and ethnicity could be used to discriminate.

Graduate researcher Chris Riederer recently collaborated with undergraduates Danny Echikson and Stephanie Huang to build a tool, You Are Where You Go, that lets anyone audit his or her social media trail.

“Many people choose not to identify themselves online,” said Chaintreau, a member of the Data Science Institute. “If your location data makes you recognizable across all of your accounts, how does that change your behavior? This is a question we now have to answer.”

PLATFORM FOR PERSONALIZED PRECISION MEDICINE
In a major leap forward for making DNA sequencing accessible to the general public, a Columbia team—led by Professor Jingyue Ju, along with colleagues at Harvard Medical School, Genia Technologies, and the National Institute of Standards and Technology—recently achieved real-time single molecule electronic DNA sequencing at single-base resolution using a protein nanopore array.

Individuals’ complete genome sequences provide important markers and guidelines for medical diagnostics, health care, and adopting healthy lifestyles, but DNA sequencing has remained expensive and too slow for broad applications. Sequencing instruments currently in wide use depend on optics to detect the building blocks of DNA; the existing single molecule electronic detection method for deciphering DNA poses difficulty for distinguishing among the four chemically similar nucleotides.

Ju and his collaborators have developed a complete system to quickly, accurately, and electronically sequence DNA via novel polymer-tagged nucleotides at the single molecule level, potentially paving the way for miniaturized DNA sequencers capable of facilitating personalized precision medicine based on patients’ genomes.

“This exciting project brings together scientists and engineers from both academia and industry with combined expertise in molecular engineering, nanotechnology, genomics, electronics, and data science to produce revolutionary,
cost-effective genetic diagnostic platforms with unprecedented potential for precision medicine,” said Ju, the Samuel Ruben-Peter G. Viele Professor of Engineering, professor of chemical engineering and pharmacology, and director of the Center for Genome Technology & Biomolecular Engineering at Columbia.

The research based on the prototype sequencer was published in *Proceedings of the National Academy of the Sciences* in May 2016, and Ju notes that the latest sequencer has advanced far beyond the early prototype in terms of read length, accuracy, yield, and speed.

**MARTHA KIM RECEIVES BORG EARLY CAREER AWARD**

Martha Kim, associate professor of computer science and director of the Architecture and Design Lab, has received the Borg Early Career Award from the Committee on the Status of Women in Computing Research. Named for pioneering computer scientist Anita Borg, the award recognizes women who have made substantial early-career research contributions and encouraged young women to enter computing fields.

An expert in computer architecture, Kim focuses on how computing power can keep pace with increasing demands, especially those posed by big data. Focused on the intersection of hardware and software, she looks to leverage the characteristics of each to enhance functionality and maximize efficiency; her efforts include making chips more efficient with new types of parallel processing, building specialized circuits called accelerators, and exploring novel architectures.

Kim’s architecture designs include an intelligent data flow that optimizes resource usage by having processing units across a chip perform calculations as inputs are ready. Accelerators she designed for database processing have resulted in 70x throughput improvements while saving three orders of magnitude in energy usage compared to traditional approaches. She won a 2013 NSF CAREER Award and served as cochair at the technical program at IEEE International Symposium on Workload Characterization.

The award also recognizes her outreach to young women interested in computing research. Kim has acted as a faculty coadviser for the Artemis Project, a summer school for underserved girls, and participated in youth conferences including Code Like a Girl. One sign of progress: Kim’s first two PhD graduates were women, as are two-thirds of her current doctoral students.

**UNDERSTANDING CELL AND TISSUE MECHANICS**

Within just a few months of joining Columbia Engineering as an assistant professor of mechanical engineering, Karen Kasza received a Clare Boothe Luce professorship, which supports women in STEM fields, from the Henry Luce Foundation. The honorific includes a five-year, $500,000 grant to support her ongoing research into the mechanics of cell and tissue behavior, particularly how cells self-organize to build tissues with the mechanical and structural properties required to function properly.

Combining tools and approaches from engineering, biology, and physics, Kasza’s research incorporates *in vivo* experimental investigations, primarily of fruit flies. In her recent work she has studied the elongation of fruit fly embryos’ head-to-tail axis, which occurs through convergent extension, tissue movements that are also important during human development.

“These studies shed light on fundamental mechanisms by which problems in cell and tissue movements contribute to birth defects,” Kasza said. “Understanding how cells generate mechanical forces and move around to build tissues during development also sheds light on what happens when those cell behaviors become improperly regulated later in life and contribute to disease states such as cancer.”

Previously, as a postdoctoral fellow in the developmental biology program at the Sloan Kettering Institute, Kasza studied how mechanical forces drive cell movements and shape multicellular tissues during fruit fly development. She received a Helen Hay Whitney Foundation Fellowship in 2011 and a Burroughs Wellcome Fund Career Award at the Scientific Interface in 2013.

Compiled by Jesse Adams
NEW FACES AT SEAS

KYLE BISHOP
Associate Professor, Chemical Engineering
Postdoctoral Fellow, Harvard University, 2009–10; PhD, Northwestern University, 2009; BS, University of Virginia, 2003

Kyle Bishop’s research seeks to discover, understand, and apply new strategies for directing colloidal matter through self-assembly and self-organization outside of equilibrium to enable nanoscale materials and machines with capabilities rivaling those of living organisms. He previously taught at Penn State University and served as a postdoctoral fellow at Harvard; he plans to teach transport phenomena and colloid science at Columbia.

SHARON (XUAN) DI
Assistant Professor, Civil Engineering and Engineering Mechanics
Postdoctoral Researcher, University of Michigan–Ann Arbor, 2014–2016; PhD, University of Minnesota, 2014; MA, Tongji University, China, 2008; BS, Tongji University, 2005

Sharon Di specializes in travel behavior analysis and transportation network modeling. Her research aims to understand and model transportation systems that are radically evolving due to the emerging communication and sensing technologies, such as driverless cars. Di is interested in leveraging large data from traffic sensors to understand transformation in travel behavior patterns and help public agencies make efficient and sustainable decisions in transportation planning and management. Shared mobility is one major direction she is pursuing at Columbia. Di teaches Infrastructure Systems Optimization.

YURI FAENZA
Assistant Professor, Industrial Engineering and Operations Research
SNSF Ambizione Fellow, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, 2015–16; Postdoctoral Fellow, University of Brussels, Belgium, 2014; Postdoctoral Fellow, EPFL, 2012–14; Postdoctoral Fellow, University of Padua, Italy, 2010–12; PhD, University Sapienza of Rome, Italy, 2010; MS, University Tor Vergata of Rome, Italy, 2006

Yuri Faenza specializes in mathematical programming, combinatorial optimization, polyhedral combinatorics, and their applications, including the power and limits of geometric algorithms for solving discrete optimization problems. A former fellow of the Swiss National Science Foundation (SNSF), he will teach courses in all areas of optimization, with an emphasis on discrete optimization.
OLEG GANG
Professor, Chemical Engineering and Applied Physics and Applied Mathematics
Postdoctoral Rothschild Research Fellow, Harvard University, 2000–2002; PhD, Bar-Ilan University, Israel, 2000; MS, Bar-Ilan University, 1994

Oleg Gang studies how nanosystems can self-assemble components of different types into programmable and rationally designed architectures, particularly for optical and biomedical applications. He also investigates the properties of soft matter on nanoscales and at the interfaces. Prior to joining SEAS, Gang conducted research at Harvard and Brookhaven National Laboratory. Named a 2016 “Inventor of the Year” by Battelle, the global science and technology organization, Gang will teach the course Topics of Soft Matter.

HARDEEP JOHAR
Lecturer in Discipline, Industrial Engineering and Operations Research
PhD, New York University, 1994; Fellow in Management, Indian Institute of Management, India, 1989; MA, Birla Institute of Technology and Science, India, 1980

Hardeep Johar has extensive experience in industry, having worked for many years as a quantitative proprietary trader at Deutsche Bank, Credit Suisse, and Morgan Stanley in New York. He was been on the management team of a startup (Peak Strategy) and an advisory board member of another (mSpoke, Inc.). Prior to joining Columbia, Hardeep served as an adjunct professor at the business schools at NYU and Columbia and Fordham Universities. At SEAS, he will teach Data Analytics for Operations Research, Computational Analysis of Social Networks, and Cloud Computing for Business Analytics.

CHRISTOPH JUCHEM
Associate Professor, Biomedical Engineering
Postdoctoral Associate, Yale University, 2007; PhD, University of Tübingen, Germany, 2006; MS, University of Bonn, Germany, 2001

Christoph Juchem’s research focuses on the improvement of technology and methods to enhance the clinical potential of magnetic resonance imaging (MRI) and spectroscopy (MRS). The goal of his laboratory is to provide crucial tools to obtain information early in the development of multiple sclerosis and other neurological conditions with dedicated MRI/MRS techniques. He previously taught in the Yale School of Medicine’s departments of diagnostic radiology and neurology and will teach Principles of Magnetic Resonance Imaging.

J. THOMAS (TOMMY) VAUGHAN
Professor, Biomedical Engineering
PhD, University of Alabama at Birmingham, 1993; BS, Auburn University, 1982

J. Thomas (Tommy) Vaughan is a pioneer in developing ultrahigh field magnetic resonance techniques and technology for biomedical applications including cutting-edge neurological, cardiac, and breast imaging—particularly advancing generation and reception of radio frequency fields and modeling and measurement of the fields in human anatomy. Previously, Vaughan taught at the University of Minnesota and Harvard and conducted research at NASA, Texas Instruments, and Massachusetts General Hospital.

(See Faculty Q&A on page 29.)
XUNYU ZHOU
Liu Family Professor, Industrial Engineering and Operations Research
Postdoctoral Fellow, University of Toronto, Canada, 1993; Postdoctoral Fellow, Kobe University, Japan, 1991; PhD, Fudan University, China, 1989; BS, Fudan University, 1984

Xunyu Zhou’s research interests include financial engineering, stochastic control, applied probability, and mathematical behavioral finance. A fellow of IEEE and of SIAM who has published extensively and garnered numerous honors, Zhou previously taught at the Chinese University of Hong Kong and the University of Oxford. At Columbia, he will teach Continuous Time Models in Financial Engineering.

APPOINTMENTS TO ENDOwed PROFESSORSHIPS

PATRICIA J. CULLIGAN
Robert A. W. and Christine S. Carleton Professor of Civil Engineering
Civil Engineering and Engineering Mechanics

Patricia Culligan is a leader in the field of water resources and urban sustainability who explores interdisciplinary solutions to the challenges of urbanization, with a particular emphasis on New York City. The Carleton Chair was established by Mrs. Carleton in honor of her husband, Robert A. W. Carleton, an alumnus, Class of 1904, and a well-known civil engineer and a strong supporter of the School.

IRVING P. HERMAN
Edwin Howard Armstrong Professor of Applied Physics
Applied Physics and Applied Mathematics

Irving Herman’s research focuses on optical physics, materials physics, and nanoscience. The Armstrong Chair was established by the University Trustees to honor noted alumnus (Class of 1913) and faculty member Edwin Howard Armstrong, who designed wide-band frequency modulation (FM) radio and invented three electronic circuits fundamental to modern radio, television, and radar.

PETER KINGET
Bernard J. Lechner Professor of Electrical Engineering
Electrical Engineering

Peter Kinget’s research combines device, circuit, signal processing, and system insights to develop new concepts for designing analog and radio-frequency integrated circuits that connect the physical, analog world to the digital world of computing. The Bernard J. Lechner Chair was established with a bequest from Bernard J. Lechner BS’57, an alumnus and electronics engineer who made major contributions to the development of digital displays, including inventing the active matrix liquid crystal display (LCD).
ELISA E. KONOFA
goo
Robert and Margaret Hariri Professor of Biomedical Engineering
Biomedical Engineering and Radiology

Elisa Konofagou is working on revolutionary ultrasound imaging and therapeutic ultrasound techniques to assess the elasticity of tissues such as the heart, vessels, and breast tumors for noninvasive detection of disease and therapy, respectively. The Hariri Chair was established in 2014 by Robert Hariri, MD, PhD, and Margaret Meade-Hariri. Dr. Hariri is an alumnus (1980) of Columbia College; and founded Celgene Cellular Therapeutics, cofounded Human Longevity, Inc., and founded Cellularity. Mrs. Hariri, a trustee of the Overlook Medical Center Foundation Board in Summit, NJ, is the president of the Hariri Family Foundation.

SANAT KUMAR
Bykhovsky Professor of Chemical Engineering
Chemical Engineering

Sanat Kumar’s research focuses on the organization of nanoparticles in a range of matrices with the goal of making transformative improvements in a variety of applications, from the creation of membranes for the efficient separation of gases and ions to the creation of biomimetic materials, that serve fields such as transportation, buildings, and energy storage. The Bykhovsky Chair was established by Michael Bykhovsky BS’83, who founded Applied Financial Technology, a mortgage analytics company. Bykhovsky is a member of the Columbia Engineering Board of Visitors and a founding member of the Columbia Engineering Entrepreneurship Advisory Board.

XUNYU ZHOU
Liu Family Professor of Industrial Engineering and Operations Research
Industrial Engineering and Operations Research

Xunyu Zhou is recognized as a leader in mathematical finance, having developed the mathematical theory of behavioral finance, a relatively new field that his seminal research underpins. Ms. Yan Cheung and Mr. Ming Chung Liu, founders of Nine Dragons Paper Holdings, Ltd., the largest producer of containerboard products in China, endowed the Liu Family Professorship.

PROMOTION TO FULL PROFESSOR

HENRY HESS
Biomedical Engineering

Henry Hess’s primary research interest is nanobiotechnology, in particular hybrid nanodevices and materials merging biological and synthetic building blocks. Creative approaches to the design of such devices draw from chemistry, biotechnology, microfabrication, biology, and engineering. His work is at the molecular scale, in particular the design of active nanosystems incorporating biomolecular motors, the study of active self-assembly, and the investigation of protein-resistant polymer coatings. Hess joined Columbia Engineering in 2009 from the University of Florida’s Department of Materials Science and Engineering. He serves as the editor-in-chief of the IEEE Transactions on NanoBioscience.
BARCLAY MORRISON III  
*Biomedical Engineering*  

Barclay Morrison aims to understand the consequences of mechanical forces on the brain and to develop strategies to mitigate, and ultimately reverse, these injurious effects. His research explores the specific cellular, molecular, and metabolic effects of injury on brain cells in response to precisely controlled biomechanical stimuli. His Neurotrauma and Repair Laboratory focuses on three main areas: the improvement of prevention strategies through development of critical biomechanical data for the living brain, the identification of novel treatment options by understanding the post-traumatic pathobiology in greater detail, and engineering of new research tools to enhance studies in prevention strategies and treatment options. Morrison, who also serves as vice dean of undergraduate programs at the School, joined Columbia Engineering in 2003 from the Division of Clinical Neurosciences at the University of Southampton.

SAMUEL SIA  
*Biomedical Engineering*  

Samuel Sia specializes in microfluidics for point-of-care diagnostics and therapeutics. His research lab focuses on using microfluidics—the manipulation of small amounts of fluids—to improve patient health. Sia’s lab recently developed a low-cost smartphone accessory that can perform a point-of-care test that simultaneously detects three infectious disease markers from a finger prick of blood in just 15 minutes. This innovation builds on earlier research from Sia’s lab—so-called lab-on-a-chip technology that uses microfluidics to miniaturize and automate routine laboratory tests onto a handheld microchip. Additional major interests of Sia’s lab are cell therapy, implantable devices, and biomaterials. A serial entrepreneur, Sia, who also is faculty co-director of entrepreneurship at the School, is cofounder of incubator Harlem Biospace and founder of Claros Diagnostics, a VC-backed company acquired by OPKO Health in 2011. His research has been supported by the NIH, NSF, USAID/Gates Foundation, Wallace H. Coulter Foundation, American Heart Association, and World Health Organization.

LATHA VENKATARAMAN  
*Applied Physics and Applied Mathematics*  

In Latha Venkataraman’s lab, the focus is measuring fundamental properties of single-molecule devices, aiming to understand the interplay of physics, chemistry, and engineering at the nanometer scale. Venkataraman and her lab fabricate single-molecule circuits, containing a molecule attached to two electrodes, with varied functionality, where the circuit structure is defined with atomic precision. They measure 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. Their experiments provide a deeper understanding of the fundamental physics of electron transport, while laying the groundwork for technological advances at the nanometer scale. Under the direction of Venkataraman, researchers recently designed a new technique to create single-molecule diodes that perform 50 times better than all prior designs. Venkataraman is the recipient of an NSF CAREER Award, a Packard Fellowship for science and engineering, and an Alfred P. Sloan Fellowship in chemistry.
PROMOTION TO TENURE

**XI CHEN**  
*Associate Professor, Computer Science*

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

**HARISH KRISHNASWAMY**  
*Associate Professor, Electrical Engineering*

Harish Krishnaswamy researches integrated devices, circuits, and systems for a variety of RF and mmWave applications. In 2015, a Columbia Engineering research team, led by Krishnaswamy, was the first to invent a technology—full-duplex radio integrated circuits (ICs)—that can be implemented in nanoscale CMOS to enable simultaneous transmission and reception at the same frequency in a wireless radio. That system required two antennas, one for the transmitter and one for the receiver. Most recently, the team developed a breakthrough technology that needs only one antenna, thus enabling an even smaller overall system, marking the first time researchers have integrated a nonreciprocal circulator and a full-duplex radio on a nanoscale silicon chip. Krishnaswamy directs the Columbia high-Speed and Mm-wave IC (CoSMIC) Lab and serves as a member of the Technical Program Committee of several conferences, including the IEEE RFIC Symposium.

**HAIM WAISMAN**  
*Associate Professor, Civil Engineering and Engineering Mechanics*

Haim Waisman’s research specialty is in computational solid and fracture mechanics with an emphasis in extended finite element methods (XFEM). XFEM allows one to model discontinuities without remeshing the computational domain. He also is interested in developing novel multiscale/multigrid techniques aimed at bridging the length and time scales to better understand material behavior from the nanoscale to the macroscale. He is the recipient of the Department of Energy Early Career Award (2012) and the EMI Leonardo Da Vinci Award (2014) from the Engineering Mechanics Institute of ASCE.

PROMOTION TO ASSOCIATE PROFESSOR

**PIERRE GENTINE**  
*Earth and Environmental Engineering*

Pierre Gentine is working on land-atmosphere interactions, convection-clouds, and surface hydrology using conceptual models, numerical models, and a wide range of data analysis tools. His overall research objective is to understand how soil and atmospheric moisture organizes across different spatial and temporal scales and, in particular, how the interactions with the atmosphere, vegetation, and landscape constrain this organization. Gentine is the recipient of a National Science Foundation CAREER Award, DOE Early Career Research grant, and NASA New Investigator Program grant.
JOHN WRIGHT  
*Electrical Engineering*

John Wright develops tools for sensing and analyzing signals and images. His work shows how to use “low-dimensional” signal models to compute correctly and efficiently with unreliable information—including noisy, incomplete, and even grossly corrupted observations. These tools have been widely applied in various areas of science and engineering. At Columbia, Wright and collaborators have used these tools to develop new lower-power sensors, new image recognition tools that cope with occlusion and disguise, and new analysis tools for identifying basic motifs in microscopy data. A key technical tool in his work is numerical optimization—in particular, several recent advances have been driven by the observation that certain seemingly challenging “nonconvex” optimization problems can actually be solved globally using efficient algorithms.

PROMOTION TO SENIOR LECTURER

JAE WOO LEE  
*Computer Science*

Jae Woo Lee, who earned his MS and PhD from the Engineering School in 2004 and 2012 respectively, joined SEAS as an instructor in computer science in 2008 and taught Advanced Programming. He specializes in computer science education, networks, software engineering, and cloud computing and serves as the director of undergraduate studies for the Department of Computer Science for Barnard, Columbia College, and the School of General Studies. A recipient of several teaching awards, Lee this year was recognized by the Columbia Engineering Alumni Association with a Distinguished Faculty Teaching Award. Prior to joining the Engineering School, he worked as a programmer, a consultant, and an entrepreneur, primarily in the financial sector.

NSF CAREER AWARD WINNERS

*Four Engineering faculty members have recently won National Science Foundation (NSF) CAREER Awards for their innovative research.*

ALLISON BISHOP  
*Assistant Professor of Computer Science*

Bishop, a member of the Data Science Institute, is developing tools to share and protect sensitive information as threats to personal privacy and data security grow in the big data era. She is looking specifically at integrating recent advances in lattice cryptography with her headway in designing security reductions in order to provide strong arguments for the security of highly flexible and customizable cryptographic systems. Flexibility is a key challenge, and Bishop hopes to build secure cryptographic systems that can accommodate various levels of access to data, thus allowing different people to access different data within the same data source. She will also use the grant to provide an entry point and training ground for emerging young scientists of all ages, including elementary school children, for whom she is writing a book that uses an interactive, fantasy format to introduce mathematical reasoning.
MATEI CIOCARLIE
Assistant Professor of Mechanical Engineering
Also a recipient of a 2016 Sloan Research Fellowship, Ciocarlie focuses on developing versatile manipulation and mobility in robotics designed for unstructured environments, building dexterity into reliable robotic hands that combine mechanical and computational intelligence and utilize tactile, proprioceptive, and range sensing. He will use the CAREER award to explore the science of manipulation for better tools assessing methods and mechanisms for planning and executing manipulation tasks, integrating solutions in hardware and software. By optimizing hand designs with planning and control algorithms and combined quality metrics, Ciocarlie aims to advance manipulation and mobility in novel robotics that are ready for use after assembly and preprogrammed for a wide range of useful tasks. His Robotic Manipulation and Mobility Lab is working on technology for a range of everyday applications, from innovative automation in manufacturing to assistive and rehabilitative robotics in health care.

PIERRE GENTINE
Associate Professor of Earth and Environmental Engineering
Gentine studies land and atmosphere interactions and the inherent feedback between the two systems, working on hydrometeorology, ecohydrology, convection, remote sensing, land-surface models, and stochastic processes using conceptual models, numerical models, and a wide range of data analysis tools. His overall research objective is to understand how soil and atmospheric moisture organizes across different spatial and temporal scales, particularly constraints in interactions with the environment. Gentine will use the award to better model turbulent fluxes and account for the largest and most efficient eddies in his team’s representation of turbulent exchange on Earth’s surface, helping enable more precise hydrologic, weather, and climate predictions using a combination of high-resolution turbulence models and observations run on supercomputers at Yellowstone. He hopes this work will improve how researchers measure and model surface fluxes to better predict evaporation, heating, and carbon fluxes.

NIMA MESGARANI
Assistant Professor of Electrical Engineering
Head of the Neural Acoustic Processing Lab, Mesgarani identifies and models the representational and computational characteristics of brain regions involved in naturalistic speech communication, unlocking the underlying neurophysiological mechanisms. His interdisciplinary approach incorporates theoretical and experimental techniques in invasive and noninvasive procedures, neural network models for speech processing, and computational neuroscience for work advancing artificial intelligence, neurolinguistics, systems neuroscience, and translational medicine. Mesgarani’s CAREER project involves computational modeling of neural networks to create a coherent theoretical and mathematical framework to understand the computational role of distinctive features of biological networks, their contribution to robust signal representations, and how to model and integrate them into current artificial neural networks. These new bio-inspired models and algorithms will have adaptive and cognitive abilities, will better predict experimental observations, and will advance understanding of how the brain processes speech. As the models’ performance approaches human abilities in tasks mimicking cognitive functions, the models will enable even more realistic experiments in the future.
SLOAN RESEARCH FELLOWS

The following SEAS professors have been awarded prestigious research fellowships from the Alfred P. Sloan Foundation.

MATEI CIOCARLIE
Assistant Professor of Mechanical Engineering
Ciocarlie is a member of the Data Science Institute and a recipient of a 2016 NSF CAREER Award.

(See opposite page for his profile.)

ROXANA GEAMBASU
Assistant Professor of Computer Science
Geambasu, also a member of the Data Science Institute, works to identify the security and privacy risks inherent in current mobile and Web technology and practice and to construct systems to address emerging threats. Her research spans security and privacy concerns across broad areas of systems research, operating systems, and databases, integrating cryptography, machine learning, distributed systems, database principles, and operating systems techniques. Working collaboratively to design, build, and evaluate interdisciplinary solutions for today’s data privacy challenges, Geambasu has devoted much of her current research to emerging technologies like cloud computing, mobile devices, and big data, developing what she calls “a new model for privacy” for more transparency and accountability for how billions of users’ sensitive data is collected and mined. She envisions a Web environment where users are more aware of the privacy consequences of their online actions and can practice responsible data management by making informed decisions about the services they choose.

DANIEL HSU
Assistant Professor of Computer Science
Hsu develops machine learning algorithms that have been used in automated language translation, personalized medicine, and privacy transparency systems. His work has produced the first computationally efficient algorithms for several statistical estimation tasks (including many involving latent variable models), provided new algorithmic frameworks for solving interactive machine learning problems, and led to the creation of scalable tools for machine learning applications. Hsu helped develop an active learning method that was later applied to electrocardiograms, greatly reducing the amount of training data needed. His work on hidden Markov models has been applied in genomics to understand the role of gene regulation in disease and how the chromatin packaging of a cell’s DNA may be implicated. More recently, Hsu, who is a member of the Data Science Institute, helped develop a tool to bring greater transparency to how personal data is used on the Web.
Nanfang Yu, assistant professor of applied physics, has won a 2016 Young Investigator Award from the U.S. Office of Naval Research for exceptionally creative research with far-reaching implications for technological needs of the Navy and the Department of Defense.

Yu is one of just 47 early-career tenure-track academic scientists selected this year for the prestigious honor, one of the oldest and most selective research advancement programs in the country. For his proposal, “Phase-Change Correlated Perovskites as a New Platform for Photonics,” he is slated to receive approximately $510,000 over a three-year period for graduate student stipends and scholarships, and for equipment and other expenses, to sustain his research.

Earlier this year, Yu received a major grant from the U.S. Air Force’s Office of Scientific Research as part of the Defense University Research Instrumentation Program (DURIP), which helps researchers procure state-of-the-art equipment for developing next-generation defense capabilities and will support his work with infrared cameras and other light sources.

Yu’s research interests include mid-infrared and far-infrared optics and optoelectronic devices and active plasmonics and metamaterials with gain media. He studies the interaction between light and structured active materials at the nanometer scale and builds novel devices including lasers, detectors, and active components for controlling light. His recent work includes investigations into what humans can learn from Saharan silver ants, uniquely capable of surviving extreme heat, and research into unusual optical waves that resist distortion.

By Jesse Adams
Dear Fellow Columbia Engineers:

These are exciting times for our School! Open a copy of Columbia Engineering to any page and you will find stories of accomplishment, discovery, and groundbreaking achievement from our students, faculty, and alumni. We are certain you will agree that our School’s legacy of excellence remains on course, and we hope you will enjoy reading about the accolades, acknowledgements, and awards that members of our community have received from around the world.

More locally, we are happy to report that our School remains a hub of intellectual curiosity on Columbia’s Morningside Campus. Robust recruitment efforts led by Dean Mary Boyce have expanded the ranks of our distinguished faculty over the past year. Construction is underway to open up more classroom and laboratory space for use by SEAS professors, researchers, and students. Columbia College, Barnard College, and General Studies undergraduates are all registering for Engineering courses in record numbers as STEM learning and engineering disciplines are undeniably viewed as essential skills for all graduates.

With so much positive news coming from the S. W. Mudd building, it’s no wonder that so many of our fellow alumni are maintaining close ties to Columbia Engineering. Our mission, as alumni, is to help the School continue its upward trajectory, and the best way we can do this is by supporting the initiatives and leadership of Dean Boyce. The Columbia Engineering Alumni Association, Columbia Engineering Young Alumni, and the Columbia Alumni Association all host programs, events, and volunteer opportunities throughout the year, connecting alumni to students, faculty, the Dean, and each other. To stay up to date regarding alumni activities and programs, follow CEAA and CEYA on Facebook at www.facebook.com/myceaa and www.facebook.com/myceya.

Class Notes: Undergraduate Alumni

1945
Class Correspondent: Gloria Reinish
reinish@fdu.edu

1951
Class Correspondent: Ted Borri
bjb63@columbia.edu

1953
Class Correspondent: Don Ross
dross52@optonline.net

1955
Class Correspondent: Leo Cirino
lcirino3333@gmail.com

1956
Class Correspondent: Lou Hemmerdinger
LHemmer@aol.com

1957
Robert Paaswell, distinguished professor of civil engineering at the City College of New York, has been selected by the Port Authority of New York & New Jersey to serve as one of eight international jurors to evaluate proposals for the new Port Authority Bus Terminal in NYC. Robert previously served as executive director of the Chicago Transit Authority. In a statement released in June, Port Authority Chairman John Degnan said: “The selection of this prestigious group of jurors is another step in honoring the commitment of the board to include in its capital plan the funds necessary to erect a replacement bus terminal on the west side of Manhattan. I look forward to reviewing the conceptual design
of a facility endorsed by this jury and sharing it with the city, the community, and most importantly, the commuters currently consigned to an outmoded and overcrowded structure, which had languished for far too long without Port Authority steps to replace it. Thankfully, that process is now underway.”

1958
Robert Drucker writes, “The most significant recent event that I am proud to report is that my grandson Brian Ross Albert, Columbia Engineering Class of 2010, received his Doctor of Philosophy in Materials Science and Engineering from MIT in June 2016. Future family plans include exploration of arctic areas around Svalbard, Norway, to see the wildlife and other points of interest. A return to the Caribbean in the late fall is also a possibility via New Orleans to see what changes have occurred since the time I worked there in offshore oil and gas platform construction activities.”

1959
Class Correspondent:
Betsy Altman
bmeca@comcast.net

Peter Demetriou MS’60, PhD’63 is one of the founders of MBC Research in New York, which is celebrating its 25th anniversary this year. He conducts marketing research for Fortune 500 companies and travels quite a bit for work as well as pleasure. Peter recently came back from China, where he was supervising a study for a multinational client. He and his wife, Mary, also spent time in Fiji over the Christmas holiday and planned to visit St. Croix and Greece this summer. In addition to traveling, Peter enjoys reading, listening to classical music, and attending classical music concerts, ballets, and operas at Lincoln Center.

1960
Besides his BS in industrial engineering, Matthew J. Sobel ’59CC, ’64GSAS earned an AB (Columbia College), an AM (Columbia’s Department of Mathematical Statistics), and a PhD from Stanford University (Operations Research). He was a faculty member at Yale, Georgia Tech, SUNY Stony Brook, and Case Western Reserve University, where he is now an emeritus professor. Matt retired in 2014 to devote more time to research, to visit his children and grandchildren more often, and to spend more time road bicycling and cross-country skiing. He remains passionately devoted to research, but he is slower at it than decades ago! He and his wife live near Cleveland, where classical music ensembles are outstanding, road bicycling is excellent, and in some winters skiing is too.

He celebrated retirement with a weeklong bicycle ride in the mountains and high deserts of Northern New Mexico. This year, Matt will participate in Cyclon (in Kingston, Ontario) and the Hilly Hundred (near Bloomington, IN), and he plans to bicycle several thousand miles in his home region.

1961
Class Correspondent:
Doug Kendall
dkjr@roadrunner.com

Ray Bode and Doug Kendall recently reconnected after being out of touch for 55 years. Ray is retired and cultivating a social life in Long Island. John (Jack) Pett moved to Sunnyvale, CA, in 1966. Jack worked in his field on classified programs and retired from Watkins Johnson in 1995. He did some consulting work afterward. Now Jack travels a bit, putters around the house, and watches the grandkids grow! His e-mail is jpett@sbcglobal.net, for those who want to get in touch!

1962
Class Correspondent:
Marshal (Mickey) Greenblatt
mg840@columbia.edu

1963
Class Correspondents:
Chuck Cole
ccole6250@att.net
Mark Herman
mnh18@columbia.edu

1964
Class Correspondent:
Tom Magnani
tm421@columbia.edu

1965
Larry Shaper writes, “I just finished building an electric-powered launch, my fifth boat, but it is the only one that my family cares to be on board, mostly because there is a graceful place to sit down with a table for food and drinks. The only times that I have enjoyed myself on a power boat are when the engine is at very low power so that it is possible to have a civil conversation, and the 2KW electric motor is just fine for that.”

1966
Steve Wolfson writes, “In May I won the Gold medal for the 1500M race (for age group 70–75) at the recent CT Senior games. Note the Columbia shirt that I wore to race in.”

1967
SOTH REUNION
To take an active role in your Class Reunion activities, please contact
1968

Steve Nahmias went from Columbia to Northwestern and completed a PhD in operations research in 1972. He taught at the University of Pittsburgh for six years and at Stanford for one year, and has been a professor at Santa Clara University since 1979. He was elected a fellow to the Manufacturing and Service Operations Management Society in 2011 and a fellow to INFORMS in 2014. Steve is the author of Production and Operations Analysis, published by Richard D. Irwin and later by McGraw Hill. The book, originally published in 1989, is currently in its seventh edition (2015) and published by Waveland Press. The seventh edition (only) is coauthored with Tava Lennon Olsen of the University of Auckland. More than 100 colleges and universities including Stanford, Berkeley, MIT, and the Harvard School of Business have adopted the text. It is used in both schools of business and schools of engineering and has been translated into Spanish (two editions), Hebrew, and Chinese.

1969

Class Correspondent:
Ron Mangione
Ronaldm@archeng.com

Larry Ellberger writes, “I’ve been happily married 47 years to Barbara (née Julius), whom I met in summer camp when we were about 13. We have three sons, Eytan, Ruven, and Shai; and two granddaughters so far, Maya and Liana. We lived most of our married life in Livingston, NJ, but also in Houston, TX, and Boca Raton, FL. We are now Florida residents, spending the summer in NJ. I have had a very satisfying corporate career in the pharmaceutical/biotech/vaccine industry, on the business side including over 100 corporate M&A transactions. I have been CEO of WR Grace and PDI and have served on the boards of several life-sciences companies, including several in Israel. I’ve retired from full-time corporate life and spend much time involved in helping Israeli biotech companies become as successful as Israel’s hi-tech industry.

“Columbia education was key to my career. In addition to the benefits of the Core Curriculum, I was fortunate to be allowed much flexibility in my Engineering years (because of the school riots in ’68 and ’69) to take many classes in Columbia Business School, which set me on my career path. I also had great fun co-producing (with Paul Shapiro ’67CC and Jim Weitzman ’69CC and also with Barnard ladies Bea Skolnick and Shelley Jaskell) Songs of the Sabras, which at the time was the most popular Israeli music/culture program on U.S. radio. I would love to hear from Paul, Jim, Bea, and Shelley.”

1970

Chester Lee writes, “My son Douglas BS’06 and his wife, Kiki, became the proud parents of Owen Clark Lee on March 4, 2016. He’s my third grandson and a future Columbian!”

Bob Schwartz writes, “After retiring from American Water, I’m now enjoying retirement to the fullest. Days are full of community service as secretary of the Montclair, NJ, Rotary; on the board of the Montclair Inn, a nonprofit senior residence; as a member of the applications review committee for the Community Engineering Corps; and tutoring for Streetsquash Newark. Leisure-time activities include travel, fishing, and single malt whisky. I lost Leslie to cancer in 2009 but am happily remarried. My daughter and son are both grown and busy with their own careers.”

1972

45TH REUNION
To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Allan Cytryn MS’79, ’75GAPP is now a member of the executive board of the Boston Global Forum, where he advises on cybersecurity policy. In this role, he recently coauthored the G7 Ise-Shima Cyber Norms, which were incorporated, in part, into the G7 Cyber Declaration—the first-ever cyber declaration by the G7 leaders. In August, he will be traveling to Vietnam to advise government and industry on cybersecurity policy.

1974

Neil Marmor writes that he “continues to enjoy the benefits of good genes [Thank you, mom & dad] and a good education. Last summer he cruised the Northwest Passage from Greenland to Nome, Alaska. As opposed to all those courageous sailors who died trying, sometimes after eating their starved comrades, he gained several pounds and communed with the spirits of past expeditions. This past winter he skied, with modest success. He continues to jog, more slowly with each passing season.

“Neil invests some of his time reading to kids, providing free financial counseling to veterans at SDSU, and teaching budgeting to situationally homeless people. He continues to support taxes for the local library and the police department. He plans to sustain his streak of never having missed
an election, but this coming November will present a unique challenge. As a reminder of the joys of the climate in San Diego, he always keeps an ice scraper in the trunk of his car. He does not miss driving in snow. He is always glad to visit family and friends and New York and go into Manhattan to enjoy the great culture of a great city.

“Life is good. Neil considers himself an extremely fortunate fellow. It’s been a great trip and it ain’t over yet.”

1975
David C. Kjeldsen MS’75 writes, “After receiving my BS and MS in 1975, I went to work for Estée Lauder cosmetics for a couple years. In 1985, I started a mail-order business selling platform tennis equipment. In 1995, I started manufacturing platform tennis equipment here in Lindenhurst, Long Island. In 2008 I was inducted into the American Platform Tennis Hall of Fame. I sold the last of my businesses in 2015 and I am now retired, looking to retire in Maine.”

1977
40TH REUNION
To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

Lawrence Pohlman MS’80, ’80BUS has had a distinguished career over 30 years of experience in equity, fixed income, and asset allocation. He regularly speaks at professional conferences and is widely published in prominent journals. Larry is currently the director of quantitative research at BMO Global Asset Management. Before BMO, Larry was the chief investment officer at BNP Paribas Quantitative Strategies, director of the Quantitative Investment Group at Wellington Management, director of research at PanAgora Asset Management, senior vice president and the director of fixed income research at Independence Investment Associates, vice president at Blackrock Financial Management, and an associate in mortgage securities research at Goldman Sachs & Co. Larry holds his PhD in finance, a master’s in finance, MBA in finance and management science, MS in operations research, and BS in nuclear engineering, all from Columbia University. He is a member of the American Finance Association, Boston Security Analysts Society, Econometric Society, the Chicago Quantitative Alliance, and MENSA. He is also an instructor in finance at Northeastern University and the University of Massachusetts, Boston campus.

1981
Class Correspondent:
James Reda
jfreda@jfreda.com

1982
35TH REUNION
To take an active role in your Class Reunion activities, please contact Gray Crenshaw at gc2700@columbia.edu or 212-854-2317.

Class Correspondent:
Dan Libby
kdl26@columbia.edu

Susan C. Bacas MS’83 is a homegrown New York City talent. Educated in the New York City public school system and having earned her bachelor’s and master’s degrees in civil and structural engineering at Columbia in 1983, she has embarked on a profession that few women entered. Susan became a managing partner at Ysrael A. Seinuk, P.C., a prestigious NYC-based structural engineering firm, where she began her successful career in 1982. She has built up an impressive project portfolio. Susan has also created a successful internship at her firm, dedicated to selecting exceptional Columbia Engineering students. Susan enjoys spending quality time with her wonderful family by traveling the world, enriching their cultural awareness. She contributes to the community by participating in the Greek National Philoptochos Society, which serves people with disabilities. She also spends her free time volunteering as the baking chairperson for the Staten Island Greek Festival, as a part-time STEM tutor, and as an advisor to the NYU Steel Bridge Team.

1983
Mike Hagan writes, “Yes, there is life after Corporate America! Retiring in 2015 was the best thing that I ever did. My wife and I have been traveling the world. This picture was taken in February 2016 as we were traveling through Chile. Patagonia and Tierra del Fuego are spectacular destinations. Since childhood I wanted to sail through the Magellan Straits and on this trip I did. We’ve been traveling through Central and Eastern Europe looking for a pied-à-terre in that part of the world. I feel truly blessed to live this life. Thank you, Mort Friedman.”

Greg Morea writes that he and his wife, Barbara, “spent a lovely two weeks in the Canadian Maritimes. Nova Scotia is breathtaking, and we had a blast at the Royal Nova Scotia International Tattoo. No, it doesn’t have anything to do with injecting ink into human bodies. It’s a performance by military bands, display teams, and dancers with lots of bagpipes, Highland dancers, and acrobatics.

“I celebrated my 32nd anniversary with Electric Boat this past summer. Who would have
thought that the young man who loved NYC and swore to return would still be in southeastern Connecticut after three-plus decades? I received a promotion from the Knights of Columbus and now serve as Grand Knight of the council. Of course, I only agreed to take the job if I was allowed to continue running my baby, the Lenten Fish Fry. Barbara is still singing with all four of her choirs, and our son and daughter-in-law Joseph and Alicia recently celebrated their first anniversary as a married couple. Both Joseph and his sister, Rebecca, are engineers working at Electric Boat.”

1987

30TH REUNION
To take an active role in your Class Reunion activities, please contact Gray Crenshaw at gc2700@columbia.edu or 212-854-2317.

Chris Kalish began service with the U.S. Peace Corps in Botswana, Africa, in July 2015 and has been assigned to the district with the highest HIV prevalence rates in Botswana in the 15-49 year old range. He works at the District AIDS Coordinator’s Office and Voice of Women Centre in Mahalapye as a Local Government Capacity Builder. In this high-risk region, Chris is leading five important projects to support the community: a District Female Condom Study (FC2), construction of the country’s third Women’s Shelter, development of a Film and Arts Center, an implementation of One Laptop per Child (leveraging technology for education), and a project to convert fly ash from the country’s coal plant to asphalt.

1988

Class Correspondents:
Caryn Frick
carynfrick@gmail.com
David Shofi
david.shofi@yahoo.com

Dawn of the Techno-Social Age

“Humanity stands at the cusp of a new technological and social renaissance,” said pioneering computer scientist Lynn Conway BS’62, MS’63 at Columbia Engineering’s annual Magill Lecture, held March 23.

Professor emerita of computer science and electrical engineering at the University of Michigan, Conway helped lay the foundations of microelectronics chip design. Fresh out of the Engineering School, she solved a fundamental architecture problem in supercomputers, enabling more powerful machines with dynamic instruction scheduling (DIS). Later, she developed scalable metal oxide semiconductor (MOS) design rules, spurring a revolution in fitting more transistors onto ever more complex chips.

Conway is also an advocate for transgender people, having endured much adversity when she decided to undergo transition in 1968. She subsequently lived in “stealth mode” for decades but, as historians sought to chronicle her early work, she went public in the 1990s to help innovators foster more inclusive environments.

Quoting Churchill, that “the farther backward you can look, the farther forward you are likely to see,” Conway highlighted the age of discovery in the 1400s, when advances in navigation, shipbuilding, and the printing press spread knowledge and began truly global trade. Later, railroads and telegraphy further accelerated change, compounding over time. Inspired by studies in history, anthropology, and sociology at Columbia, Conway sought in her career to maximize diffusion of her open-ended method for better and smaller chips.

“The idea was to use computers to design new chipsets for more powerful computers for more sophisticated chipsets, and so on, and do ever more with ever less,” Conway said.

Coauthoring the textbook Introduction to VLSI Systems and serving with the U.S. Department of Defense’s Strategic Computing Initiative, she advanced “the freedom of the silicon press,” helping chips progress from holding a few thousand transistors to several billion today.

Looking ahead, Conway predicted that our time marks “the dawn of the techno-social age.”

“These aren’t frivolous playthings,” she said. “They illuminate a vast frontier for human empowerment and amplification.”

By Jesse Adams
David Shofi, vice president, IP Strategy Solutions, and Chief IP Counsel for CPA Global, was recently named to the IAM300 list of The World’s Leading IP Strategists. CPA Global is a leading partner to thousands of organizations throughout the world, providing innovative technology and service solutions across the IP lifecycle. After spending more than 20 years in the IP industry practicing law and developing improved strategies and processes for IP generation, protection, monetization, and enforcement, David joined CPA Global in June 2015. His mission is to aid clients in identifying opportunities for improvement in IP strategy and portfolio management, driving process efficiencies, developing new strategic and innovative solutions, and facilitating greater return on their investments. His experience has provided great perspective and appreciation for the challenges facing IP professionals today, and his role as a strategic and trusted IP partner to colleagues across the industry is proving to be timely and impactful. Whether it is through extending teams and capabilities, identifying opportunities for process improvement, or implementing technology for advanced portfolio management and analytics, David enjoys having a positive effect on clients in the increasingly complex and challenging area of intellectual assets. He has been an active speaker at IP and legal conferences across the world, sharing his best practices with others. David and his wife, Leanne, are proud of their Baldwin Wallace University–bound son, Michael, and their daughter, Mallory, who just finished her sophomore year of high school!

1990
Class Correspondent:
Laura Cordani Christopher
zhchristophers@gmail.com

1991
Class Correspondent:
Radhi Majmudar
radhi@majmudar.org

1992
25TH REUNION
To take an active role in your Class Reunion activities, please contact Beth Manchester at em2702@columbia.edu or 212-854-4472.

1993
Class Correspondent:
Herbert Kreyszig
Hek7000@gmail.com

1996
Class Correspondent:
Enrico Marini Fichera
em75@columbia.edu

1997
20TH REUNION
To take an active role in your Class Reunion activities, please contact Star Sawyer at ss3858@columbia.edu or 212-851-2402.

1999
David Chung writes that he and his wife, Eliza, welcomed Caden to the world in February 2016! The family is healthy and well.

2000
Class Correspondent:
Daisy Chow
daisy@caa.columbia.edu

Stephen Del Percio writes, “My wife, Allison; daughter, Charlotte; and I welcomed another daughter, Elisabeth Suzanne Del Percio, on April 18, 2016.”

Lev E. Givon MS’03, PhD’16 writes, “I completed my doctorate in computational neuroscience at Columbia’s Electrical Engineering Department in May, where I developed a novel graph database platform called NeuroArch and a collaborative modeling framework called Neurokernel for emulation of the fruit fly brain on multiple graphics processing units (GPUs). I’m happy to report that both open source projects continue to be actively developed by a growing international team of researchers at Columbia and other institutions—see http://neurokernel.github.io for more info! After graduation, I joined the Charles Stark Draper Laboratory..."
in Cambridge, Massachusetts, as a computational modeling and machine intelligence scientist, where I’m currently working on other fun projects.”

2001  
Class Correspondent:  
Catherine Marcinkevage  
marcinkevage@gmail.com

2002  
15TH REUNION  
To take an active role in your Class Reunion activities, please contact Beth Manchester at em2702@columbia.edu or 212-854-4472.  
Class Correspondent:  
John Morris  
jpm53@columbia.edu

Heather (Balsky) Weiss writes, “My husband, Scott Weiss ’04CC, and I welcomed a baby girl (Charlotte) to our family in February. My husband and I are both working in finance and have stayed close by on the Upper West Side.”

2003  
Class Correspondent:  
Amar Doshi  
abd19@columbia.edu

2004  
Class Correspondent:  
Eric Rhee  
eric.rhee@gmail.com

Eric Rhee writes, “Hello, Class of 2004! It’s been a pretty hot summer in the New York area. As we get older, it seems family news is the most common and most important type of update. A big congratulations to Justin Saechee and his wife Veronica on the birth of their son, Owen. Please send updates to eric.rhee@gmail.com, whether you have a new job, new family member, or even fun memories from our time at Columbia.”

2005  
Class Correspondent:  
Devang Doshi  
devang.doshi@gmail.com

2006  
Class Correspondent:  
Nick Jennings  
nfj2003@caa.columbia.edu

2007  
10TH REUNION  
To take an active role in your Class Reunion activities, please contact Jack Reilly at jr2813@columbia.edu or 212-851-0734.  
Class Correspondent:  
Tamsin Davies  
tamsin.davies@gmail.com

Alex Baumer writes that he is getting married in August! After getting his PE license in civil engineering and working as a structural engineer at Robert Silman Associates in NYC, he now works at SunLink in California analyzing, designing, and testing prototype mounting racks and solar trackers for large PV solar power arrays. His two-year-old dog, Cali, recently survived a near-fatal oleander poisoning and she is making a great recovery. Alex is still on the board of SlantShack Jerky, a small beef jerky company founded by seven Columbia alumni (and three others). At press time, he was still deciding whether to go to Burning Man again this year.


2008  
Class Correspondent:  
Amy Lin  
seas2008.engineeringnews@gmail.com

2010  
Class Correspondent:  
Heather Lee  
meheatherlee@gmail.com

Ravi Chacko writes, “My sophomore year at Columbia I got a knee infection after an ACL surgery. That’s when my good luck really began! My hospital stay left me puzzled by the body’s effect on the mind, and vice versa. A year later, I was studying this puzzle at the NIH. I continue to study the mind-body problem in the MD/PhD program at Washington University in St. Louis. We develop brain-computer interfaces to enhance attention. My colleagues and I started a student-run biotech incubator called IDEA Labs. Through it, I cofounded a company that makes the Mindset app. The app detects stress using wearables and manages it with evidence-based therapies. It’s like a Fitbit for mental health. We set out to improve the mental health of veterans. Two years later we were funded and pitching at the largest startup event in the world. Better still, my college sweetheart, Nisha, is still by my side. I met her in Señora Gloria’s classical Spanish dance class. She’s still dancing with me, with a ring.” Ravi would like SEAS alums to reach out, ravi@datadoghealth.com, and check out www.mindset-app.com.

Since starting his travel consulting company, pointdozer, to help others travel for free, Victor Leung has helped his clients save over $200,000 in travel expenses. He is currently working on an online video course that can help recently engaged couples travel to their honeymoon destinations with almost no out-of-pocket cost. If you have any interest in learning this new hobby, you can always find him at victor@pointdozer.com.

Evan Roth MS’11 has been living in Philadelphia for the past five...
Investing in the Future, with a Global Eye

Noha El-Ghobashy BS’96, MS’00, is fostering the next generation of engineers—and equipping them to solve today’s global challenges.

El-Ghobashy was appointed the associate executive director of programs and philanthropy for the American Society of Mechanical Engineers (ASME) last October. She oversees The ASME Foundation which in 2014 funded $1.8 million in university scholarships, K-12 STEM initiatives and other programs benefitting the global engineering profession.

For elementary and high school students, ASME wants to inspire students to think about engineering differently. “We talk about it as a field you enter to make an impact on society,” El-Ghobashy explained.

She said she also wants to change the way groups think about youth outreach. “There’s often a misconception with foundations that they’re ultimately in the business of charity,” she remarked. “What we’re trying to do is invest in the future workforce: We’re really trying to build the talent pipeline and ensuring that those students are equipped to solve the challenges we face as global citizens.”

Keeping the focus firmly on global needs is critical, she added. “Billions of dollars are invested in solving global poverty, and yet in some places it’s on the rise,” she said. “We think there’s a role for engineering to play that ultimately lifts communities out of poverty.”

To that end, El-Ghobashy is incredibly proud of the work of E4C, Engineering 4 Change, the group she is now president of. E4C was founded more than five years ago with ASME, the Institute of Electrical and Electronics Engineers, and Engineers Without Borders. Their goal is to work together to create and share ideas and solutions for global challenges. And they also want to make sure engineering is included in the discussion happening with policy makers.

“Over the past five years, we’ve really been able to articulate what’s working and not, and to take a position on the idea of engineering rigor in a space where you have a lot of talk of politics and policy,” she said. “We speak to not just the engineering community but the development community.”

Bringing an engineering perspective to the table when the worldwide political discussion turns to issues in water, energy, health, housing, agriculture, sanitation, and information systems is E4C’s goal.

“We are mobilizing a community of people eager to solve global challenges and do it in a responsible way,” she said.

By Jennifer Ernst Beaudry
a child, immigrating to New York from Jamaica. This kindling was reignited during my final design project geared towards developing countries. I was inspired by the challenge of creating the plan of how our equipment would be used effectively; it’s this inspiration that guided my journey.

“Within no time I found myself aboard the Orbis Flying Eye Hospital on a whirlwind global tour! The Orbis Flying Eye Hospital is a mobile teaching hospital used to train local healthcare workers and broadcast public health messages in support of a mission to treat and prevent avoidable blindness. My experience with working in various countries drove me to pursue an MSc in Global Health and Public Policy at the University of Edinburgh. I wanted to complement the practical skills gained with the knowledge of the wider, often complex, environment that health interventions work in, as to better address the needs of the populations and countries I want to serve. I am anticipated to graduate fall 2016 and hope to continue to develop my career in public health and international development.”

2012
5TH REUNION
To take an active role in your Class Reunion activities, please contact Jack Reilly at jr2813@columbia.edu or 212-851-0734.

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

Akshay Purohit writes, “Inspired during my time at Columbia, I did the Teach For India Fellowship postcollege. The challenges were immense, the experience was rewarding, and I joined my family-owned enterprise, Neptunus Power Plant Services Pvt. Ltd., armed with invaluable learning. In April of this year, Neptunus was awarded the India SME 100 award by the India SME Forum, backed by the government of India. This award recognizes the top 100 small- and medium-sized enterprises in the country, of 49,023 nominations this year! Neptunus specializes in engine and mechanical equipment services to the Marine, Offshore and Industrial Sectors. We have offices in India, UAE, and Tanzania; and customers in Europe, Asia, Africa, and the Middle East. We realize that this is just the start of our journey from Good to Great, but we are immensely thankful to our customers, stakeholders, employees, business partners, and well-wishers.”

2013
Class Correspondent:
Mary Byers
mbyers2202@gmail.com

After working at Wheelabrator Technologies Inc., David Ling Qiu relocated from Hampton, NH, to Hong Kong in September 2015 to become senior manager of project management and environmental management at China Everbright International Limited, a Chinese environmental and renewable energy conglomerate.

2014
Class Correspondent:
Victoria Nneji
vcn2101@columbia.edu

Mycheal Crafton writes, “Since graduation I have hit some notable career milestones. The most notable are becoming a certified Engineer in Training and being accepted in the Civil Engineering MS Program at Columbia Engineering. I genuinely look forward to being back on campus as a SEGUE Scholar, where I will study topics on sustainable building. On a more personal note, I hope to continue connecting with students of underserved communities who can benefit from a little extra help. As of late, I’ve also gained an interest in cycling—so get ready, Morningside!”

2015
Class Correspondent:
Noureen Nanjee
noureen.nanjee@gmail.com

Tolu Akinade writes, “Looking back it’s hard to believe that I graduated from SEAS just one year ago. The past year has been filled with a mixture of new developments, experiences, challenges, and triumphs. After graduation, I went home to Qatar for my sister’s high school graduation, and then my family went on vacation in Italy to visit Rome and Florence. I had the pleasure of working as a Research Assistant for Dr. Antonio Fojo after graduation at the National Institutes of Health and then at Columbia University Medical Center. The lab has an interest in the biology and treatment of neuroendocrine tumors as well as how the trafficking of proteins on microtubules is affected by cancer therapies. I completed my MD/PhD application and interviews during my year off school, and I’m happy to announce that I will be matriculating as an MD/PhD student at Columbia University Medical Center this fall! This past year has been a wonderful transitional year for me, and being in the real world has allowed me to grow as an individual. I’m looking forward to what the next chapter in my life holds.”

Andres Smith writes, “After graduating from SEAS having majored in Electrical Engineering, I moved back to my hometown of Caracas and started working as a Presales Engineer for ZTE Corporation in Venezuela.
My experience began in a different way as I spent five months working with RF Engineers learning how to plan and optimize (2G/3G/LTE) cellular networks, and afterwards I finally started getting involved in a Transport Network project in the presales department, where I have learned how to take requirements and deliver solutions to the client exposing the pros and cons of each option. Also, this year during the Easter Holidays I traveled back to New York as every time I think back about my time in the Big Apple I feel nostalgic. I felt right ‘at home’ once more when I landed, surrounded by exciting Broadway musicals, world-class museums, some amazing weather, and the freedom I can’t have in my country. Visiting my Alma Mater, and of course taking a ride on the 1 train again to 116th Street, was a must. New York is magical!”

2016
1ST REUNION
To take an active role in your Class Reunion activities, please contact Beth Manchester at em2702@columbia.edu or 212-854-4472.

Olachi Oleru writes, “I promised myself that I would take it easy after graduating in May, but that hasn’t really been the case. Instead, I found myself exploring the world of entrepreneurship, as three of my friends/classmates and I launched Luso Labs LLC! After receiving funding from the Columbia Venture Competition, Jahrane Dale BS’16, Stephanie Yang BS’16, Ritish Patnaik BS’16, and I chose to pursue this venture to alleviate the threat of cervical cancer worldwide. Our team aims to do this with the cerVIA system—a medical device that we created for our senior design project that can provide automated, accurate, and accessible cervical cancer screening for women in low-income areas. With additional funding opportunities and a pilot study in the future, we feel excited for what’s to come and appreciate the support and guidance that the Columbia community has provided. Check us out at www.lusolabs.co and look for us in New York City and Palo Alto!”

Compiled by Jesse Adams

Save the Date!
Reunion: June 1–4, 2017

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ColumbiaSEAS
@ColumbiaEngineering
Astronaut and Columbia Engineering Professor of Professional Practice Mike Massimino BS’84 is set to publish his first book, *Spaceman: An Astronaut’s Unlikely Journey to Unlock the Secrets of the Universe*, this October.

Mike’s memoir delves deeply into his remarkable career as a NASA astronaut, engineer, adventurer, and mentor. From witnessing Neil Armstrong’s historic “small step for man” while growing up in Long Island to his torturously circuitous path to NASA, Mike details his journey into space, including his personal experiences on two space flights to the Hubble Space Telescope (STS-109 in March 2002 and STS-125 in May 2009) and of losing close friends in the space shuttle Columbia disaster.

After studying at Columbia Engineering and MIT and obtaining two patents for his work in human operator control of space robotics systems, Mike worked as a research engineer and pursued his lifelong dream of becoming an astronaut. Rejected three times by NASA, he was told his eyesight would never be good enough. Undaunted, he was finally accepted on his fourth try, beginning an extraordinary 18 years in which he logged more than 570 hours in space. He became a spacewalker on the final mission to service the Hubble Space Telescope and the first to tweet from orbit. He set a team record with crewmates for the most cumulative spacewalking time in a single shuttle mission.

In 2014, Mike returned to Morningside Heights as professor of professional practice in mechanical engineering at SEAS. He also leads Columbia’s Extreme Engineering program, a speaker and video series that showcases exploration and innovation at the edge of what is possible.

On Earth, he has become a much sought-after speaker and ambassador for STEM education, giving talks around the world; advising the Intrepid Sea, Air & Space Museum; and playing himself in a recurring role on CBS’s *The Big Bang Theory*. Of his new memoir, Mike says, “I hope to convey to the readers of the book that one should never give up in pursuit of a dream, how rewarding it can be to be involved in a technical career you truly love, and just how cool it is to fly in space.”

*By Jesse Adams*
Program Notes:
Graduate Alumni

BIOMEDICAL ENGINEERING
Qi Duan PhD’08 recently won the poster award (First Place) in the International Society for Magnetic Resonance in Medicine’s 2016 MR Engineering study group poster contest.

Tomoya Saito MS’13 writes, “During my time at Columbia, I developed a strong interest in applying my engineering skills to solve real-world problems in healthcare. This was inspired partly by the fascinating research I did in Professor Samuel Sia’s lab developing microfluidic diagnostic devices for global health. After graduating, I started working at biotechnology company Genentech, Inc., in South San Francisco, to try and put my engineering skills to the test. After starting in a two-year rotational program in process development, I joined the device development group as an engineer supporting the development and commercialization of medical devices for drug delivery. I most recently transitioned to a device team leader role for one of our marketed devices, leading the engineering team and working collaboratively to support commercial production and help bring critical medicines to patients. I am truly thankful to Columbia Engineering for providing me with the skills to get to where I am and allowing me to make a difference in healthcare.”

CHEMICAL ENGINEERING
Dejia Kong MS’16 writes, “I am now doing an internship in West Covina, CA. My job is mainly RA about solid fuel cells.”

Jacques Zakin MS’50 writes, “After graduation I held two industrial jobs, most notably with Socony Mobil Oil Company Research Labs in Greenpoint, Brooklyn (11 years). I had the good fortune to receive a company fellowship to study at NYU (D Eng Sci ’59). In 1962, my wife (a 1950 Barnard alum) and three children and I migrated to the Ozarks, where I taught at the University of Missouri-Rolla for 15 years. My research focused on drag reduction studies of polymer solutions. Two sabbaticals, 1968–69 at the Technion in Haifa and the other at the Naval Research Labs in Washington, DC (1975–76), were quite research productive. In 1966 our twin daughters were born. In 1977 I joined the Ohio State Department of Chemical Engineering as department chair. I served until 1994, following which I became the Helen C. Kurtz Professor of Chemical Engineering. A split sabbatical followed—six months as Fulbright Research Professor at the Technion and six months at an NJIT Environmental Consortium.

“In 2000 I became Helen C. Kurtz Professor Emeritus. Since then, I have been teaching part-time and continuing research focusing on surfactant drag reduction studies including enhancement of heat transfer properties. Columbus has turned out to be a gem of a place to live—not as exciting as New York (but not as crowded) nor as quiet as Rolla but having qualities of both.”

CIVIL ENGINEERING AND ENGINEERING MECHANICS
Rishee Jain MS’11, PhD’13 will be joining the Stanford University faculty this fall as an assistant professor of civil and environmental engineering. He will be the founding director of the Stanford Urban Informatics Lab, a research lab focused on utilizing data science to deepen the understanding of sustainable urban building systems and human dynamics.

COMPUTER SCIENCE
Zhe He MS’09 writes, “After
graduating from Columbia Engineering with an MS in computer science in 2009, I obtained my PhD in computer science at the New Jersey Institute of Technology, where I developed semantic and structural methods for improving the quality of biomedical ontologies and terminologies. After I got my PhD in January 2014, I joined Columbia University Medical Center as a postdoctoral research scientist and did research in data-driven assessment of clinical trial generalizability. In August 2015, I finished my postdoc training and joined Florida State University’s School of Information as a tenure-track assistant professor. At FSU, I am now teaching both undergraduate and graduate courses on information technology and doing research in health and biomedical informatics.

Dragomir R. Radev MS’96, PhD’99, a professor of electrical engineering and computer science and director of the Computational Linguistics and Information Retrieval (CLAIR) lab at the University of Michigan, has been elected a fellow of the Association for Computing Machinery (ACM) for “contributions to natural language processing and computational linguistics.”

Dragomir is an authority in the field of computational linguistics, which utilizes insights from computer science and linguistics to understand computational aspects of language. His research involves information retrieval, natural language processing, machine learning, bioinformatics, text and data mining, social networks, social media, collective behavior, text generation, information extraction, and artificial intelligence. His work has included “News in Essence,” an online multidocument news summarization system employing information retrieval, natural language processing, and information extraction to categorize, distill, present, and analyze information on current events.

Dragomir is cofounder and program chair of the North American Computational Linguistics Olympiad (NACLO), an annual contest in which high school student teams solve linguistic and natural language processing problems. Finalists compete each year in the International Linguistics Olympiad (IOL), and he has served as head coach of the U.S. team at IOL for nearly a decade. He also edited and compiled Puzzles in Logic, Languages, and Computation, a two-volume set that collects the best English-language problems created for students competing in NACLO. Additionally, he serves as secretary of the Association for Computational Linguistics.

William Weiss MS’74, MPhil’78 writes, “Columbia always makes a difference. In an on-campus interview in 1978, the interviewer immediately asked me how soon I could start at his company. I said, ‘You don’t know anything about me, and you’re already offering a job to me?’ He replied, ‘I know you are getting your degree from Columbia Engineering, that’s all I need to know.’ I had never been to Newport, Rhode Island, but when I went there for an interview with the Navy’s submarine research lab, I knew I had found the place I had always been looking for. There have been and will be so many fascinating projects. I am part of the Navy Task Force on Climate Change. A bucket list trip was going on a Navy/NASA expedition to a glacier in Greenland. If anyone would like some spectacular photos of Greenland, just send an e-mail to me at william.s.weiss@navy.mil. At 64, I am closer to the end of my career than even the middle, but I keep charging on, enjoying the challenges of each day and looking forward to the next exciting adventure.”

EARTH AND ENVIRONMENTAL ENGINEERING

Shahnoza Boboeva MS’15 writes, “During my studies I took classes which were related to sustainable energy and sustainability, and at the same time I did my master’s thesis on ‘The potential of a waste-to-energy plant in Tajikistan.’ My supervisor was Professor Nickolas Themelis from the Earth and Environmental Engineering Department. Currently, I am working at the New York City Department of Design and Construction as a project manager. I am managing a $20MM project on design and replacement of city-owned petroleum storage tanks in 38 sites in Brooklyn, Queens, and Staten Island. The main purpose of my current project is to reduce CO₂ emissions into the environment by using clean fuel oil. My current project and position are very interesting, and I hope that my current achievements are just a beginning. In the future, I will do my best to help our environment, our Earth, to become cleaner, greener and more sustainable, where people will be able to live healthily and happily.”

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH

Since 2008, Michael Horodniceanu MS’73 has served as president of MTA Capital Construction, where he oversees construction of more than $20 billion in Metropolitan Transportation Authority megaprojects—the largest transit infrastructure program in the United States. Projects include the Second Avenue Subway, East Side Access, and Penn Station Access for the Metro-North Railroad. These projects have earned Michael a worldwide reputation as a recognized expert in the fields...
of transportation infrastructure and engineering. Most recently, he has traveled to Tel Aviv, Israel, as a pro bono advisor on the new light rail system being built there, after a delegation from that city toured the MTA’s megaprojects. Similarly, Michael was invited to Melbourne, Australia, to consult on its massive rail project after a delegation including Victoria’s premier made two trips to the US to see MTA’s projects firsthand. He was recently named one of the real estate industry’s “Power 100” by the Commercial Observer and has been featured on the cover of Engineering News-Record for his many accomplishments.

Etienne Meriaux MS’16 writes, “I’ve moved back to France, where I am now working for the luxury division of L’Oréal in supply chain management. It is a very stimulating and enriching first job, and amazing to see all the supply chain and business concepts I learned at Columbia applied in real life.”

Niti Poosomboon MS’16 writes, “After graduating I have been in New York City because I am currently working at EXL Service as an analytics consultant. I am mainly spending my time with my family, who has been visiting from Thailand, after work and during the weekends. However, I am planning trips to Connecticut, Toronto, and Japan later this year to refresh myself up after tough classes at Columbia.”

Mukund Sanghi MS’09 writes, “After graduating from The Fu Foundation School of Engineering and Applied Science, where I pursued operations research, I joined my family business based in Rajasthan, which includes cinema, food and beverages, fuel, and automobiles. The family business dates back a century now, founded by my great-grandfather Shri Motilal G Sanghi, who was a pioneer in the automobile industry, and my grandfather, statesman and parliamentarian Shri N K Sanghi. Recently, I founded a book publishing company called Pirates, which publishes fiction and nonfiction titles. A film produced by me under the banner of Pirates called This Will End in Murder was picked up for sale in Berlin this year, for which I traveled to the 66th Berlin International Film Festival and the 69th Cannes Film Festival. Myself and my wife, Kanika, who is a graduate from National Institute of Fashion Technology, are blessed with a baby girl named Mira. We stay in the beautiful lake city of Udaipur, India.”

Compiled by Jesse Adams
IN MEMORIAM

David S. Johnson, Faculty

Columbia Engineering mourns the loss of David S. Johnson, a leader in theoretical computer science, who passed away March 8, 2016, at age 70. He served as a visiting professor of computer science at Columbia Engineering since 2014.

A major contributor to the field of computational complexity and the design and analysis of algorithms, David was perhaps best known for his seminal contributions to the development of NP-completeness theory, which helps pinpoint problems that are difficult to solve efficiently. His 1979 classic, *Computers and Intractability: A Guide to the Theory of NP-Completeness*, coauthored with Michael Garey, remains one of the most cited texts in all of computer science, with over 56,000 citations.

David’s work on experimental analysis of approximation algorithms was immensely influential in establishing rigorous standards for algorithms that find approximately optimal rather than exactly optimal solutions. He also researched and contributed to a broad range of foundational topics in both mathematics and computer science, including combinatorial optimization, network design, routing and scheduling, facility location, and the Traveling Salesman Problem.

Born in 1945, David studied mathematics as an undergraduate at Amherst before earning a master’s and doctorate in mathematics at MIT, devoting his thesis to “Near-Optimal Bin Packing Algorithms.” He then began a long and productive career at Bell Labs (and later AT&T Research) where he published extensively on the interplay between theoretical and experimental analysis in computer science. He was active within the theoretical computer science community, founding the annual Symposium on Discrete Algorithms (SODA) as well as creating the DIMACS Implementation Challenges. Throughout his career he served on innumerable committees and edited for multiple publications, including the *Journal of the Association for Computing Machinery*. He also taught as a visiting professor at Rutgers and the University of Wisconsin.

A fellow of the Association for Computing Machinery, among numerous other honors and titles, David received the 2010 Donald E. Knuth Prize for his work in theoretical and experimental analysis of algorithms. Earlier this year, he was elected to the National Academy of Engineering.

Beyond his tireless passion for advancing the frontiers of computer science, David is remembered as a generous and supportive colleague who hosted a yearly picnic for computer scientists in his backyard in New Jersey and loved science fiction, photography, and rock ‘n’ roll. He is survived by his wife, Dorothy, and son, Jack, among other family members.

“We will miss David very much. He was a wonderful colleague and mentor for students,” said Julia Hirschberg, chair of Columbia’s Department of Computer Science.

Compiled by Jesse Adams and Linda Crane

Alumni

1939

**Aimison Jonnard (MS, Chemical Engineering)** of McLean, VA, passed away on September 24, 2015. He was 99. Aimison was born in Sewanee, TN. In 1930, Aimison’s family moved to Manhattan, KS, which quickly became Aimison’s most beloved hometown, as it was here that he rode horses over the Konza Plain, swam, danced, skated, golfed, played tennis, became an Eagle Scout, and made lifelong friends. He attended Kansas State University, where he studied chemical engineering and joined Beta Theta Pi fraternity. After graduation, he taught chemistry at his alma mater, later receiving a scholarship to earn a master’s at the Engineering School. While at an early career job at the Mellon Institute in Pittsburgh, he earned his PhD in chemistry from the University of Pittsburgh. During World War II, Aimison joined DuPont to work on the production of a new product—nylon—and the manufacture of plastic nose cones for warplanes. Later, Aimison worked for companies including Shell, Celanese, and Esso/Exxon, and also became an adjunct professor at Brooklyn Poly Tech. He authored *Business Aspects of Chemistry*, a series of books, tapes, and lectures that he presented to scientists at chemical corporations throughout the US, Canada, and Europe. Aimison was recognized by the American Chemical Association, Chemical Marketing Research Association, and American Institute of Chemical Engineers and was twice elected to Sigma Xi. In 1972, he took a “retirement” job as chief of the Division of Energy at the International Trade Commission in Washington, DC, where he worked for 29 years. Aimison loved to travel, garden, play tennis, golf, and...
run. He is survived by his wife of 54 years, Jean, and three children and their families.

**1943**

Henry Charles (Hank) Beck (MS ’48, Industrial Engineering and Operations Research), engineer, oceanographer, and executive, died March 8, 2016, at age 92. He was born in New York City and attended public schools before attending Columbia Engineering, where he graduated in 1943 with a BS degree in mechanical engineering. Upon graduation he enlisted in the Navy and was commissioned at the Naval Academy in Annapolis. He served in World War II on Destroyer Escorts in both the Atlantic and Pacific fleets, earning four battle stars in operations in New Guinea, Borneo, the Philippines, and Okinawa. Hank remained in the Naval Reserve for over 20 years after the war, retiring with the rank of Commander.

He returned to Columbia’s Nevis Cyclotron Labs for the design and construction of what was then the world’s most powerful atom smasher. While there, he earned an MS degree in industrial management as well as a PE license. After completion of the cyclotron, he entered the industry as chief engineer and New York sales manager of a firm in the power press industry. He was recruited by Columbia’s Hudson Labs to conduct oceanographic research, the beginning of a 35-year career in this field. He spent much time at sea aboard the Lab’s four vessels and at field stations on Fire Island, NY; Bermuda; and Puerto Rico. During his 18-plus-year tenure he was awarded many patents and had many papers published covering his development of oceanographic instrumentation, acoustic projectors, and listening systems as well as structures, handling gear, and winches.

Hank pioneered the field of deep-ocean anchoring of ships to hold their positions for acoustic experiments in depths up to 20,000 feet and participated in the development of special winches, cables, and handling gear to accomplish this. He was the point of contact between NOAA (Department of Commerce) and the Oceanographer of the Navy for engineering matters. He was a representative of the Oceanographer on a number of studies conducted by the Marine Board of the National Academy of Engineers and at numerous reviews conducted by the Office of Management & Budget. Hank retired as the Navy’s senior civilian oceanographer in 1985. He always enjoyed travel, visiting over 120 countries and all 50 of the United States. Hank is survived by his wife of 64 years, Gloria (Grano) Beck; his daughter, Dr. Jacqueline Toner; his son, Henry Richard Beck; and three granddaughters.

**1946**

Allan Gabriel Anderson of Vero Beach, FL, passed away peacefully on May 26, 2016, at age 96. Born in Hartford, CT, Allan spent his early years in West Hartford, CT, attending local schools and graduating from Hall High in 1938. After high school, he attended Worcester Polytechnic Institute. Later, he transferred to the Engineering School where he graduated with a BS in chemical engineering in 1946. In 1943, Allan married Shirley Barton. They had three children together. While Allan held a number of senior executive positions with several different companies, he was and had remained, until recently, a very active volunteer. He was a faithful person who was always ready to give his time, talent, and treasure to help those in need. In 1985, he retired from Bath Iron Works in Bath, ME, where he had been working as manager of market planning and development since 1978. He embraced retired life by continuing his volunteer efforts, making a number of new friends and enjoying New England life. In December 1994, his wife, Shirley, passed away. Allan later married Cynthia Bauer and lived in Vero Beach, FL. Cynthia died in April 2014 at the age of 100. He is survived by his three children, Peter Allan Anderson, John Harold Anderson, and Elizabeth Anderson Dailey, along with nine grandchildren and 11 great-grandchildren.

John W. Hoopes Jr. (PhD’51, Chemical Engineering), 94, of Kennett Square, PA, passed away peacefully on June 16, 2016, John, who went by the name Jack, was born in Wilmington, DE, and grew up in Kennett Square. He graduated from Bowdoin College (class of 1943) majoring in physics and from MIT (class of 1944), Phi Beta Kappa, majoring in chemical engineering. He was a member of Tau Beta Pi. Jack then earned a master’s degree (1946) and a PhD in chemical engineering (1951) from the Engineering School. After teaching at SEAS for four years, he took a position at Atlas Powder Co. in his hometown of Wilmington. At Atlas (which eventually became AstraZeneca) Jack rose to director of the chemical engineering department. One of his early achievements was developing sorbitol from sugar. He worked as an engineer for 26 years. After retiring he took a job that he loved, teaching engineering at Widener University in Chester, PA, for 18 years, until he was 79. He was an excellent photographer and loved jazz, sailing, and bulldogs. Jack is survived by his wife, Marjorie Hoopes; daughters Kathryn and Pamela; and four grandchildren.

**1949**

William Joseph Armento (MS, Civil Engineering and Engineering Mechanics) passed away peacefully at home at age 101. Born to Italian immigrants Joseph and Josephine Grassi Armento, Guglielmo (William) Rocco was the third of seven children. Around age 13 he changed his middle name to Joseph, to both honor his father.
and because he did not like the sound of Rocco with his last name. After graduating from Stuyvesant, Bill attended the School of Technology at City College of New York (CCNY) on a New York State Regents Scholarship of $100 per year (a significant sum during the Depression). He graduated cum laude with a BS in engineering and a master’s of civil engineering and received the Engineering Alumni Award “for greatest proficiency in civil engineering of the graduating class of June 1935.” The GI Bill enabled him to earn his MS at Columbia Engineering in 1949.

Bill began his engineering career in New York City, working on projects such as the Henry Hudson and Bronx Whitestone bridges and the East River (now FDR) Drive. He taught engineering classes at both CCNY and Brooklyn Polytechnic Institute (now part of NYU). During World War II he served in the U.S. Navy, achieving the rank of Lieutenant, and taught celestial navigation and salvage diving on the Normandie at Pier 88 in Manhattan. In the 1950s, Bill worked on the Bellevue medical science and hospital buildings and the 60-story Chase Manhattan Bank building, as well as on the Delaware River Bridge. He also contributed to designing the substructures of the Verrazano-Narrows Bridge, linking Staten Island and Brooklyn. A member of Parsons, Brinkerhoff, Quade and Douglas, Bill worked on preliminary designs for the Bay Area Rapid Transit (BART) system and, in 1963, relocated to San Francisco to head the structural department for construction of the system; he settled his family in San Mateo.

Later that decade, he lectured and wrote extensively on this project, including presentations at the University of Naples and the College of Engineering in Milan, Italy; he maintained an interest in the expansion of the BART system over the years. As a specialist in underground structures, Bill traveled and worked on subway projects in Taipei, Singapore, and Caracas, as well as the Metropolitan Atlanta Rapid Transit Authority (MARTA), the Los Angeles Metro Rail project, and the downtown Seattle transit project. A Parsons Brinkerhoff vice president, he did not retire until July 1994. Bill leaves behind Elvina, his wife of 70 years; his daughters Valerie, Anne (Patrick Dunn), Janice (James Scherba), and Lisa Armento; and several grandchildren; as well as his sole surviving sibling, Jill Armento Curran.

1956
Harry M. Spatzer passed away on February 4, 2016, at his home in Glen Mills, PA. He was 91. Harry was a civilian advisor to the U.S. Marine Corps in Vietnam in 1968-1969. Mr. Spatzer was a member of St. Thomas the Apostle Church in Glen Mills, PA. He worked his way through high school and college as a mechanic for Pan Am and TWA. According to his obituary, Harry was the mechanic of choice for Howard Hughes, who became his friend. After achieving his degree in mechanical engineering from Columbia Engineering he joined Boeing, where he spent his entire professional career. Harry was a key member of the engineering team that designed the first Boeing 707. He was a passenger of the first 707 transcontinental flight departing Idlewild Airport on November 1, 1965. In his 30-plus-year career with Boeing, he spent two tours in Vietnam, during the war. He traveled to Afghanistan, Iraq, and Iran. He was the director of Naval Operations for the Boeing Company. After retirement, Harry taught engineering and advanced mathematics at a local college in Delaware County. He and his wife, Jeanne, traveled internationally and enjoyed a full retirement life. They both loved the beach on Long Beach Island, NJ, and spent their summers there. His many interests included stamp collecting, classical music, poetry, and his love of baseball and the New York Yankees. He is survived by his wife, Jeanne Spatzer; four children; his stepson; 10 grandchildren; and eight great-grandchildren.

1966
Rafik R. Habra (MS’67, Electrical Engineering) passed away after a long illness on April 29, 2016, at his home in Stamford, CT. He was 70. Rafik was born in Jaffa, Palestine, and spent his childhood in Cairo, Egypt, and later moved to Beirut, Lebanon. He graduated from SEAS with an MS in electrical engineering. Rafik married the former Karen Rueger on July 5, 1970, at St. Mary’s Church in Wappingers Falls, NY. Rafik began his career with IBM at their East Fishkill location in 1967 and in 1997 transferred to the IBM Almaden Research Center in San Jose, CA. He retired in 2002 after receiving numerous awards including an IBM Corporate Award for his work on interactive wiring as well as a U.S. patent. After retirement, he tutored in French, Arabic, and mathematics. Rafik was generous, kind, and very fond of classical music. He enjoyed reading, travel, and special times with his extended family. In addition to his wife, Karen Habra, he is survived by his daughters, Elise and Christine Carbonetti.

1968
Arthur (Art) Irving Casabianca, age 69, of Annandale, VA, died suddenly at his home on May 3, 2016. A native of New York City, Art was a graduate of the Bronx High School of Science. After graduating from Columbia Engineering, he worked as a civil engineer and later as a training consultant for government and private agencies, before retiring to start his own consulting business in 1996. Art was a loving and devoted father. In his spare time, he collected vintage cars, coins, and model trains. He is survived by daughters Leah B. Casabianca and Julia A. Casabianca. He is also survived by cousins Shelley Amdur (John Carlson), Cindy Amdur (Fred Clark), and Steven Kaufman (Barrie Keller) and their families.

OTHER DEATHS REPORTED
We also have learned of the passing of the following alumni and friends of the School:

Ervin M. Bradburd BS’41, MS’43
George O. Curme III BS’43
Walter Edwin Buch BS’45
Joseph Clifford “Cliff” DeAnna BS’45, ’46CC
Robert B. Kollmar BS’45, MS’47, ’46CC
Michael T. Gasparik BS’48
John M. Verdi MS’49
Nathan Boileau Marble IV BS’51, MS’52
Denison P. Diebolt BS’56
Irving Hirschberg MS’56
William (Bill) Mosberg BS’56
Robert K. Vander Yacht MS’56
Kenneth Alan Bodenstein BS’58, ’57CC, ’60BU5
Jerry R. Peterson MS’60, EngScD’64
Alfredo Antonio Castro-Bassi MS’62, EngScD’66
Harshkumar C. Desai MS’66
Ardeshir Rostami MS’69
Alan P. Zabarsky MS’72
Costas D. Varmazis EngScD’74

FRIENDS
Edward C. Kalaidjian ’42CC, ’45LAW
June R. Stuhler
Jeff Franklin BS’68 credits Columbia Engineering with many things: an education, a vocation, and a network of friendships stretching back 50 years. And that gratitude is what inspired him and his wife, Linda, to give back, with the creation last year of the Jeffrey and Linda Franklin Scholarship Fund.

“I truly believe that the Engineering School, and the things that happened both before and after graduation, set my career on the path that it took,” he said. “And so it really became a desire on my and Linda’s part to pay it back.”

Franklin graduated with a bachelor’s degree in chemical engineering in 1968. He and his chemical engineering classmates were the last of the Engineering School’s students to attend a five-week academic program at Camp Columbia, in rural Connecticut near Bantam Lake. The experience created a certain closeness among this group, as evidenced by the two or three dinner get-togethers that they have had, and continue to have, virtually every year since graduation.

Camp Columbia alumni—called “Owls”—used to hold annual reunion events, at the Camp, for past attendees. It was at the annual reunion in the summer of 1971 that Jeff met fellow alumnus Ken Harris BS’64, who invited him to apply for a position working for the City of New York under Mayor John Lindsay. That meeting—and the subsequent internal management consulting position in the city’s welfare department—gave him a completely new outlook on, and greater appreciation for the value and broad applicability of, the undergraduate engineering education, he said.

“It changed my vision of what a Columbia engineer could do,” he added.

After 12 years in management consulting, including positions at Citibank and City Investing, Franklin pivoted again, channeling his passion for personal finance into a new career as a certified financial planner, and founder and owner of Life and Wealth Planning, LLC, a job he’d hold for the next 31 years.

“I enjoyed it more than I can express,” he said. “The interaction with people and the ability to help clients by educating them so that they can take control of their own personal finances—it all was absolutely wonderful.”

After selling his firm in 2013, Jeff has devoted himself to studying, and educating others about another passion: wine.

“I do it on a part-time basis,” he remarked. “My feeling is, I don’t want to be a full-time anything anymore. I think I’ve earned the right to wake up late.”

The Jeffrey and Linda Franklin Scholarship Fund supported its first student last year, and the Franklins have ambitious goals to create between five and eight such scholarships, all of which will be fully endowed through their estate plan.

By planning their future giving now, the Franklins are able to consider a gift that will have a transformational impact on Columbia Engineering’s undergraduate financial aid program.

“I never would have been able to attend Columbia without the full-tuition scholarship that I received,” Franklin noted. “There will be people who are able to attend Columbia through our giving, and maybe one or two or three of them will do something similar to what we’re trying to do and expand on it and keep that spirit and goodwill going.”

Linda Franklin said discovering that they could create a scholarship fund now—then fully endow it later through their estate—made the decision easy.

“Originally when we were doing our estate planning, I was joking—or maybe not—saying, ‘It really is too bad that we’ll be dead, and we’ll never know who these young people who will receive the scholarships are.’” Linda Franklin remarked. “So we thought, why don’t we do something while we’re alive and with our eyes open?”

“This year we went to our first scholarship dinner and met the young woman who received our first scholarship,” Jeff Franklin said. “We have no children of our own, so it was great to see in person the people who are benefiting by what we’re doing. If you’re a parent, you see these benefits in real time, so finding out we could do that as well was very attractive to us.”

By Jennifer Ernst Beaudry
LET’S COME TOGETHER TO CHANGE LIVES THAT CHANGE THE WORLD

OCTOBER 26

Discover all the new ways you can give through Columbia. Join us on Columbia Giving Day.

GIVINGDAY.COLUMBIA.EDU
Local high school students learned how to design, prototype, and test a biomedical device as part of Hk Maker Lab, a six-week summer program, now in its third year. The program is a partnership with Harlem Biospace, HYPOTHÉsис, Teachers College, and Columbia Engineering. (Photo by Timothy Lee Photographers)