Shaping Cities for People and the Planet

As Professor Elie Bou-Zeid eloquently explains on page 14 of this magazine, the way we build and reshape urban areas over the coming decades will determine a lot about the long-term health of society and this planet.

No small task, but Princeton excels at this kind of grand challenge. The future of cities is a complex mix of societal, technological, environmental, economic, and ethical questions, and Princeton is well equipped to knit creative, effective solutions. More generally, the Metropolis Project that Elie introduces is just one example of the high-impact work and focus on societal benefit at the School of Engineering and Applied Science. We have tremendous momentum and growth in data science, bioengineering, and robotics and cyber-physical systems, as well as in advancing the overall diversity and inclusion of the school.

All this work brings together two distinctive strengths of Princeton engineers: a culture of fluidly integrating diverse viewpoints and disciplines, and the ability to distill problems to their core constraints, then develop solutions with widespread impacts.

I welcome your comments, questions, and personal stories of engineering in the service of society.

H. Vincent Poor *77
Interim Dean
Michael Henry Strater University
Professor of Electrical Engineering
Emily A. Carter, dean of Princeton University’s School of Engineering and Applied Science, became the executive vice chancellor and provost of the University of California, Los Angeles, on Sept. 1, 2019.

H. Vincent Poor, the Michael Henry Strater University Professor of Electrical Engineering who served as dean from 2006 to 2016, is serving as interim dean as a search for Carter’s successor proceeds.

Carter, who was the founding director of the Andlinger Center for Energy and the Environment for six years before becoming dean of engineering in July 2016, championed an important set of initiatives, including planning for a new campus neighborhood for engineering; a new first-year curriculum; growth of research and teaching in data science, bioengineering, robotics, and the future of cities; and multiple resources to strengthen diversity and inclusion across faculty, staff, and students.

“Emily Carter has made extraordinary contributions to Princeton as a scientist, mentor, center director, and dean,” said Christopher L. Eisgruber, president of Princeton University. “She is a distinguished leader and brilliant scholar with heartfelt commitments to academic excellence, diversity, and the environment. Though we will miss having Emily as our colleague at Princeton, we look forward to applauding her accomplishments as she returns to UCLA.”

At UCLA, where she was a faculty member for 16 years before joining the Princeton faculty in 2004, Carter serves as the university’s second-ranking officer and as the chief operating and academic officer. The position calls for “bringing broad vision and executive leadership to campus-wide policy, planning, initiatives, and operations.”

“Working with so many dedicated and extraordinarily talented colleagues at Princeton, as well as passionately supportive alumni, has been an honor and privilege,” Carter said. “With their shared vision and momentum, the School of Engineering and Applied Science will continue to grow in serving humanity through innovation and generations of amazing students.” –Steven Schultz
A NEW HOME FOR COMPUTER SCIENCE

GIFT FROM ERIC AND WENDY SCHMIDT TO CREATE

Historic Guyot Hall will be substantially rebuilt and expanded to create a new home for Princeton’s Department of Computer Science, thanks to a gift from Eric Schmidt ’76 and his wife, Wendy Schmidt. Planned for completion in 2026, the building will be renamed as the Eric and Wendy Schmidt Hall and will consoli- date the computer science department — which is currently spread out over nine differ- ent buildings — into one purpose-built space.

“Eric Schmidt’s brilliant career as a com- puter scientist makes the Schmidt name es- pecially fitting for the new home of Princeton’s world-class Department of Computer Science,” said President Christopher L. Eisgruber. “We are deeply grateful to Eric Schmidt ’76, his wife, Wendy Schmidt, and Schmidt Futures for their visionary gift and generosity. Their extraordinary commitments to this new facility, to the Schmidt DataX Fund, and to the Schmidt Transformative Technology Fund have powerfully enhanced Princeton’s capacity for teaching, innovation, and collaboration that open new frontiers of learning and improve the world.”

Earlier this year, the University announced the gift establishing the Schmidt DataX Fund, which will advance the breadth and depth of data science impact on campus, acceler- ate discovery in three large, interdisciplinary research efforts, and create opportunities to educate, train, convene, and support a broad data science community at the University. Additionally, in 2009 the Schmidts established Eric and Wendy Schmidt Transformative Technology Fund, an endowment which sup- ports the invention, development, and utiliza- tion of cutting-edge technology that has the capacity to transform research in the natural sciences and engineering at Princeton.

Eric Schmidt was formerly chief executive officer of Google from 2001 to 2011 and since then serves as executive chairman of Alphabet and Google’s parent company. He has also previ- ously served as a trustee of the University. Wendy Schmidt is a businesswoman and philanthropist. She is the president of The Schmidt Family Foundation and co-founder of Schmidt Ocean Institute.

Eric Schmidt noted that when he earned his undergraduate degree from Princeton in 1976, “I majored in electrical engineering, be- cause computer science was barely an option. Now it’s the largest department at Princeton and its data science has the potential to trans- form every discipline, and find solutions to profound societal problems. Wendy and I are excited to think about what will be possible when Princeton is able to gather students and faculty in one place, right at the center of cam- pus, to discover now-unimaginable solutions for the future century.”

Stu Feldman ’68, Schmidt Futures chief scientist, said “Princeton University’s computer science department is already one of the best in the world, and with this beautiful and larger purpose-built space, it is exciting to imagine how its stature will continue to grow.”

Princeton’s computer science department has grown to become the largest undergradu- ate major at the University, with approximately 25% of students majoring or earning a certifi- cate in the discipline. A record 60% of under- graduates enroll in COS126, the introductory computer science course, and the University will have 44 tenure-track computer science faculty members in the fall semester of 2019.

More than 36% of the department’s under- graduate majors are women, about double the national average.

“Princeton recognizes that computational thinking as a mode of scholarship, inquiry, and critical thinking is essential across campus,” said Jennifer Rexford ’91, the Gordon S. Wu Professor of Engineering and chair of Princeton’s computer science department. “We are deeply grateful for Eric and Wendy Schmidt’s gift, which makes it possible to have a central location for computer science in which we can create intellectual collisions and serendipitous encounters between faculty and among students, creating human connec- tions that spark new ideas across campus and beyond.”

Guyot Hall was built in 1909, and was named for Princeton’s first professor of geography and geography, Arnold Guyot, a member of the faculty from 1854 to 1884. The building’s construction was supported with proceeds from gifts made to Princeton by Cleveland H. Dodge 1879 and his mother to benefit the University’s programs in geography and biology.

Renovations will preserve the original collegiate Gothic architectural details of the building’s exterior, and the Guyot name will be recognized in a new built space located elsewhere on campus which will be associ- ated with Princeton’s environmental science programs. The Schmidts’ gift will come to Princeton from the Schwab Charitable Fund.

The renovation of Guyot Hall will increase the square feet assigned to the computer sci- ence department and will also build capacity for future growth of the department’s faculty and student body. During renovation of Guyot, the University will provide additional interim space in the Friend Center for the depart- ment. Construction is planned to begin in early 2024, with the computer science department projected to move into the renovated building in mid-2026.

COMPUTER SCIENTIST KERNIGHAN *69 ELECTED TO AMERICAN ACADEMY OF ARTS AND SCIENCES

Brian Kernighan ’69, a pioneer of early programming languages and software tools and a scholar known for distilling and clarify- ing complex technical subjects, has been elected to the American Academy of Arts and Sciences. A professor of computer science, Kernighan is among five Princeton faculty members, a visiting professor, and six alumni joining the academy this year.

Kernighan’s work focuses on programming, software tools, application-oriented languages, and technology education. He is the author of a series of books that have become known for clarity and precision. Among them are “The C Programming Language” (Prentice Hall, 1978), written with Dennis Ritchie. The book, known among programmers as “K&R,” is a funda- mental text on the language. His most recent books include “Millions, Billions, Zillions” (Princeton University Press, 2018) and “Understanding the Digital World” (Princeton University Press, 2017).

Kernighan received his master’s and doctoral degrees in electrical engineering from Princeton. He worked at Bell Labs for 30 years before joining the Princeton faculty in 2002. Among other honors, he is a recipient of the USENIX Association Lifetime Achieve- ment Award and is a member of the National Academy of Engineering.
ANTS’ SURVIVAL STRATEGY COULD AID LEADERLESS GROUP ROBOTICS

Ants’ frenzied movements may seem aimless and erratic to a casual observer, but closer study reveals that an ant colony’s collective behavior can help it thrive in a harsh environment—and may also yield inspiration for robotic systems.

In a new analysis, Princeton researchers created a mathematical model to explain how desert harvester ants collectively weigh the cost of losing water while foraging against the benefit of bringing in more food. The model is a tool for investigating how ant colonies respond to a changing environment, and how behavioral differences among colonies affect their long-term survival and reproductive success. The team published their results in the journal PLoS Computational Biology.

Professor Naomi Ehrich Leonard ’85, the study’s senior author, has previously analyzed the dynamics of bird flocks and fish schools to understand how large groups can operate efficiently without central control. Insights gained from these natural systems can help in the design of robot teams to carry out search and rescue missions or take measurements of environments inaccessible to humans.

–Molly Sharfach

GOOGLE AI LAB BOLSTERS INNOVATION AND INVENTION

Two Princeton University computer science professors are leading a new Google AI lab that is located in the town of Princeton and which officially launched in May.

The lab, at 1 Palmer Square, is already playing a vital role in expanding New Jersey’s innovation ecosystem by building a collaborative effort to advance research in artificial intelligence. The lab builds on several years of close collaboration between Google and professors of computer science Elad Hazan and Yoram Singer, who will split their time working for Google and Princeton. The work at the lab includes a small number of faculty members, graduate and undergraduate student researchers, recent graduates, and software engineers.

“We are thrilled that Google is in Princeton,” President Christopher L. Eisgruber said in celebrating the new lab at an event that was also attended by former chairman and current CEO of Google Eric Schmidt ’76 and New Jersey Governor Phil Murphy. “By bringing together talented researchers from Princeton and Google, and by giving them access to Google’s exceptional computing resources, this collaboration promises to deepen our understanding of machine learning and produce exciting innovations,” Eisgruber said.

–Liz Fuller-Wright

ARTIFICIAL INTELLIGENCE DETECTS A NEW CLASS OF MUTATIONS BEHIND AUTISM

Many mutations in DNA that contribute to disease are not in actual genes, but instead lie in the 99% of the genome once considered “junk.” Even though scientists have recently come to understand that these vast stretches of DNA do in fact play critical roles, deciphering these effects on a wide scale has been impossible until now.

Using artificial intelligence, a Princeton-led team has decoded the functional impact of such mutations in people with autism. The researchers believe this powerful method is generally applicable to discovering such genetic contributions to any disease.

Publishing in the journal Nature Genetics, the researchers analyzed the genomes of 1,790 families in which one child has autism spectrum disorder. The approach allowed the team to rule out other members do not. The method sorted among 120,000 mutations to find those that affect the behavior of genes in people with autism. Although the results do not reveal exact causes of cases of autism, they reveal thousands of possible contributors for researchers to study.

Much previous research has focused on identifying mutations in genes themselves. Genes are essentially instructions for making the many proteins that build and control the body. Mutations in genes result in mutated proteins whose functions are disrupted. Other types of mutations, however, disrupt how genes are regulated. Mutations in these areas affect not what genes make, but when and how much they make.

Until now, it was not possible to look across the entire genome for snippets of DNA that regulate genes and predict how mutations in this regulatory DNA are likely to contribute to complex disease, the researchers said. The This study is the first proof that mutations in regulatory DNA can cause a complex disease.

“This method provides a framework for doing this analysis with any disease,” said Olga Troyanskaya, professor of computer science and genomics and a senior author of the study. The approach could be particularly helpful for neurological disorders, cancer, heart disease, and many other conditions that have eluded efforts to identify genetic causes.

“This transforms the way we need to think about the possible causes of those diseases,” said Troyanskaya, who also is deputy director for genomics at the Simons Foundation’s Flatiron Institute in New York, where she led a group of co-authors.

–Steven Schultz

Genes predicted to be disrupted by regulatory mutations in people with autism tend to be involved in brain cell functioning and fall into two categories. One category (shown in red) relates to synapses, communication hubs between neurons, and the other (shown in blue) relates to chromatin, the highly structured form of DNA and proteins required for proper gene expression in chromosomes.
SUNLIGHT PULLS HYDROGEN FROM WASTEWATER

Hydrogen is a critical component in the manufacture of thousands of common products from plastic to fertilizers, but producing pure hydrogen is expensive and energy intensive. Now, a research team at Princeton has harnessed sunlight to isolate hydrogen from industrial wastewater.

In a paper published in the journal *Energy & Environmental Science*, the researchers reported that their process doubled the currently accepted rate for scalable technologies that produce hydrogen by splitting water. The technique uses a specially designed chamber with a “Swiss cheese” black silicon interface to split water and isolate hydrogen gas. The process is aided by bacteria that generate electrical current when consuming organic matter in the wastewater; the current, in turn, aids the water-splitting process.

The team, led by Zhiyong (Jason) Ren, professor of civil and environmental engineering and the Andlinger Center for Energy and the Environment, chose wastewater from breweries for the test. They ran the wastewater through the chamber, used a lamp to simulate sunlight, and watched the organic compounds break down and the hydrogen bubble up.

The process “allows us to treat wastewater and simultaneously generate fuels,” said Jing Gu, a co-researcher and assistant professor of chemistry and biochemistry at San Diego State University.

The researchers said the technology could appeal to refineries and chemical plants, which typically produce their own hydrogen from fossil fuels, and face high costs for cleaning wastewater.

Historically, hydrogen production has relied on oil, gas, or coal, and an energy-intensive method that involves processing the hydrocarbon stock with steam. Chemical manufacturers then combine the hydrogen gas with carbon or nitrogen to create high-value chemicals, such as methanol and ammonia. The two are ingredients in synthetic fibers, fertilizer, plastics, and cleaning products, among other everyday goods.

Although hydrogen can be used as a vehicle fuel, the chemical industry is currently the largest producer and consumer of hydrogen. Producing chemicals in highly industrialized countries requires more energy than producing iron, steel, metals, and food, according to a 2016 report from the U.S. Energy Information Administration. The report estimates that producing basic chemicals requires more energy than producing iron, steel, metals, and food.

On Alcatraz, the students saw the microgrid that powers the island, composed of solar panels and batteries. The ability to use solar energy to support most of the island’s operations, despite periodic cloudiness and nightly darkness, reflects decades of improvements in battery cost and technology, said Darren Hammell ’01, the president and CEO of Princeton Power Systems. Hammell taught the course as part of his tenure as a Gerhard R. Andlinger Visiting Fellow in Energy and the Environment. Hammell had behind-the-scenes access to the Alcatraz power systems because his company built and deployed the island’s microgrid. He founded Princeton Power Systems field operator and a National Park Service ranger with Darren Hammell, CEO of Princeton Power Systems who teaches the course, and Princeton graduate student Isla (Xi) Han, along the rooftop of the historic prison on Alcatraz Island.

The trip took students to the front lines of Silicon Valley, from startups and incubators to multi-million-dollar solar and battery companies, including Tesla and SunRun, to see up close how entrepreneurs are commercializing new energy technologies.

Through case studies on existing companies and via collaborative discussions and presentations on company business models, the students learned many factors that affect how a technology is scaled up. The trip allowed students to use that knowledge in conversations with company executives.

“As we were able to ask them questions about why they made certain decisions,” said Erin Redding, a senior in the Woodrow Wilson School of Public and International Affairs. “That was really cool to be able to go from a class project to actually applying that knowledge in conversations with a CEO of a startup.” —Molly Seltzer
A commercial fluorescence-based biosensor typically carries an array of classical optical components including multiple filter sets, lenses, and gratings. The more sensitive the system is, the more expensive and bulky the setup.

The researchers found that tiny metal layers already built into modern microchips can relatively easily be adapted to take advantage of light’s unusual behavior when interacting with structures smaller than a single wavelength of light. Harnessing the light in this way allows for detection of thousands of biological substances, from bacterial DNA to hormones. And because modern microchips are already designed to be extremely small, these structures can be made using standard manufacturing techniques, Sengupta said.

“As a result, the new system is small enough that you could start thinking about putting it in a pill,” he said. “But if you want the system to be small, the more complex and bulky optical instrumentation employed in diagnostic labs. As a result, the new system is almost as small as a grain of salt, and far less costly to manufacture than current diagnostic systems.”

In a study with implications for efforts to halt the spread of antibiotic-resistant bacteria, researchers at Princeton have identified a new, troubling path that some bacteria take toward resistance.

“Our study has demonstrated that persister bacteria can add substantially to the risk that antibiotic-resistant mutants will arise,” said Mark Brynildsen, an associate professor of chemical and biological engineering at Princeton and the study’s senior author. “We’ve known that because they survive the first wave of treatment, persisters can cause chronic infections. But their role in promoting drug resistance is an unexpected and troubling finding.”

To help slow the emergence of lethal superbugs, clinicians and pharmacologists will need to adopt new therapeutic tactics against persisters. “Our study offers compelling data that when treating bacterial populations, we have to get rid of the persisters,” said Brynildsen. “–Adam Hadhazy
OPTIMIZING OPERATIONS FOR AN UNPRECEDENTED VIEW OF THE UNIVERSE

Under construction on a remote ridge in the Chilean Andes, the Large Synoptic Survey Telescope (LSST) will boast the world’s largest digital camera, helping researchers detect objects at the solar system’s edge and gain insights into the structure of our galaxy and the nature of dark energy. This extraordinary power is attracting some of the world’s top astronomers, each with their own observational needs and timescales and all contending with sporadic cloud cover and other variable conditions. In short, a major scheduling challenge.

An automated telescope scheduler developed by researchers at Princeton and the University of Washington aims to maximize the LSST’s efficiency over the span of its operation, currently planned for 10 years beginning in 2023. The team includes Elahesadat Naghib ’19, who earned a Ph.D. in Princeton’s Department of Operations Research and Financial Engineering, and Professor Robert Vanderbei.

The scheduler will collect real-time data on factors including cloud cover, sky brightness, and astronomical “seeing” — the amount of star twirling caused by Earth’s atmosphere, which can affect the resolution of telescope images. While cloud cover is relatively rare at the LSST site in the Atacama Desert, one of the driest places on Earth, clouds are still a concern for the telescope’s operation. At each moment of the night, these measurements will help a decision-making algorithm determine where in the sky the telescope should point and which filter it should use to capture an image. The LSST will use six filters that allow the transmission of different wavelengths of light, ranging from ultraviolet to near-infrared. The light spectra emitted by astronomical features such as supernovae or exploding stars, can reveal key information about their origins and chemical composition.

“Because we’re making a real-time decision, the LSST can actually evaluate the clouds and be able to keep observing, whereas [with previous telescope algorithms] they would have to shut down the whole observatory when the night was cloudy,” said Naghib.

In addition to accounting for weather and other variable conditions, the scheduler incorporates information about the length of time required for the telescope to rotate from one field of view to another. Optimizing the efficiency of these movements is particularly important for the LSST because it will change positions faster than previous telescopes, and therefore make more observations in a given time. Each night, the scheduler will prioritize points of the sky not observed during the previous night, enabling the telescope to observe the entire southern sky every three nights.

“One of the challenges in this project is that different regions of the sky have different constraints and different objectives, and we have to respect all of those based on what they require,” explained Naghib, who spent a semester working with astronomers at the University of Washington to refine the scheduler’s functions. —Molly Sharlach

Atomic interactions in everyday solids and liquids are so complex that some materials’ properties continue to elude physicists understanding. Solving the problems mathematically is beyond modern computers, so scientists at Princeton have turned to an unusual branch of geometry.

Researchers led by Andrew Houck ’00, a professor of electrical engineering, built an electronic array on a microchip that simulates particle interactions in a hyperbolic plane, a geometric surface in which space curves away from itself at every point. It is difficult to envision — the artist M.C. Escher used hyperbolic geometry in many of his mind-bending pieces — but perfect for answering questions about quantum interactions, which govern the behavior of atomic and subatomic particles.

The researchers used superconducting circuits to create a lattice that functions as a hyperbolic space. By introducing photons into the lattice, researchers can answer a wide range of difficult questions by observing the photons’ interactions.

“You can throw particles together, turn on a very controlled amount of interaction between them, and see the complexity emerge,” said Houck.

Alicia Koliar ’10, a postdoctoral research associate at the Princeton Center for Complex Materials and the lead author of the study published in Nature, said the goal is to allow researchers to address complex questions that are very difficult to solve with computer models.

“We’re trying to implement a model at the hardware level so that nature does the hard part of the computation for you,” Koliar said. —Molly Sharlach
PRINCETON RESEARCHERS DEVELOPED A MATHEMATICAL ANALYSIS OF DANCERS’ DECISIONS IN THE RULE-BASED IMPROVISATIONAL WORK “THERE MIGHT BE OTHERS.” THE DANCE GROUP IMPROVISES FROM A REPertoire OF POSSIBLE MOVEMENTS, THE DYNAMICS OF THE ARTISTIC DECISIONS BECOME EVEN MORE COMPLEX.

A team led by Nazemi Erhich Leonard ’85 investigates collective behavior in nature and art to inform the design of control systems for robot teams operating in challenging environments. Leonard, the Edwin S. Wilsey Professor of Mechanical and Aerospace Engineering, is the senior author of a recent mathematical analysis of dancers’ decisions and opportunities for collaborative composition in the rule-based improvisational work “There Might Be Others,” choreographed by Rebecca Lazier, a senior lecturer in dance in the Lewis Center for the Arts. In the piece, dancers make sequential choices among 44 movement modules inspired by a variety of dance styles. Performance rules guide and constrain when, where, and how the dancers perform the sequence of modules. Professor of Music Dan Trueman *99 composed accompanying music that also relies on rules and improvisation.

“The dancers were incredible to work with,” said Leonard. “They could express the way it made them feel when our manipulations of the rules gave them 200 ideas. We learned new ways in which we could impose constraints on the dancers that would make the art more challenging, and therefore more interesting and more exciting.” –Molly Sharlach

CONFERENCE EMPHASIZES WIDE IMPACTS OF GROWING CITIES

Any attempt to address challenges of the future, from clean energy to a sufficient food supply, must grapple with the issues raised by the planet’s rapidly growing cities, speakers said during a May 6 conference at Princeton.

“We believe that the future of cities is the future of the planet,” Emily Carter, then dean of engineering, said in her opening address in the Friend Center lecture hall.

Emphasizing the New York-Philadelphia corridor’s strong innovation ecosystem, the conference, called Building the Future: New Technological Frontiers in Cities, brought together representatives from academia, industry, and government to discuss research and policies. Princeton led coordination of the conference with Rutgers University, the College of New Jersey, the New Jersey Institute of Technology, and Stevens Institute of Technology. Twenty-three regional and national firms described technological innovations during a corporate session; and 16 city governments, state offices, and planning organizations highlighted municipal needs and issues. The conference also offered a panel discussion with three mayors moderated by Beth Simone Novack, New Jersey’s chief innovation officer.

The conference highlighted Princeton’s new Metropolis Project, which supports research into systems and technologies that will help make cities more sustainable, resilient, livable, and equitable. Speakers said that as the world population continues to urbanize, ways in which cities cope with that growth will be among the most critical decisions facing global leaders.

“We are going to be, by and large, an urban species,” said Elie Bou-Zeid, a professor of civil and environmental engineering, and Foundation Relations and The Metropolis Project, which supports research into systems and technologies that will help make cities more sustainable, resilient, livable, and equitable.

“The conference was organized by Princeton’s Office of Corporate Engagement and Foundation Relations and the Metropolis Project, with support from Lyft. The participating institutions have since formed a working group to seed further research.” –Amelia Herb and John Sullivan
Elie Bou-Zeid’s research uses mobile sensors such as the vehicle-mounted Mobile Urban Sensing Technology (MUST) to gather data about urban environments. The research team includes (from left) Hamidreza Omidvar ’19, Einara Zahn, Bou-Zeid, and Maider Llaguno.

In the following pages, we survey how research of Princeton faculty, students, and postdocs is enabling a better urban future. In the wired city, we consider the important role of new hardware, software, and information networks in collecting and analyzing data and creating knowledge. The sustainable city showcases innovative building blocks of the metropolis such as new materials, structures, and systems. The built city then looks at the larger scale, considering how buildings can be better designed and monitored and evaluating the risks cities incur from natural hazards such as flooding. The livable city surveys sensor technologies and models to monitor and improve urban environmental quality. Finally, the moving city delves into critical and rapid shifts in transportation technology and patterns in the modern metropolis. These are but a few samples of how Princeton researchers work daily to shape a better urban future.

Elie Bou-Zeid is a professor of civil and environmental engineering and the director of the Program in Environmental Engineering and Water Resources.
In cities of the future, infrastructure will be electronic as well as physical. The sensors and networks that support business, leisure, and everyday life will face much greater demand and scope.

**THE WIRED CITY**

**Wireless networks and energy systems**
To support the information infrastructure of the future, cities will need wireless systems, including emerging 5G networks that can accommodate traffic from a multitude of smart devices and sensors, and enable the exploding capacity demands of urban communications.

**Jennifer Rexford ’91**
Gordon Y.S. Wu Professor in Engineering

**Networks, internet measuring**
Rexford is among Princeton researchers who work on measuring and managing information superhighways by giving networks the ability to self-monitor and adapt to traffic in real time.

**Naveen Verma**
Professor of Electrical Engineering

**Application-driven circuits**
In cities of the future, the most pedestrian elements such as walls, floors, and other surfaces will be self-assessing and self-monitoring. Sensors developed at Princeton Engineering can detect structural damage or chemical changes in the environment, or monitor the activities happening in a space.

**Forrest Meggers**
Assistant Professor of Architecture and the Andlinger Center for Energy and the Environment

**Building systems design and integration, thermodynamics of the urban environment**
Engineering researchers are designing low-energy building systems to harness geo-thermal power and heat transfer to make buildings more sustainable, comfortable, and efficient.

**Yueh-Lin (Lynn) Loo ’01**
Director, Andlinger Center for Energy and the Environment

**Complex materials and thin-film electronics**
Princeton researchers are working to create technology that allows buildings to adapt to their occupants’ needs. Devices such as smart windows developed by Loo regulate how much sunlight and solar heat enters the building to improve occupants’ comfort and reduce heating, cooling, and lighting needs.

**Sigrid Adriaenssens**
Associate Professor of Civil and Environmental Engineering

**Engineering design framework for the future urban environment**
Cities of the future will become increasingly dense, which necessitates highly efficient design. Princeton engineers are rethinking fundamental approaches to structures such as Adriaenssens’ ultra-lightweight long-span bridges and buildings, which require a minimum of anchor points.

**Claire White**
Associate Professor of Civil and Environmental Engineering and the Andlinger Center for Energy and the Environment

**Sustainable cement**
Expanding cities will mean even greater use of concrete — a major source of greenhouse gas emissions — for buildings, sidewalks, and roads. Researchers at Princeton are working to make concrete more sustainable by replacing conventional cement with lower-energy alternatives including industrial byproducts and processed minerals, together with routes to permanently encapsulate carbon dioxide.
Structures are cities’ building blocks, and as cities grow and change, the role of structures must change as well. In some cases, it means protecting and modifying existing buildings; in others, it means designing new structures to meet emerging needs.

**THE BUILT CITY**

**James Smith**
William and Edna MacAleer Professor of Engineering and Applied Science

Hydrometeorology, flooding and the hydrologic cycle
Climate change is predicted to worsen flooding that threatens urban systems. Researchers at Princeton use advanced techniques to measure rainfall, gauge atmospheric conditions, and understand the physics of extreme flooding to protect people and cities.

**Maria E. Moreyra Garlock**
Professor of Civil and Environmental Engineering

Creative and resilient urban engineering
Future coastlines will become increasingly urbanized, while simultaneously being threatened by rising sea levels and other coastal environmental hazards. Princeton researchers are studying novel building techniques such as elegant thin-shell concrete structures that can withstand these changes.

**Branko Glišić**
Associate Professor of Civil and Environmental Engineering

Structural health monitoring
New construction techniques are important, but it is estimated that roughly half the buildings that will make up cities in 2050 are already standing today. Princeton researchers are developing techniques to monitor the structural integrity of buildings and infrastructure to signal needed repairs before they become emergencies.

**Denise Mauzerall**
Professor of Civil and Environmental Engineering and Public and International Affairs

Air quality policy
Princeton researchers analyze model results on strategies to reduce air pollution and greenhouse gas emissions around the world. They evaluate the co-benefits of emission reductions for human health, food security, solar electricity generation, and climate change in order to inform productive, far-sighted environmental policies.

**Mark Zondlo**
Associate Professor of Civil and Environmental Engineering

Atmospheric chemistry and composition
Mobile sensors attached to airplanes or vehicles, combined with sophisticated modeling, allow researchers to identify the emissions of air pollutants and greenhouse gases, thereby helping to improve air quality and the climatic footprints of urban and global environments.

**Gerard Wysocki**
Associate Professor of Electrical Engineering

Laser-based systems for chemical sensing
Princeton researchers are developing techniques to detect chemical threats to urban environments using sophisticated lasers and sensing systems that offer fast, compact, highly sensitive, and selective detection of airborne molecules.

**Gerard Wysocki**
(Lypsy pictured at right)

**Mark Zondlo**

Photo by G. Brad Lewis

**Denise Mauzerall**

Photo by Frank Wojciechowski

**THE LIVABLE CITY**

As humanity becomes more urbanized, maintaining health and happiness in crowded environments becomes critical. Clean air, clean water, and efficient transit systems are essential parts of the solution.

**James Smith**

**Maria E. Moreyra Garlock**

**Branko Glišić**

**Denise Mauzerall**

**Mark Zondlo**

**Gerard Wysocki**

**Mark Zondlo**

Photo by G. Brad Lewis

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(Lypsy pictured at right)

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**Gerard Wysocki**

Associate Professor of Electrical Engineering

(Lypsy pictured at right)

**Laser-based systems for chemical sensing**
Princeton researchers are developing techniques to detect chemical threats to urban environments using sophisticated lasers and sensing systems that offer fast, compact, highly sensitive, and selective detection of airborne molecules.
Transportation into, out of, and within cities has been one of the key enablers of urban growth. As cities grow larger and more complex, ensuring that people, goods, and information flow smoothly will become all the more important.

Optimization under uncertainty
Princeton researchers across a range of disciplines work to optimize systems from power grids to transportation networks to ensure that increasingly complex cities will run smoothly despite often-incomplete information.

Transportation
In future cities, smart-driving, on-demand car fleets have the potential to make transportation safer, more efficient, and more eco-friendly as well as more accessible to older adults and people with disabilities.

Alternative fuels and low-carbon energy conversion
In addition to needing better materials for storing energy in batteries, vehicles of the future will require low-carbon bio-derived liquid fuels that are greener and more efficient alternatives to conventional fossil fuels.

As a microcosm of the challenges facing coastal cities around the world, New York’s Jamaica Bay pretty much has it all.

Home to about 3 million people, one of the world’s busiest airports, and sensitive coastal ecosystems, Jamaica Bay is a lagoon bordered by Brooklyn and Queens at the southwestern edge of Long Island. This region is vulnerable to an evolving set of threats, including sea-level rise, increasingly intense storms, and shifting rainfall patterns.

This complexity makes it a perfect place to apply the cross-disciplinary approach that a team of Princeton University researchers is bringing to improving the resilience of New York and other coastal cities. Culminating years of research funded by the National Science Foundation and supported by the Princeton Environmental Institute, the Princeton team recently published a 170-page report that details existing conditions, analyzes climate and sea-level trends, and proposes solutions to protect Jamaica Bay’s neighborhoods, infrastructure, and ecology.

“We are exploring ways to build resilience that is multilayered and multifaceted,” said Guy Nordenson, professor of architecture and affiliated member of the Department of Civil and Environmental Engineering. Along with Nordenson, principal collaborators at Princeton include Ning Lin ’10, associate professor of civil and environmental engineering, and Michael Oppenheimer, the Albert G. Milbank Professor of Geosciences and International Affairs and the Princeton Environmental Institute.

In the Jamaica Bay report, the authors propose a two-tiered set of storm barriers: an outer 6.7-mile barrier linking high ground to the north and south of the bay could be closed to protect John F. Kennedy International Airport and other critical areas against extreme events; while a lower, more inland barrier would provide passive protection against tidal flooding as sea levels rise, yet preserve the ecology of the marshes.

The work is part of a larger effort in New York and beyond, Lin, Nordenson, and...
Oppenheimer are longstanding members of the New York City Panel on Climate Change (NPCC), a group established by the city in 2008 that released its fourth major study in March 2019. By studying and applying solutions in New York, the Princeton team seeks to build a broader methodology for protecting coastal cities.

A key element of the work is combining state-of-the-art climate projections with the particular practical questions that affect cities. Lin said that city officials need details about rainfall, storm surge, sea level, and wind, not just large-scale features such as air and sea temperatures.

“There is a gap between the decision-making and the large-scale climate protections,” said Lin. While broad climate projections are critical, she said, regional officials are dealing with more immediate problems. “You are going to make a decision for this building, this dam, this community.” In a talk at an NPCC conference in March, Oppenheimer said the practical work of analyzing hazards and solutions for New York has informed his work as a contributing author to reports for the Intergovernmental Panel on Climate Change, the lead international organization assessing climate change. He cited recent studies, supported by the NPCC, on worst-case scenarios about melting of the Antarctic Ice Sheet and the impact on sea-level rise for cities such as New York. The work is an example of collaborations that “grow from the local to the global, as well as from the global down to the local,” he said.

“NPCC provides an example to the rest of the world for how localities can approach the analysis problems characterized by substantial uncertainty, yet deliver science that is ready to be used by policymakers,” Oppenheimer said, noting that New York already has made intelligent use of the work.

“The NPCC’s science, including the Prince-ton team’s integrative work spanning engineering and architecture, has informed everything from our updated building and zoning codes to the design of our large-scale coastal protection projects,” said Jaimey Bavishi, director of the New York City Mayor’s Office of Recovery and Resiliency.

In addition to Nordinson, Lin, and Oppenheimer, the authors of the Jamaica Bay report include Professor of Architecture Paul Lewis *92, graduate alumnus Rennie Jones ’16, former research scholar Reza Marsooli, and Catherine Seavitt of the City College of New York. Undergraduates Yolanda Jones ’20 and Reuben Zeiset ’20 and Reuben Zeiset ’20 and Reuben Zeiset ’20.”

### FACULTY HONORED FOR DISTINGUISHED TEACHING AND MENTORING

**Peter Ramadge**, the Gordon Y.S. Wu Professor of Engineering, received the engineering school’s 2019 Distinguished Teacher Award. Ramadge’s research focuses on machine learning and signal processing. Recently, he has worked with colleagues in neuroscience on analysis of functional Magnetic Reso-nance Imaging (fMRI). Ramadge also directs the Princeton Center for Statistics and Machine Learning.

Sharad Malik, chair of electrical engineer- ing, said in the award nomination that Ramagde’s teaching style “blends a deep commit- ment to fundamentals with essential real-world examples, providing students with both a firm grounding and a real sense of how to apply their knowledge.”

“Peter’s teaching is marked by incredible dedication, meticulous attention to detail, and outstanding caring and mentorship for his students,” said Malik, the George Van Ness Lothrop Professor in Engineering.

Kenneth Norman, chair of psychology and co-teacher of a course with Ramadge, said in the award nomination that “Peter’s approach is to extract the essence of the material and present it with such searing clarity that even students who have seen the material before learn something new.”

Emily A. Carter, former dean of engineering, shown at the 2019 Class Day, was recognized for her work with graduate students. **Matthew Weinberg**, assistant professor of computer science, received the annual award for excellence in undergraduate teaching from the Princeton University chapter of the Phi Beta Kappa honor society. He was one of two faculty members who received the award.

Weinberg studies algorithmic mechanism design, algorithmic game theory, and algo-rithms under uncertainty.

Engineering student organizations have twice honored Weinberg for excellence in teaching for his class on economics and computing.

Students highlighted Weinberg’s skill in preparing students for the math and theory requirements in computer science. Ching-Wei Weinberg’s strength in accommodating the varied experience of students, they noted that his courses “serve as a meaningful stepping stone toward deeper theory for students with more mathematical maturity.” And, when students struggle with the material, they are meet with Weinberg’s “willingness to meet until late hours and for much longer than scheduled in order to get ‘un-stuck’ on a problem.”

Peter Ramadge

**Emily A. Carter**, former dean of engineering, was one of four faculty members who received the award. Carter’s research combines applied mathematics, quantum mechanics, and physical chemistry to enable the discovery and design of materials for sustainable energy technologies.

Despite substantial administrative duties during her tenure, students described Carter as an attentive and involved mentor. “I always felt that my academic well-being and success remained her priority,” said one former advisee.

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Peter Ramadge

**Emily Carter**, former dean of engineering, was one of four faculty members who received the award.
RECENT FACULTY AWARDS, PROMOTIONS, AND HONORS

CHEMICAL AND BIOLOGICAL ENGINEERING
José Avalos
Camille Dreyfus Teacher-Scholar, National Science Foundation (NSF)

Clifford Brangwynne
MacArthur Fellowship, John D. and Catherine T. MacArthur Foundation

Pierre-Thomas Brun
Howard B. Wentz Jr. Junior Faculty Award, School of Engineering and Applied Science (SEAS)

Pablo Debenedetti
Alpha Chi Sigma Award for Chemical Engineering Research, American Institute of Chemical Engineers

Yueh-Lin (Lynn) Loo *01
Defense Science Study Group, 2020-2021

Robert Prud’homme
Editor, Patent Award, Research & Development Council of New Jersey

CIVIL AND ENVIRONMENTAL ENGINEERING
Branko Glišić
Fellow, American Academy of Arts and Sciences

James Smith
Hydrologic Sciences Medal, American Meteorological Society

Claire White
Gustavo Colonnetti Medal, International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM)

Michael Friedman
National Academy of Sciences

Brian Kemigian *09
Member, American Academy of Arts and Sciences (see story, page 3)

E-Council/GECE Excellence in Teaching Award, SEAS

Gilliat Kol
E. Lawrence Keyes Jr. / Emerson Electric Company Faculty Advancement Award, SEAS

Sloan Research Fellowship, Alfred P. Sloan Foundation

Wyatt Lloyd *13
Sloan Research Fellowship, Alfred P. Sloan Foundation

Avind Narayanan
Presidential Early Career Award for Scientists and Engineers, NSF

Edward Felten
Distinguished Service Award, Association for Computing Machinery (ACM)

Member, U.S. Privacy and Civil Liberties Oversight Board

Robert Fish
Fellow, Institute of Electrical and Electronics Engineers (IEEE)

Michael Freedman
Grace Murray Hopper Award, ACM

Thomas Funkhouser
Fellow, ACM

Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH) Academy, ACM

Tom Griffiths
Troiland Research Award, National Academy of Sciences

COMPUTER SCIENCE
Ibrahim Atsalis
E-Council/GECE Excellence in Teaching Award, SEAS

Mark Braverman
Alan T. Waterman Award, NSF

Bernard Chazelle
Test-of-Time Award, European Symposium on Algorithms

Computer Science (SEAS)

Gustavo de León
E. Lawrence Keyes Jr. / Emerson Electric Company Faculty Advancement Award, SEAS

Jason Fieldscher
Defense Science Study Group, 2020-2021

Claire Gmachl
Head of Whitman College

Andrew Houch ’00
E-Council/GECE Excellence in Teaching Award, SEAS

Shashad Malik
Intel Outstanding Researcher Award, Intel Corporate Research Council

Distinguished Alumni Award, University of California-Berkeley Department of Electrical Engineering and Computer Science

Prateek Mittal
Young Investigator Program Award, U.S. Army Research Office

H. Vincent Poor ’77
Benjamin Carver Lamme Award, American Society for Engineering Education

Honorary Doctor of Engineering, University of Waterloo

Peter Ramadge
Distinguished Teacher Award, SEAS

Alejandro Rodríguez
Presidential Early Career Award for Scientists and Engineers, NSF

Jeffrey Thompson
Presidential Early Career Award for Scientists and Engineers, NSF

Sloan Research Fellowship, Alfred P. Sloan Foundation

Mykhaylo Shkolnikov
E. Lawrence Keyes Jr. / Emerson Electric Company Faculty Advancement Award, SEAS

Sloan Prize, INFORMS Optimization Society

OPERATIONS RESEARCH AND FINANCIAL ENGINEERING
Amir Ali Ahmadi
Presidential Early Career Award for Scientists and Engineers, NSF

Optimization Society Young Researchers Prize, INFORMS (Institute for Operations Research and the Management Sciences)

E-Council/GECE Excellence in Teaching Award, SEAS

MECHANICAL AND AEROSPACE ENGINEERING
Emily Carter
Distinguished Alumni Award, Caltech

Luc Delhez
Faculty Early Career Development (CAREER) Award, NSF

Tyoong Jin
International Prize, Combustion Society of Japan

Andrei Kosmrlj
Alfred E. Phan Faculty Award, SEAS

Anirudha Majumdar
Amazon Research Award, Amazon.com Inc.

Faculty Research Award, Google AI

Alexander Smits
Fluid Dynamics Prize, American Physical Society

Claire Gmachl
Head of Whitman College

Jeffrey Thompson
Faculty Award, INFORMS Optimization Society

Sloan Prize, INFORMS Optimization Society

Michael Friedman
International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM)

Yueh-Lin (Lynn) Loo *01
Computer Science (SEAS)

Jennifer Rexford ’91
Special Interest Group on Data Communications (SIGCOMM) Award for Lifetime Contribution, ACM

Robert Sedgewick
Largy P. Steele Prize for Mathematical Exposition, American Mathematical Society

Karl V. Karlstrom Outstanding Educator Award, ACM

E-Council/GECE Excellence in Teaching Award, SEAS

Distinguished Alumni Award, University of California-Berkeley

Department of Electrical Engineering and Computer Science

Professor Thomas Funkhouser
Member, U.S. Privacy and Civil Liberties Oversight Board

Avind Narayanan
Presidential Early Career Award for Scientists and Engineers, NSF

Jamie Smith
Hydrologic Sciences Medal, American Meteorological Society

Clare White
Gustavo Colonnetti Medal, International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM)

Michael Friedman
International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM)

Clare White
Gustavo Colonnetti Medal, International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM)
The thesis experience allows Princeton students to apply the material skills they’ve learned over four years at the University. With the guidance of faculty advisers, all undergraduates discover new ways to apply their knowledge.

“I am amazed by the resilience and motivation some of them display,” said Elad Hazan, a computer science professor. “They truly become researchers.” – Melissa Moss

Emily Abdo, chemical and biological engineering
Plans after graduation: Working as an engineer for Jacobs Engineering at Johnson Space Center in Houston, Texas
On pushing through: “It’s been a challenge, but it also has been a really good lesson in how to start a huge project and take it all the way to completion.”

Maryam Bahrami, computer science
Plans after graduation: Pursuing a Ph.D. in theoretical computer science at MIT
On learning through collaboration: “Collaborating with several people taught me about how my approach to research is sometimes different from others, and how to utilize those differences to produce better work.”

Mayee Chen, operations research and financial engineering
Plans after graduation: Starting a Ph.D. in computer science at Stanford University
On new directions in research: “My adviser (Elad Hazan) helped me work through the steps of generalizing my algorithm and pointed out the most interesting directions to take the project. My work with him has shaped my goals of continuing to pursue machine learning research.”

Whitney Huang, mechanical and aerospace engineering
Plans after graduation: Working as an engineer at Zipline International
On theory and application: “Despite my project being on the application side of the research spectrum, having a theoretical basis informing each design decision I made is so important.”

Joyce Kimoyo, civil and environmental engineering
Plans after graduation: Working for InterSystems Corporation before attending graduate school
On seeing the bigger picture: “A key takeaway from my thesis research is that there is a big intersectionality between technology and environmental studies, especially in understanding the terrain of energy access in information-starved areas like sub-Saharan Africa.”

Bhaskar Roberts, electrical engineering
Plans after graduation: Pursuing a Ph.D. in computer science at Princeton
On the intellectual journey: “You learn to push through setbacks even if you’re still not getting results after months and months of working on it. Although you never know how far away the next success is, you know that it has to be out there.”
Two engineers were among seven graduate students who received the Graduate School’s annual teaching awards in April.

Mattias Fitzpatrick graduated in June with a Ph.D. in electrical engineering (applied physics). He served as an assistant in instruction (AI) for “Foundations of Engineering: Electricity and Photonics.” He received the electrical engineering department’s Richard C. Hough Teaching Award and the Keller Center for Innovation in Engineering Education’s Outstanding Teacher Award.

James Sturm ’79, the Stephen R. Forrest Professor of Electrical Engineering, said Fitzpatrick developed the entire lab component for the course, which was offered for the first time in spring 2018 to address the preparation of incoming engineering undergraduates. “Due to this new freshman physics/math sequence in the School of Engineering and Applied Science, approximately 20 sophomores are now majoring in engineering who would have otherwise transferred out,” Sturm said. “Mattias Fitzpatrick deserves the credit for a large fraction of this result.”

Said a student, “It has been very inspiring to have a chance to learn from someone so passionate and enthusiastic about their field of study, who also has great skills in simplifying and clarifying the material.”

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With a strong basis in fundamental science, Princeton graduate students pursue research that pushes the boundaries of their fields. Some of their innovations involve highly theoretical math, while others emerge from hands-on work in the laboratory or in the field. All use technology to address real-world needs and problems. Projects featured here include computer vision systems, analysis of insect behavior that will inform robotics controls, and techniques to combine historic preservation and environmental sustainability.

JENI SORLI
CHEMICAL AND BIOLOGICAL ENGINEERING
Hometown: Red Lodge, Montana
B.S.; University of Colorado-Boulder
Organic semiconductors enhance technologies including solar cells, lighting, displays, and sensors. They are easier and cleaner to synthesize than traditional materials and can be made into devices that are flexible and relatively inexpensive. Researchers can adjust organic semiconductors’ properties by changing their chemical structure. Sorli is developing a deeper understanding of how such changes alter the structures and the optical and electronic properties of organic semiconductors, such as electrical charge transport when the semiconductor is assembled into thin-film structures. Her work highlights the importance of understanding molecular structure and processing conditions to enable future applications of organic materials in electronics.

REBECCA NAPOLITANO
CIVIL AND ENVIRONMENTAL ENGINEERING
Hometown: Hamden, Connecticut
B.A.; University of Colorado-Boulder
Historic structures are abundant in cities across the nation, yet millions stand vacant. Napolitano develops tools for documenting, diagnosing, and communicating damage of historic buildings to promote projects such as adaptive reuse and retrofitting. She uses drones and image-based 3D reconstruction work to document structures’ conditions, numerical simulations and machine learning techniques to understand how damage could have occurred, and virtual reality to convey this information to a broad audience. This research not only strives to preserve cultural heritage, but also promotes sustainable practices. By recycling buildings, engineers can reduce carbon emissions and material waste in the hopes of creating sustainable cities for the future.

YINDA ZHANG
COMPUTER SCIENCE
Hometown: Dalian, China
B.E.; Tsinghua University, China
M.E.; National University of Singapore
Zhang, who completed his doctorate in 2018, studied computer vision, allowing artificial intelligence (AI) systems to understand the world through visual inputs, such as in photos or videos. Within this realm, his main research focus was 3D scene understanding, which investigates how to measure the 3D shape and meaning of the surrounding environment. While it is still extremely challenging for computers to fulfill these tasks, Zhang integrated computer vision algorithms with computer graphics and emerging deep-learning techniques to significantly improve their performance. The ultimate goal of his research was to empower the visual perception component of next-generation AI systems with comprehensive and robust scene understanding capability.

KYUNG MIN LEE
ELECTRICAL ENGINEERING
Hometown: Seoul, South Korea
B.E.; Cooper Union, New York
Organic semiconductors, an alternative to conventional silicon-based electronics, offer exciting opportunities for designing unconventional electronic devices for many uses. Lee’s research focuses on building systems with light-emitting organic semiconductors, including flexible displays with high efficiency and biodegradable electronics. Enabling energy efficiency and biodegradability is an interesting scientific problem, but it also has important practical implications for reducing energy consumption and electronic waste. Lee’s most recent endeavor is building light-emitting polymer transistors to drive synthetic chemistry for use in batteries. She hopes to see organic electronics research help solve problems of plastic waste and energy consumption.

RENATO PAGLIARA VÁSQUEZ
MECHANICAL AND AEROSPACE ENGINEERING
Hometown: Guatemala City, Guatemala
B.S.; Simon Fraser University, Canada
Pagliara Vásquez seeks insights for designing decentralized, robust, high-performance systems that adapt to environmental conditions by studying the collective behaviors of biological systems. He has demonstrated how feedback across different timescales helps regulate ant colonies’ foraging, allowing them to thrive in the hot desert region of the southwestern United States. Pagliara Vásquez is also studying the spread of disease to better understand the spread of ideas across networked systems. His work on resilient collective behavior will help illuminate other decentralized biological processes in ecology, medicine, and the environment, and will help create robust and systematic methodologies that enable engineered multi-agent systems to inherit some of the remarkable features of natural systems.

PIERRE YVES GAUDREAU LAMARRE
OPERATIONS RESEARCH AND FINANCIAL ENGINEERING
Hometown: Denholm, Canada
B.S., M.S.; University of Ottawa, Canada
Gaudreau Lamarre develops mathematical tools using probability to analyze complex physical systems. Often, in a phenomenon called universality, some broad properties of large systems can be observed independent of the system’s microscopic details. A problem of great interest to mathematicians and physicists is to understand the mechanisms that cause universality and to build mathematical machinery to study the quantitative features of such systems. Gaudreau Lamarre has helped develop mathematical tools providing a deeper understanding of the universal behavior in some models of interacting particle systems, such as gases of positively charged particles. His goal is to advance this work across multiple types of natural and human-made complex systems.

Photos by Frank Wojciechowski
ALUMNI TAPPED FOR NATIONAL SERVICE, ADVISORY ROLES

Eric Schmidt ’76 joined the National Security Commission on Artificial Intelligence. He heads the group of 15 tech experts who advise the government on national security implications of artificial intelligence and on how to maintain U.S. dominance in the technology market. Schmidt, who has a B.S.E. in electrical engineering from Princeton, is the former executive chairman of Google’s parent company, Alphabet Inc.

Christopher Hart ’69 *71, who holds a B.S.E. and M.S.E. in mechanical and aerospace engineering from Princeton, was hired as an independent safety adviser to Pacific Gas and Electric Company to focus on wildfire threats. He also headed delegations examining the Federal Aviation Administration’s certification of the Boeing 737 Max airliner. Hart is the former chairman of the National Transportation Safety Board.

ALUMNI NAMED TO LEADERSHIP ROLES IN BUSINESS

Curtis Arledge ’87 joined the Manner Investment Group LLC, an international investment management firm. He serves as chairman and CEO and heads the asset management platform of ORIX USA, a major investor. Arledge’s undergraduate degree is from Princeton and his M.B.A. is from Stanford, became the head of Oracle for over 20 years. He was president of product development at Oracle for over 20 years. Arledge is a member of Princeton’s School of Chemical Engineering and Applied Science Leadership Council.

Douglas Pagan ’93 joined KSiQ Therapeutics, a drug discovery company, as CFO. Before this, Pagan was CFO of Paratek Pharmaceuticals, playing a key role transforming Paratek from a development-stage company to a commercial one. His B.S.E. in chemical engineering is from Princeton, and his M.B.A. is from Columbia.

ALUMNI HONORED FOR RESEARCH AND TEACHING

Frances Arnold ’79, the Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry, and director of the Donna and Benjamin M. Rosen Bioengineering Center at Caltech, won the 2018 Nobel Prize in Chemistry for pioneering directed evolution of enzymes. Her bioengineering methods for creating new enzymes have benefited industry, medicine, and other fields. Arnold earned her B.S.E. in mechanical and aerospace engineering at Princeton and her Ph.D. in chemistry from the University of California-Berkeley.

Audrey Ellbee Bowden ’01 was named a fellow of the International Society for Optics and Photonics. A professor of biomedical engineering at Vanderbilt University, Bowden graduated with a B.S.E. in electrical engineering from Princeton and a Ph.D. in biomedical engineering from Duke University.

Lance Collins ’81, the Joseph Silbert Dean of Engineering at Cornell University, was presented with the Edward Bouche Legacy Award, which especially recognizes educators and advocates who promote diversity and inclusion. Collins has a Ph.D. from the University of Pennsylvania and a B.S.E. in chemical engineering from Princeton, where he serves on the advisory council for the Department of Mechanical and Aerospace Engineering.

J. Alex Halderman ’03 *09, a professor of electrical engineering and computer science and director of the Center for Computer Security and Society at the University of Michigan, received an Andrew Carnegie Fellowship. His winning proposal is titled “Strengthening Election Cybersecurity with Evidence-based Elections.” Halderman received his A.B. and Ph.D. from Princeton, both in computer science.

Sindee Simon *92, the Whitacre Department Chair and Horn Professor of Chemical Engineering at Texas Tech University, was named recipient of the 2019 International Award from the Society of Plastics Engineers. She is the first woman in the society’s history to receive the award. Simon holds a B.S. from Yale University and a Ph.D. from Princeton, both in chemical engineering.

Avi Wigderson *83, the Herbert H. Maass Professor in the School of Mathematics at the Institute for Advanced Study, was recognized with the Donald E. Knuth Prize for outstanding contributions to the foundations of computer science. His research includes randomized computation, cryptography, and circuit complexity. Wigderson earned his Ph.D. at Princeton in electrical engineering/computer science after receiving his B.A. from the Israel Institute of Technology in 1980.

In 2019, Marvin J. Johnson Award in Microbial and Chemical Technology from the American Chemical Society’s Division of Biochemical Technology. He is the Gore Professor of Chemical and Biomolecular Engineering at the University of Delft and director of Delft University of Technology’s Institute for Innovation in Manufacturing Biopharmaceuticals. Lee’s B.S.E. in chemical engineering is from Princeton and his Ph.D. in the same subject is from Caltech.

Kelvin H. Lee ’91 received the 2019 Marvin J. Johnson Award in Microbial and Chemical Technology from the American Chemical Society’s Division of Biochemical Technology. He is the Gore Professor of Chemical and Biomolecular Engineering at the University of Delft and director of Delft University of Technology’s Institute for Innovation in Manufacturing Biopharmaceuticals. Lee’s B.S.E. in chemical engineering is from Princeton and his Ph.D. in the same subject is from Caltech.

Sindee Simon

Photos courtesy of the subjects.

Elizabeth Clymer ’03 was appointed CFO of Jobcase, a social media platform where members can manage multiple aspects of their work-lives. She previously spent 10 years as an operating partner at Bain Capital Private Equity. Clymer’s B.S.E. in operations research and financial engineering is from Princeton and her M.B.A. is from Harvard.

Thomas Kurian ’90, who holds a B.S.E. in electrical engineering from Princeton and an M.B.A. from Stanford, became the head of Google Cloud. He was president of product development at Oracle for over 20 years. Kurian is a member of Princeton’s School of Engineering and Applied Science Leadership Council.

Douglas Booth ’86 was named president and CEO of Aptom, a pharmaceutical company. Previously, he served as president of Impax Laboratories’ generic division. Booth’s B.M.A. is from the University of Pennsylvania and his B.S.E. in mechanical and aerospace engineering is from Princeton.

Douglas Boothe

Elizabeth Clymer

Thomas Kurian

Douglas Pagan

S. Raja Krishnamoorthi