Catalyzing bold ideas
Innovation funds spark creativity and impact

One of the ineffable qualities that ties together much of what we do in engineering is creativity – building on a base of knowledge and stretching, collaborating, re-imagining. While Princeton has always sought to foster such inventiveness, many more opportunities have emerged in the last decade as a result of gifts that established “innovation funds.”

As Dean for Research Pablo Debenedetti eloquently explains in an essay on page 9, these are funds administered within the University, to which researchers can apply with bolder ideas than would be allowed by conventional funding sources, and with less paperwork. In short, the idea is to allow our extraordinary faculty and students the freedom to do their best work. This vision has resonated with alumni and friends who have seen the benefits of creativity and freedom in their own lives and have generously given more than $70 million for engineering-related innovation funds.

On page 15 of this magazine, you’ll read about electrical engineers who invented a novel way to control a computer with neither touch nor cameras and are applying the technology to the critical issue of maintaining sterile conditions in operating rooms. In another project (page 12), faculty from computer science, architecture, and civil and environmental engineering are combining forces to rethink the interaction of light and buildings to save energy. These are just two examples of projects sparked by innovation funds.

Where has freedom to be creative made a difference in your life? Please let us know your stories and join us whenever possible on campus!

H. Vincent Poor Ph.D. ’77, h80
Dean
Michael Henry Strater University
Professor of Electrical Engineering
UNIVERSITY OPENS ENTREPRENEURSHIP ‘HUB’

After earning a degree in astrophysical sciences, Jared Crooks returned to Princeton to pursue master’s degrees in mechanical and aerospace engineering and public affairs – but that’s not all. This summer, he is adding pages to his busy schedule by starting a business to streamline drug companies’ clinical trials.

“You could say that I am curious about a number of different things,” Crooks said with a laugh.

On a Monday morning last May, Crooks joined a small group for an impromptu tour of the Princeton University Entrepreneurship Hub, a new incubator space to advance entrepreneurial initiatives and education for faculty, students and alumni. The hub, located in space leased by the University at 34 Chambers St. in downtown Princeton, will house the Keller Center’s annual eLab program, which supports student ventures, as well as shared working space for startups founded by faculty, students and alumni.

Crooks is one of the first users of the Entrepreneurship Hub as a member of one of the seven eLab teams working there over the summer. This summer is eLab’s fourth season; previously, teams worked in offices in the Engineering Quadrangle. “It looks awesome,” Crooks said after visiting the space. “I can’t wait to start working here.”

The eLab program concludes with formal demonstrations in August in which teams present their work to business leaders.

“When I was here as an undergraduate, eLab did not even exist,” said Crooks, a member of the Class of 2011 who received his master’s degrees at Commencement June 2. Now the program has become an integral part of the University’s effort to assist students and faculty to pursue new ventures.

Mung Chiang, who chaired the Princeton Entrepreneurship Advisory Committee, which recommended the creation of the Entrepreneurship Hub, said the new space will provide “an essential anchor” for a wide range of startup activities at Princeton. The 10,000-square-foot facility offers meeting rooms, offices, classrooms and information technology support. The space is part of Princeton’s efforts to provide more
PRINCETON E-FFILIATES ENTERS FIVE-YEAR PARTNERSHIP WITH EXXONMOBIL

The Princeton E-ffiliates Partnership, an initiative that forges collaborations between industry and Princeton University experts, has entered a five-year agreement with ExxonMobil to pursue transformational innovations in the fields of energy and the environment.

“Meeting the world’s energy needs in a sustainable way is a formidable challenge,” said Pablo Debenedetti, Princeton’s dean for research. “Developing economically viable solutions requires the collaborative efforts of industry, government and academia. We are delighted that ExxonMobil is joining E-ffiliates, broadening the vibrant collaboration between Princeton and leading industry partners in the energy and environmental sectors.”

Debenedetti added that such partnerships are a distinctive activity of Princeton’s Andlinger Center for Energy and the Environment, which administers the E-ffiliates program.

During a recent signing ceremony on Princeton’s campus, ExxonMobil committed to investing $5 million during the next five years, making it the largest financial commitment in the E-ffiliates Partnership. The company will immediately begin working with research groups across the University, including selected graduate students and postdoctoral researchers, who will be designated ExxonMobil Fellows.

“This investment is a part of ExxonMobil’s broad commitment to partner with the best and brightest universities to research and discover next-generation energy solutions,” said Vijay Swanar, vice president of research and development for ExxonMobil Research and Engineering Co. “Our goal is to find meaningful and scalable solutions to meet global energy demand.”

Yueh-Lin (Lynn) Loo Ph.D. ’01, associate director of external partnerships at the Andlinger Center, said that in addition to accelerating research, the partnership supports the University’s overall educational mission by enhancing interactions between students and practitioners. ExxonMobil is the world’s largest publicly traded oil and gas company.

“Our partnership with ExxonMobil is a new paradigm for conducting research on campus and exemplifies the central goal of E-ffiliates: lowering barriers for collaboration and facilitating deep and fruitful industry-academic partnerships,” said Loo. (Loo, whose term ended June 30, is succeeded by Paul Chirik, the Edwards S. Sanford Professor of Chemistry.)

Loo said the agreement with ExxonMobil is the first of its kind on campus because it establishes an umbrella framework that makes it easy for any business unit of ExxonMobil to undertake research projects with any department or laboratory at Princeton. Such a broad agreement could serve as a model for future interactions with companies, she said.

Further facilitating interactions, E-ffiliates will host a visitor-in-residence from ExxonMobil, who will catalyze research initiatives and collaborate across the campus.

Princeton E-ffiliates Partnership, founded in 2011, offers companies an opportunity to explore research frontiers and engage faculty and students outside the companies’ core expertise. E-ffiliates is administered by the Andlinger Center in collaboration with the Princeton Environmental Institute, the School of Architecture, and the Woodrow Wilson School of Public and International Affairs.

“Having our faculty and students work closely with industry is essential to developing economically viable and environmentally responsible solutions to meet the world’s energy needs,” said Emily Carter, founding director of the Andlinger Center. “ExxonMobil brings a global perspective and a long-standing commitment to innovation that, coupled with Princeton’s deep expertise, will help move impactful, sustainable technologies into the market.”

In its first three years, member contributions have enabled E-ffiliates to fund a wide range of faculty research projects focused on greenhouse gas reduction and new forms of energy production, as well as to facilitate key policy discussions related to energy. In 2013 and 2014, for example, E-ffiliates, working with corporate partners, convened high-level federal and state energy officials to address the valuation and integration of distributed sources of energy into electricity grids. Technology-oriented projects have included the development of new types of turbines that can harness electricity from free-flowing water; innovative approaches for deploying energy storage systems on electricity grids; and technologies for producing concrete with lower greenhouse gas emissions. -Steven Schultz
IS SMALL THE FUTURE OF NUCLEAR POWER? REPORTS ‘DISTILL’ COMPLEX TOPICS

Designs for “small” nuclear reactors that are less than a third the size of conventional ones offer an intriguing route to more sustainable energy production, but present challenges of cost and potential linkages to nuclear weapons, according to a new report from the Andlinger Center for Energy and the Environment.

The report is the second in the center’s series of Distillates briefings written by Princeton researchers and intended to provide succinct and substantive information to policymakers, educators, students and other citizens. The Distillates series covers emerging topics in energy and the environment that combine technological, economic and policy considerations. A Distillate issued in 2014 covered grid-scale electricity storage.

“The goal of the Distillates project is to distill down to the essence the key concepts associated with emerging energy technologies so that any interested party can understand the associated technological, environmental, economic and policy issues facing them,” said Emily Carter, founding director of the Andlinger Center. “We aim to provide good, solid information about these important topics as a form of public education.”

The topic of nuclear power is particularly important today, said Robert Socolow, professor emeritus of mechanical and aerospace engineering and leader of the Distillates series. “The nuclear reactors of the United States, France and Japan are getting old, and planning for their successors, nuclear or non-nuclear, needs to begin,” he added, adding that China and India have ambitious plans for nuclear power that could involve types of power plants not deployed previously. Nuclear power offers climate-change benefits, especially when it displaces coal, but the tense diplomacy over Iran’s nuclear power capabilities makes vivid – nuclear power also provides multiple routes to nuclear weapons. Socolow said. “Today’s conversations about innovation and cost-reduction via so-called small modular reactors are confined to in-groups and must be broadened,” he said. “Otherwise, the many valid concerns about siting, safety, waste management and, above all, nuclear weapons, will be undervalued at this crucial time.”

The report presents a new approach to categorizing the many designs under consideration for small modular reactors. The authors conclude that none of the designs are able to avoid the potential problem of nuclear materials being diverted for use in weapons and some designs may even exacerbate the potential.

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The 28-page report and its four-page executive summary, as well as the previous report on grid-scale storage, are available at https://acee.princeton.edu/distillates. –SS

Countries with small modular reactors under development

After the deal: reducing Iran’s long-term nuclear risks

Even as Iran and six global powers negotiated a nuclear accord this summer, Princeton researchers were looking at how to reduce nuclear risks beyond the 10-year horizon of many of the pact’s key provisions.

One way to reduce this risk is by converting Iran’s enrichment program from a national to a multinational enterprise, according to a policy report published in the journal Science by a team of experts that included Alex Glaser, assistant professor of mechanical and aerospace engineering with a joint appointment in the Woodrow Wilson School of Public and International Affairs.

“Reducing proliferation risks by ending national control over dangerous civilian nuclear activities is an important idea with a long history,” Glaser said. “As civilian nuclear technology keeps spreading, multinational control may offer the only realistic way to stop the spread of nuclear weapons capability.”

Glaser collaborated on the report with Frank von Hippel, professor of public and international affairs, and Zia Mian, a research scientist at the Wilson School’s Program on Science and Global Security. Glaser’s research combines technical aspects of nuclear fuel cycle technologies and policy questions related to nuclear energy and nuclear weapons proliferation.

One of the biggest concerns is Iran’s uranium enrichment program, which uses high-speed centrifuges to concentrate the specific form of uranium needed to power a nuclear reactor. Such enrichment plants can be reconfigured quickly to produce weapons-grade uranium.

In their article, the authors explain the special risk of modern enrichment technology and how this risk increases dramatically with the number of centrifuges and the available stockpile of uranium. Taken together, these factors determine the “breakout time” – the time it would take a country to acquire enough weapons-grade material for one nuclear bomb.

Making sure that the breakout time is at least one year has been a key objective of the United States in talks with Iran. The Princeton authors propose that Iran’s neighbors and one or more members of the group that includes France, Germany, the United Kingdom, China, Russia and the United States could purchase a share of Iran’s primary nuclear enrichment plant. This would give the world continued access to Iran’s centrifuge program and confidence that it was being used only for peaceful purposes – in a way that goes beyond traditional international nuclear safeguards.

To ensure even greater transparency, Middle Eastern countries could form a regional nuclear inspectorate, when politically appropriate, to supplement current international safeguards. “This would be similar to what Argentina and Brazil did after they both simultaneously gave up their nuclear-weapon programs, von Hippel said.

“The nuclear deal with Iran and a multinational approach to uranium enrichment could be important steps toward a long-hoped-for nuclear weapon-free zone in the Middle East,” Mian said. –B. Rose Huber

Combining technical and policy expertise, Princeton researchers published a paper in the journal Science examining how to reduce long-term risks of nuclear weapons proliferation in Iran. From left, Zia Mian and Frank von Hippel of the Program on Science and Global Security collaborated with Alex Glaser who is jointly appointed at the Woodrow Wilson School of Public and International Affairs and the Department of Mechanical and Aerospace Engineering.
Denisa Buzatu (pictured), a civil and environmental engineering major, devoted her senior thesis to developing a moving façade to improve the energy efficiency of buildings. Buzatu said it was challenging to scale up her system, but she successfully created a model with eight panels that move and fold in response to electrical signals. “I had to fail many times,” she said.

For example, the surface could integrate solar panels as well as sensors that monitor the amount of sunlight hitting the building. The modules could flatten automatically during sunny periods to simultaneously collect energy and shade the building, then use part of the collected energy to fold away when cloudy.

Buzatu, who is from Slatina, Romania, completed the architecture and engineering structures track of her major and planned to pursue a graduate degree at Yale School of Architecture. She is a member of the Princeton chapter of the American Society of Civil Engineering and served as the group’s social chair.

Buzatu worked with Sigrid Adriaenssens (rear), an assistant professor of civil and environmental engineering who advised Buzatu on her project. “Within the open-ended senior thesis project, Denisa immediately took charge to formulate an interesting research question, and developed a realistic research plan which she is implementing with great success.” —Stacey Huang ’16
Researchers at Princeton University have found that the common test of bouncing a household battery is not an effective way to check a battery’s charge.

“The bounce does not tell you whether the battery is dead or not, it just tells you whether the battery is fresh,” said Daniel Steingart, an assistant professor of mechanical and aerospace engineering and the Andlinger Center for Energy and the Environment. 

The battery bounce test, popularized in online videos, shows that fully charged batteries bounce very little when dropped, while those that have been used for a while bounce higher. The height of the bounce increases as the batteries discharge, and that has led to the belief that a reduction in charge causes the higher bounce.

Steingart was intrigued by how the bouncing changed as batteries discharged – it was not a linear increase. Instead, the height rapidly increased and then leveled off. His research team has been investigating for some time internal changes related to battery discharge, and he wondered whether the changing bounces reflected an important change in the batteries.

They devised a quick experiment in which they dropped a common battery through a Plexiglas tube and used a computer microphone to record it striking a benchtop. The researchers used the time between bounces to determine the height of the bounce.

“What I really loved about this experiment is that the result holds a lot of scientific importance, but also it is the kind of thing I can show to someone without a scientific background and they can still get something out of it,” said Shoham Bhadra, a graduate student in electrical engineering and the Andlinger Center for Energy and the Environment and the lead author of the paper reporting the findings.

Don’t throw away those bouncing batteries.

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The scope of the school’s innovation funds research enterprise.

...important principle of anonymous peer review. Innovation funds thus encourage originality and reward risk-taking, while preserving the all-inclusive character of the School of Engineering at the engineering school is spreading across the campus. As dean for research, my office administers innovation fund competitions titled Ideas in the Natural Sciences, New Industrial Collaborations, New Ideas in the Humanities, Intellectual Property Accelerator, and Collaborations Between Artists and Scientists or Engineers. Especially noteworthy in this context is the Eric and Wendy Schmidt Transformative Technology Fund, which every year awards sums that can be as high as $1 million to one project involving the development of a new and innovative technology. The goal is to create a thriving campus-wide system in support of excellence through creativity in research.

This issue of E-Quad News features examples of research made possible by innovation funds. I hope that you enjoy reading these inspiring accounts of innovation and pursuit of consequential research.

A few years ago, researchers in Peter Jaffe’s laboratory noticed that ammonium was inexplicably disappearing from a soil sample taken from the Assunpink Wildlife Management Area southeast of Princeton. Jaffe, a professor of civil and environmental engineering, suspected that an unidentified type of bacteria was converting the ammonium into the soil. What was truly interesting was the bacterium’s effectiveness at reducing nitrogen in the absence of oxygen – a behavior with potentially important implications for sewage treatment and other processes.

In addition to the technical challenges of identifying the mystery bacterium, Jaffe knew that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding. He realized that potential funders would see his idea as too speculative for traditional funding.

The researchers are now exploring the bacterium’s effectiveness at reducing pollutants that include ring hydrocarbons such as benzene, as well as heavy metals including copper and uranium. “These are probably the most common organic pollutants at superfund sites,” Jaffe said. The chemicals, once widely used in industry, are difficult to remove from the environment, “very recalcitrant,” as Jaffe said. The researchers are now exploring the bacterium’s effectiveness at reducing pollutants that include ring hydrocarbons such as benzene, as well as heavy metals including copper and uranium. “These are probably the most common organic pollutants at superfund sites,” Jaffe said. The chemicals, once widely used in industry, are difficult to remove from the environment, “very recalcitrant,” as Jaffe said. The researchers are now exploring the bacterium’s effectiveness at reducing pollutants that include ring hydrocarbons such as benzene, as well as heavy metals including copper and uranium. “These are probably the most common organic pollutants at superfund sites,” Jaffe said. The chemicals, once widely used in industry, are difficult to remove from the environment, “very recalcitrant,” as Jaffe said. The researchers are now exploring the bacterium’s effectiveness at reducing pollutants that include ring hydrocarbons such as benzene, as well as heavy metals including copper and uranium. “These are probably the most common organic pollutants at superfund sites,” Jaffe said. The chemicals, once widely used in industry, are difficult to remove from the environment, “very recalcitrant,” as Jaffe said. The researchers are now exploring the bacterium’s effectiveness at reducing pollutants that include ring hydrocarbons such as benzene, as well as heavy metals including copper and uranium. “These are probably the most common organic pollutants at superfund sites,” Jaffe said. The chemicals, once widely used in industry, are difficult to remove from the environment, “very recalcitrant,” as Jaffe said.
Civil engineers typically spend a lot of effort securing structures in place, but Sigrid Adriaenssens is finding new possibilities in motion. “If we allow structures to move, we can do some very interesting things with them,” said Adriaenssens, an assistant professor of civil and environmental engineering.

Specifically, Adriaenssens is interested in elastic deformation - the ability of a structure to deform in response to a force and then return to its original shape once the force is removed. One of her newest projects involves creating a folding shade on the outside of buildings. The shade would open and close as the sun strikes the structure’s surface – illuminating and darkening the interior as needed.

“It would be a beautiful feature that helps define the architecture,” she said. “But it would also be a component that would be very useful for the building.”

Working with Axel Kilian, an assistant professor of architecture, Adriaenssens is developing a thin structure assembled around bi-metallic beams. When sunlight heats a beam, it expands the two metal components of the beam, it expands the two metal components – the sun's energy.

“If we change the thickness of the material, the shape of the cells and other components, we can create completely different structures,” she said.

The sunshade project, with its unusual but innovative perspective, is the type of work that is often difficult to support through traditional funding. Adriaenssens has funded the research through the Andlinger Innovation Fund, which is administered by the Andlinger Center for Energy and the Environment and is intended to promote cross-disciplinary collaborations outside traditional funding systems.

“The approach of combining structures, forms and materials for environmental and structural performance is new, and it can be difficult to fit into traditional funding models,” Adriaenssens said. “The grants make it possible to undertake a new kind of research.”

In another unusual project, Adriaenssens and Kilian are teaming up with Adam Finkelstein, a computer science professor, to create a simple reflector to draw daylight into offices. The researchers hope that the work, supported by the University’s Wilkie Family Fund, could someday substantially decrease the amount of energy used for lighting a building.

They call the reflector a light shelf. It is simple in concept, but quite complex to pull off. The shelf not only needs to draw light into a variety of shapes and orientations, it also needs to be cheap enough to deploy in large numbers of windows.

“It is a reflective surface that mounts on a window,” Adriaenssens said. “The shelf can be made up of very small areas and each is oriented in such a way that they maximize the amount of light reflected inside. Finkelstein, a specialist in computer graphics, said it is like focusing an array of tiny mirrors to produce a beam of light.

“The idea is to redirect light coming from the sun to bounce off the ceiling the same way that light fixtures do,” he said. “It’s hard to make a reflector that works optimally for any orientation of window, at any latitude, at any time of the year and at any time of the day. So part of the goal of the project is to think about how to design a reflector that would do a reasonable job across different times of day and times of the year and that can be customized for a particular location.”

“With this device, we can reduce that usage by 20 to 60 percent depending on the location,” said Adriaenssens, who added that the researchers hope to have a prototype in about a year. “The ultimate goal is to produce a simple device that could reduce energy consumption, particularly in large office buildings.”

Another critical application will be designing the many small structures that make up the shelf with an eye to maximizing the amount of light reflected inside. Finkelstein, a specialist in computer graphics, said it is like focusing an array of tiny mirrors to produce a beam of light.

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On a pristine field of superfluid helium, Stephen Lyon is coordinating the world’s tiniest rush hour.

The commuters are electrons, rushing and bunching toward an array of microscopic gates “like turnstiles on the subway,” said Lyon, a professor of electrical engineering. His team of researchers is using shifts of voltage like the signal board at New York’s Penn Station, sending streams of electrons zipping back and forth across the helium.

The goal is to do something impossible for a normal station: marshal thousands of electrons through a line of 80 turnstiles in precise choreography at precisely the same time. The timing must be exact, because the smallest lag by just one electron would ruin the procedure.

The purpose behind this feat of control is to build the world’s most accurate standard of electrical current: a device sensitive enough to tickle out electricity by the electron but powerful enough to be used as a practical meter. In short, they hope to complete what the procedure.

Lyon explained that he arrived at the current measurement called coherence. Essentially, “right now, we have ways of making extremely accurate resistors; and we have ways to measure voltage, but there is no way to measure current at that level of accuracy,” Lyon said.

It is a shift from Lyon’s normal research area. Typically his team works on quantum computing—the ongoing effort to develop a practical computer that uses the strange laws of quantum physics to solve problems that are currently closed to modern mathematics. But Lyon explained that he arrived at the current experiment after revisiting an old idea.

“Back in the 1970s people were using electrons floating on helium to conduct ‘exciting physics,’” he said. Helium’s unique subatomic properties allowed physicists to study quantum phenomena but by 1998 Daniel Tsui, a fellow Princeton Engineering faculty member, won a Nobel Prize for his exploration of the fractional quantum Hall effect using semiconductors, and electrons on helium was set aside.

Lyon specializes in an area of quantum computing called coherence. Essentially, he finds ways to place thousands of electrons in the same condition (called a ‘spin state’) and keep them there for a relatively long period. Normally, Lyon works with incredibly pure silicon, but he wondered whether helium would serve as a better material.

“I started thinking about the things, and I was talking to a friend of mine, Neil Zimmerman, who works at NIST (the National Institute for Standards and Materials),” Lyon said. “He said ‘that sounds like something we are trying to do with semiconductors to make a current meter.’”

To pursue the idea, Lyon received support from the University’s Project X Fund, which provides backing for work that is either too speculative for traditional funding. Lyon explained that the frozen helium, cooled to just a few degrees Kelvin, fills the spaces around his 80-turnstile array. The electrons float just above the surface of the helium, moving according to the slightest change in voltage. There are other substances that create this floating effect, Lyon said, but the helium allows the greatest freedom of motion.

“We believe that the helium could be the key,” said Lyon. “At the scale of electrons, the helium is perfectly smooth. It is so smooth that the electrons go exactly where they are supposed to.”

The trick is to coordinate the flow of the electrons and to ensure that only one passes through at a time. At this point, the commuters are still crowding—the team is sending two electrons through.

“We think we can get it down to one if we manage the voltage,” Lyon said. “Of course, we could also be running into an unknown aspect of physics; but that would be pretty interesting as well.”

Stephen Lyon, professor of electrical engineering, is using his expertise in the physics of quantum computing to invent a fundamentally new way to measure electrical current. The work with graduate student Spencer Nichols (right) is supported by the engineering school’s Project X fund, which helps faculty pursue ideas outside their normal area of work, spurring creativity that could lead to unanticipated payoffs.

“Our team—graduate students Yingzhe Hu and Liechao Huang and Aoxiang Tang—uses the electric field from electronic components to sense changes in capacitance caused by a hand gesture. Those components are not affected by the lighting or the short distance.”

When the team first developed the technology, they were thinking it would first find use as a way to control mobile devices or to play games. Verma said a grant from Princeton’s Helen Shapley Hunt Fund is allowing the team to stretch in a new direction and adapt the technology for medical use as well.

“In a way, it is a simple problem—you touch something and you get it dirty. They want to avoid that,” he said. “We believe our technology could offer a solution.”

Operating rooms can be messy places—and the digital age doesn’t necessarily help. Hospital workers carefully sterilize all equipment between procedures but high-tech displays now frequently used during surgeries can be particularly difficult to clean. That is where a research team advised by Naveen Verma, James Sturm and Sigurd Wagner is working on a solution.

“Surgeons might have multiple images from a patient, and they might want to flip through them during a procedure—but they don’t want to touch anything that could possibly spread an infection,” said Verma, an associate professor of electrical engineering. “So we have been working on integrating 3D gesture sensing into medical displays.”

Verma said that camera sensors often are unsuited to operating rooms both because of the lighting conditions and because cameras can have trouble focusing over the short distances between the surgeons and the displays.

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When the team first developed the technology, they were thinking it would first find use as a way to control mobile devices or to play games. Verma said a grant from Princeton’s Helen Shapley Hunt Fund is allowing the team to stretch in a new direction and adapt the technology for medical use as well.

“In a way, it is a simple problem—you touch something and you get it dirty. They want to avoid that,” he said. “We believe our technology could offer a solution.”

Operating rooms can be messy places—and the digital age doesn’t necessarily help. Hospital workers carefully sterilize all equipment between procedures but high-tech displays now frequently used during surgeries can be particularly difficult to clean. That is where a research team advised by Naveen Verma, James Sturm and Sigurd Wagner is working on a solution.

“Surgeons might have multiple images from a patient, and they might want to flip through them during a procedure—but they don’t want to touch anything that could possibly spread an infection,” said Verma, an associate professor of electrical engineering. “So we have been working on integrating 3D gesture sensing into medical displays.”

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After a rush-hour bridge collapse killed and injured hundreds in Minneapolis in 2007, Branko Glišić wanted to know if he could develop a more efficient sensor to help engineers detect the signs of failure before it was too late.

Glišić, an associate professor of civil and environmental engineering, specializes in improving the condition of large structures – one of his research teams uses the University's Streicker Bridge as a laboratory. Typically, the work is done with arrays of thin metal wires – although researchers use fiber optics in Streicker – but after Glišić attended a presentation by a colleague at Princeton, he thought there might be a better approach.

To try it, he needed researchers with experience in chemical engineering, and he found them in the Department of Chemical and Biological Engineering. “But after processing, I thought there might be a better approach,” Glišić said. “Polymer sensors can also measure several different types of strain at once, which should let engineers isolate specific problems affecting a bridge. Bridges and other concrete structures must withstand strain from outside forces, such as wind and heavy loads. But the concrete also naturally shrinks and expands in response to temperature and humidity, which adds another type of load. “Changes in temperature place far more strain on a typical bridge deck than typical structures such as plastics that conduct electricity, could offer a number of advantages. First, metal wires can only handle so much strain before they snap and stop sending measurements. “In some cases, you might have cracking that would not threaten the structure, but it would break the sensor,” Glišić said. “Polymers are much more ductile than metal – they can be stretched to a much greater extent.”

The polymer sensors can also measure several different types of strain at once, which should let engineers isolate specific problems affecting a bridge. Bridges and other concrete structures must withstand strain from outside forces, such as wind and heavy loads. But the concrete also naturally shrinks and expands in response to temperature and humidity, which adds another type of load. “Changes in temperature place far more strain on a typical bridge deck than the heavier trucks,” Glišić said. The ability to monitor several conditions at once results from an unusual property of a conductive polymer, polyaniline. One of Loo’s graduate students, Melda Sezen, discovered the polymer during a routine test in which she exposed the polymer to acid to increase its conductivity. She noticed something strange: the acid changed the material’s electrical response to stretching. “Normally, when you stretch the material, its resistance increases,” said Sezen, now a third-year graduate student in chemical and biological engineering. “But after processing, stretching causes the resistance to decrease.”

The discovery seemed significant for bridge monitoring, Glišić said, because it allows the sensors to deliver a more complex set of information. “So there’s the exciting possibility of developing a circuit that would produce a positive and a negative signal in response to stretching. My former graduate student Yoo Yao performed theoretical analysis of the circuit and confirmed conceptual feasibility.”

The researchers are working to use this switching behavior to develop a sensor that will allow engineers to isolate different types of strain. Glišić said it is possible to do this with metal sensors, but it requires a fairly complex array. “We intend to build a single gauge that would tell us all of the factors – how much is the concrete shrinkage, what is the temperature influence, how much is the mechanical action,” he said.

The work so far has been supported by the engineering school’s Anonymous Fund. Glišić said the initial support has been critical because the original idea for the new sensors would have been difficult to fund by traditional means.

“Do the research, you need funding,” he said. “But to get the funding you need some preliminary results. That is why the University’s support has been so important.”
Hurricanes are among the most studied weather patterns on the planet – scientists track them with radar, watch them with satellites and fly through them with special aircraft.

But despite the effort, and the high stakes involved, major gaps remain in scientific understanding of these colossal storms.

“There are still many aspects that remain poorly understood, particularly as hurricanes change as they move inland,” said James Smith, the William and Edna Macaleer Professor of Engineering and Applied Science and chair of civil and environmental engineering.

Smith is among a group of researchers at Princeton and affiliated institutions pursuing better methods to quantify the threat that hurricanes pose to coastal communities.

“We are working to develop tools for real-time forecasting and for long-term risk analysis,” said Ning Lin Ph.D. ‘10, an assistant professor of civil and environmental engineering. “We are trying to estimate extreme wind, storm surge and rainfall all at the same time.”

Lin is collaborating with a number of colleagues to better understand how hurricanes change as they move inland and how to quantify the threat that different storms pose to communities along the Atlantic and Gulf coasts.

“We want to better predict the chance that a location will be hit with a hurricane and better estimate the severity of the damage,” Lin said.

In one project, Lin and Smith are collaborating with researchers from the U.S. Geophysical Fluid Dynamics Laboratory in Princeton to develop models that better predict how hurricanes develop as they pass over land.

“Over land, hurricanes lose many of the common characteristics of hurricanes over the open ocean, and these changes affect the hazards of extreme rainfall and flooding,” Smith said.

It won’t necessarily change the aggregate amount of rain, but it will create regions of extremely heavy rainfall.”

Smith and Lin also are collaborating to develop a model to simulate the effects of hurricanes interacting with storms that don’t originate in the tropics, as was the case when Hurricane Sandy, or “Superstorm Sandy,” devastated areas of New York and New Jersey in 2012. The researchers say the interaction, called extra-tropical transitions, can alter both the track and the severity of storms along the coast—so it is critical to understand the phenomenon, particularly for northern states.

“The odd path of Sandy and the extreme rainfall of Irene were both tied to extra-tropical transitions,” Smith said. “Many hurricanes that affect the United States north of the Mid-Atlantic undergo extra-tropical transition.”

Lin is also collaborating with Jianqing Fan, the Frederick L. Moore, Class of 1918, Professor in Finance, to develop advanced statistical methods to estimate the frequency and severity of hurricanes and model how they will evolve with the changing climate.

Fan said that the goal is to better understand risks that specific areas face to allow society to make decisions about development in coastal regions.

“What are the risks, what are the tradeoffs, if we decide to build in a certain area?” he said. “With a better understanding of statistical modeling and hurricane physics, answering that question is quite possible.”

In addition, Lin aims to predict storm damage based on characteristics that are specific to certain locations. Toward this goal, her team conducted a detailed examination of damage in Ortley Beach, New Jersey, in the aftermath of Hurricane Sandy, along with a research team from the University of Notre Dame.

“Our students documented the damage, converted the photos and images to numbers, and developed a comprehensive GIS-based database,” Lin said. “Then they did an analysis on the damage to determine why some houses were more damaged than others—what contributed to the damage, how it was affected by environmental conditions, and other factors.”

The researchers compared their findings with flood maps produced by the Federal Emergency Management Agency and found that the federal maps underestimated the study area’s vulnerability to storm surge damage.

“We think their wave modeling is not sufficient,” Lin said. “If an area is on high ground, they assume it will not be vulnerable. But waves can cause severe damage to near-shore structures even if they are on relatively higher ground.”

The researchers are continuing to work on their damage calculations with a goal of developing a specific model both to forecast possible damage and to give planners an opportunity to minimize damage in the long run.

Lin, who helped support the different projects with grants from the University’s Project X Fund, the Andlinger Fund for Energy and the Environment, and the Cooperative Institute for Climate Science, said the grants allowed for collaborations that are often difficult to support by other means.

“Princeton is a great environment for collaboration, but when you rely on outside funding you often find yourself collaborating with people in your field,” she said. “These funds have allowed us to explore new collaborations across several different disciplines.”

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Luca Nagy, a graduate student in civil and environmental engineering, helps assess storm damage at Ortley Beach, New Jersey, an area hard hit by Hurricane Sandy.
Modem medical testing allows doctors to diagnose and treat conditions that once would have been fatal or debilitating. But for many people around the world, the lack of access to medical tests means that diseases and injuries go unrecognized and untreated.

A Princeton research team is working to develop a method that could help solve this problem by allowing a common smartphone to conduct medical tests now only available in sophisticated laboratories. The initial phase of the project concentrates on traumatic brain injury, which affects millions of people worldwide.

“Traumatic brain injury often goes undiagnosed,” said Stephen Chou, the Joseph C. Egin Professor of Engineering and leader of the research team. “Current diagnostics for brain injury are often not easily accessible and they are not always effective.”

Supported by a grant from the Eric and Wendy Schmidt Transformative Technology Fund, Chou’s team is working on a sensor, called an M-Plate, that could diagnose a variety of medical conditions with a few drops of a person’s blood or saliva. The sensor, which is smaller than a camera’s SD storage card, would detect biological markers produced inside the human body that indicate an injury or disease. The plate creates fluorescence in the presence of these markers and uses nanotechnology to produce a signal clear enough to be captured by a common cell-phone camera.

Developing the smartphone test presents several significant challenges. The at-home test would need to work with blood drawn from a pinprick – a sample 1,000 times smaller than one drawn for a conventional lab test. Chou’s team must also develop a specialized filter for both the smartphone’s camera and flash, because neither is well suited for chemical identification.

When it comes to global warming, most people worry about power plants. Claire White thinks about another kind of plant – those that make cement.

“We found that by adding really small quantities of zinc oxide nanoparticles to produce cement that uses a pinprick blood sample to detect traumatic brain injury.

And the team will need to integrate these components and write software for data analysis and communication. If the project succeeds, the user would simply photograph the M-Plate with a smartphone. The software would interpret the optical signal of biomarkers from the plate and give immediate advice to the user.

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“The method is very simple,” Chou said, adding that he believes that operating the device will require no formal training.

Cement production and cement powder are major components of greenhouse gas emissions,” said White, an assistant professor of civil and environmental engineering and the Andlinger Center for Energy and the Environment. “It accounts for between 5 and 8 percent of human-made carbon dioxide.”

Along with co-researchers from across the University, White is exploring ways to manufacture cement without contributing to global warming. Most of these cement substitutes eliminate the need to burn limestone at high temperature, a critical step in standard cement production that accounts for much of the CO2 emissions. By using waste components, such as slag from steel manufacturing, manufactur- ers can cut greenhouse emissions by 80 to 90 percent, White said.

One of White’s projects, supported by the Princeton E-ffiliates Partnership Fund, involves using X-ray tomography to study possible methods for eliminating tiny cracks that develop as some of the alter-native cements dry. The results have been encouraging so far.

“We don’t have data indicating how well they will last for 50 to 100 years,” she said. Her research group is now working to simulate aging under a variety of conditions without altering the chemical composition of the cement in unrealistic ways.

“This is an area in which universal research is needed,” she said. “We have the ability to take a longer view.”

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White's research team is working to develop a method that could help solve this problem by allowing a common smartphone to conduct medical tests now only available in sophisticated laboratories. The initial phase of the project concentrates on traumatic brain injury, which affects millions of people worldwide.

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Three members of the engineering school faculty and one graduate student were recognized for outstanding teaching at graduation ceremonies this year.

Paul Prucnal, a professor of electrical engineering, was one of four University faculty members who received the President’s Award for Distinguished Teaching at Commencement ceremonies. Prucnal, who investigates ultrafast optical techniques with applications to communications and signal processing, joined the Princeton faculty in 1988. Prucnal is regarded as a mentor and as a creative instructor, and one current student said that he “tirelessly explains concepts until they are crystal clear.” Colleagues praised Prucnal’s dedication to his students and to teaching. One noted that “Paul’s students are unmatched in their intellectual independence and ability to self-study, and Paul’s record in winning teaching awards given by student selection is unmatched.”

Michael Littman, a professor of mechanical and aerospace engineering, was awarded the School of Engineering and Applied Science’s Distinguished Teacher Award. Littman is known for his wide-ranging expertise. The co-inventor of the Littman laser, his research has included such topics as quantum optics and the search for planets orbiting distant stars. A noted historian of engineering, science and technology, Littman joined the Princeton faculty in 1979.

In announcing the award, Jeremy Kasdin BSE ’85, the engineering vice dean, said that Littman has “a sustained record of excellence in teaching our students and contributing to our education mission.”

“This award is about teaching, and I am hard-pressed to think of a faculty member more deserving,” said Kasdin, a professor of mechanical and aerospace engineering.

Michael Mueller, an assistant professor of mechanical and aerospace engineering, was one of four recipients of the Graduate Mentorship Awards, which are bestowed by the McGraw Center for Teaching and Learning. Mueller, who specializes in the modeling of turbulent reacting flows, joined the faculty in 2012. Students said that although Mueller is very encouraging and always available to assist, he pushes graduate students to constantly improve in their field. Students mentioned the advances they have made while working with Mueller, as well as his understanding of the challenges facing graduate students.

“Looking back,” one student wrote, “I realize that Michael wanted to bring me out of my comfort zone so that I could mature intellectually.”

Alexandra Piotrowski, a fourth-year graduate student in chemical and biological engineering, served as a preceptor for the course, “Quantitative Principles in Cell and Molecular Biology.” Celeste Nelson, an associate professor of chemical and biological engineering, said that Piotrowski played a critical role in the class’ success. Nelson said that Piotrowski’s decision to work as an assistant instructor five times in her three years at Princeton is indicative of her dedication to teaching. “I want others to know how much of a positive impact she has had on my experience here at Princeton, as well as my life,” one student said. Piotrowski expects to complete her Ph.D. in 2016.

Students laud faculty for excellence in teaching

The undergraduate Engineering Council and the Graduate Engineering Council annually elect professors to receive the Academy’s Excellence in Teaching Award. The recipients at the spring 2015 ceremony were, from left, Howard Stone, Paul Prucnal, and Amir Ali Ahmadi. Ramon van Handel, not pictured, also received the award. Prucnal, a five-time winner, was given a Lifetime Achievement Award.

Eric Wood, a professor of civil and environmental engineering, was elected to the National Academy of Engineering, one of the highest honors across all engineering fields. Wood, the Susan Dod Brown Professor of Civil and Environmental Engineering, was recognized by the academy “for development of land surface models and use of remote sensing for hydrologic modeling and prediction.” Among other accomplishments, Wood led a team of researchers at Princeton in the development of a drought monitor capable of observing isolated regions not served by other systems. Working with UNESCO, Wood and the members of his Terrestrial Hydrology Research Group deployed the monitor at several research sites in Africa and South America. Wood joined the Princeton faculty in 1976. A fellow of the Royal Society of Canada, he is a recipient of the Alfred Wegener Medal from the European Geosciences Union and the Prince Sultan Bin Abdulaziz International Prize for Water. He is among 67 members and 12 foreign members elected to the academy this year.

Sanjeev Arora, the Charles C. Fitzmorris Professor in Computer Science, was elected to the American Academy of Arts and Sciences.

Arora was honored for his work in computational complexity theory. Arora made important contributions to development of a methodology that allows mathematicians to verify even the most complex problems by checking the proof in just a few locations. The method, called the PCP Theorem, works by converting the logical statements of a proof into a mathematical form designed to highlight errors. Arora was a graduate student at the University of California at Berkeley when he, along with a group of colleagues, developed the method. Since then, among other work, Arora has developed approximate solutions to a class of problems, known as NP-hard problems, that have so far foiled mathematicians’ attempts to solve them. He is the founding director of Princeton’s Center for Computational Intractability.

Arora joined the Princeton faculty in 1994. A fellow of the Association for Computing Machinery, he is a recipient of the Gödel Prize and the ACM-Infosys Foundation Award in the Computing Sciences. He is among 197 members elected to the academy this year. Members are selected for their contributions to the arts, science and society.

ENGINEERING FACULTY ELECTED TO NATIONAL ACADEMIES

Michael Mueller, assistant professor of mechanical and aerospace engineering, works with graduate students Sili Deng (left) and Bruce Perry (right).
CHEMICAL AND BIOLOGICAL ENGINEERING
Ilhan Aksay  
Fellow, National Academy of Inventors

Mark Brynildsen  
CAREER Award, National Science Foundation

Celeste Nelson  
Ttiele Lecturer, University of Notre Dame

Rodney Priestley  
2014-100 Most Influential African-Americans, The Root

Richard Register  
Fellow, American Institute of Chemical Engineers

CIVIL AND ENVIRONMENTAL ENGINEERING
Kelly Caylor  
Director, Princeton University Program in Environmental Studies

Michael Celia  
Ph.D. ’83  
2015 Argys Visiting Professorship, University of Stuttgart

Ning Lin  
Ph.D. ’10  
2014 Lloyd’s Science of Risk Prize

Denise Maurerfell  
Science Advisory Board, U.S. Environmental Protection Agency

Eric Wood  
2014 Prince Sultan International Prize for Water

COMPUTER SCIENCE
David August  
Fellow, IEEE

Mark Braverman  
Stephen Smale Prize, Society for the Foundations of Computational Mathematics

Nick Feamster  
Test of Time Award, Networked Systems Design and Implementation

Adam Finkelstein  
Fellow, Association of Computing Machinery

Margaret Martonosi  
Jefferson Science Fellow, The National Academies

Marie R. Pistilli  
Women in Electronic Design Automation Achievement Award, Design Automation Conference

Jennifer Rexford  
BSE ’91  
Board of Directors, Open Networking Foundation National Test of Time Award, Networked Systems Design and Implementation

Olga Troyanskaya  
Deputy Director for Genomics, Simons Center for Data Analysis

RECENT FACULTY AWARDS

ELECTRICAL ENGINEERING
Emmanuel Abbe  
Bell Labs Prize 2014 (Inaugural recipient)

Mung Chiang  
2014 N.J. CEO of the Year, non-profit category, New Jersey Technology Council

Nick Feamster  
2014 INFORMS Design Science Award, with EDGE Lab team

Paul Cuff  
2015 Young Investigator Program Award, Air Force Office of Scientific Research

H. Vincent Poor  
Ph.D. ’77, h80  
2015 Athanasios Papoulis Award, European Association for Signal Processing

COMPUTER SCIENCE
David August  
Fellow, IEEE

Mark Braverman  
Stephen Smale Prize, Society for the Foundations of Computational Mathematics

Nick Feamster  
Test of Time Award, Networked Systems Design and Implementation

Adam Finkelstein  
Fellow, Association of Computing Machinery

Margaret Martonosi  
Jefferson Science Fellow, The National Academies

Marie R. Pistilli  
Women in Electronic Design Automation Achievement Award, Design Automation Conference

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Olga Troyanskaya  
Deputy Director for Genomics, Simons Center for Data Analysis

OPERATIONS RESEARCH AND FINANCIAL ENGINEERING
Amir Ali Ahmadi  
Young Investigator Award, Air Force Office of Scientific Research

Sebastien Bubeck  
Research Fellow, 2015 Alfred P. Sloan Foundation

Han Liu  
Career Award, National Science Foundation

Ramon van Handel  
Erdos Prize, INFORMS Applied Probability Society

Edeard P. Sloan Foundation

Naomi Leonard  
BSE ’85  
Glenn L. Martin Medal, University of Maryland Clark School of Engineering

Lex Smits  
Editor-in-Chief, American Institute of Aeronautics and Astronautics Journal 2014 AIAA Aerodynamic Measurement Technology Award

Operations Research and Financial Engineering

Electrical Engineering

Emmanuel Abbe  
Bell Labs Prize 2014 (Inaugural recipient)

Mung Chiang  
2014 N.J. CEO of the Year, non-profit category, New Jersey Technology Council

Nick Feamster  
2014 INFORMS Design Science Award, with EDGE Lab team

Paul Cuff  
2015 Young Investigator Program Award, Air Force Office of Scientific Research

H. Vincent Poor  
Ph.D. ’77, h80  
2015 Athanasios Papoulis Award, European Association for Signal Processing

COMPUTER SCIENCE
David August  
Fellow, IEEE

Mark Braverman  
Stephen Smale Prize, Society for the Foundations of Computational Mathematics

Nick Feamster  
Test of Time Award, Networked Systems Design and Implementation

Adam Finkelstein  
Fellow, Association of Computing Machinery

Margaret Martonosi  
Jefferson Science Fellow, The National Academies

Marie R. Pistilli  
Women in Electronic Design Automation Achievement Award, Design Automation Conference

Jennifer Rexford  
BSE ’91  
Board of Directors, Open Networking Foundation National Test of Time Award, Networked Systems Design and Implementation

Olga Troyanskaya  
Deputy Director for Genomics, Simons Center for Data Analysis

OPERATIONS RESEARCH AND FINANCIAL ENGINEERING
Amir Ali Ahmadi  
Young Investigator Award, Air Force Office of Scientific Research

Sebastien Bubeck  
Research Fellow, 2015 Alfred P. Sloan Foundation

Han Liu  
Career Award, National Science Foundation

Ramam van Handel  
Erdos Prize, INFORMS Applied Probability Society
FELTEN JOINS WHITE HOUSE AS DEPUTY CHIEF TECHNOLOGY OFFICER

Edward Felten, a Princeton computer scientist who is a leading expert on computer security, has been named U.S. Deputy Chief Technology Officer in the White House’s Office of Science and Technology Policy.

Felten, who is the Robert E. Kahn Professor of Computer Science and Public Affairs, came to the University in 1993 and since 2006 has held a joint appointment with the Department of Computer Science and the Woodrow Wilson School of Public and International Affairs. Felten was the first chief technologist for the Federal Trade Commission, serving from January 2011 through August 2012. Felten assumed his new duties full-time on June 1, taking a leave of absence from Princeton until Dec. 31, 2016. He plans to return to the University in spring 2017.

“Ed Felten is a leader in the field of technology policy, and we are delighted that he will again be providing his expertise in the nation’s service,” said Cecilia Rouse, dean of the Wilson School. “At this juncture in history, it is critically important to have leaders who understand both technology and policy.”

In his new role, Felten will work under U.S. Chief Technology Officer Megan Smith to advise President Barack Obama and his staff on policy issues.

“The tremendous insight that Ed has brought to his research and teaching over the decades will serve the nation very well,” said H. Vincent Poor, dean of Princeton’s School of Engineering and Applied Science. “As technological advances and policy decisions become increasingly intertwined, Ed exemplifies how someone with deep technical expertise can engage in the policy arena for the benefit of society.”

BOOK HARNESSES ‘THE OTHER F WORD’

When John Danner teaches Princeton students about succeeding in starting and running a business, one of his chief topics is failure. Not necessarily how to avoid it but how to harness it. “Failure is one resource that you and your organization produce every day,” Danner and co-author Mark Cooperensmith wrote in their new book, “The Other F Word” (Wiley 2015). Danner, entrepreneurship specialist at the Keller Center and Department of Electrical Engineering, has taught a range of entrepreneurship courses, including a freshman seminar, a sophomore-level introduction and a senior-level class on starting ventures to address social needs. He discussed the book, born from his teaching and his own experience starting and consulting for companies, at a reception hosted by the Keller Center on May 21.

RECORD-SIZED CLASS OF 2015 CELEBRATED FOR SCHOLARSHIP AND SERVICE

The Princeton Class of 2015 included a record number of engineering students – 303 pursuing BSE degrees and 29 with an A.B. in computer science – 36 percent more than last year. At Class Day ceremonies June 1, the School of Engineering and Applied Science presented the following awards.

J. Rich Steers Award
Joseph Bolting
Electrical Engineering

Eric Shullman
Civil and Environmental Engineering

Jeffrey O. Kephart ’80 Prize in Engineering Physics
Mark Stone
Physics

Andrew Ward
Electrical Engineering

J. Rich Steers Award
Joseph Bolting
Electrical Engineering

Eric Shullman
Civil and Environmental Engineering

Jeffrey O. Kephart ’80 Prize in Engineering Physics
Mark Stone
Physics

Andrew Ward
Electrical Engineering

J. Rich Steers Award
Joseph Bolting
Electrical Engineering

Eric Shullman
Civil and Environmental Engineering

Jeffrey O. Kephart ’80 Prize in Engineering Physics
Mark Stone
Physics

Andrew Ward
Electrical Engineering

Tau Beta Pi Prize
Nicole Schiavone
Mechanical and Aerospace Engineering

Joseph Clifton Eglin Prize
Henrique de Freitas
Operations Research and Financial Engineering

Elana Woldenberg
Mechanical and Aerospace Engineering

George J. Mueller Award
Sebastian Grimbarg
Mechanical and Aerospace Engineering

Michael Manhard
Civil and Environmental Engineering

Calvin Dodd MacCracken Senior Thesis/Project Award
Denisa Buzzata
Civil and Environmental Engineering

Lore Von Jaskowsky Memorial Prize
Anne Muslim
Chemical and Biological Engineering

Erika Portnoy
Computer Science

James Hayes-Egner Palmer Prize in Engineering
David Fridovich-Keil
Electrical Engineering
STUDY ABROAD OFFERS CHANGE OF PERSPECTIVE, NEW OPPORTUNITIES

During a six-week break from his studies at Oxford University, David Dyrda BSE ’15 travelled through France, Italy and the Czech Republic. But the place that left the greatest impression was Rome.

“There are ruins just mixed into the city,” said Dyrda, who graduated in June with a degree in mechanical and aerospace engineering. “The mixture of modernity and history is just unparalleled.”

Dyrda, from Orland Park, Illinois, spent his entire junior year abroad as part of the Oxford-Princeton Exchange in Engineering. He took five engineering courses while abroad, the equivalent of seven Princeton courses, and completed his thesis a year early as part of Oxford’s “fourth-year projects.”

Dyrda said the academics at Oxford were thorough. “I covered all of the normal material I would have covered while at Princeton,” as well as some engineering topics that he probably would not have found at Princeton, he said. But he learned a lot outside the classroom as well.

“The process of planning these trips taught me a lot of independence, but I also was able to really learn about the United States through the eyes of Europeans,” he said. “Their personal happiness isn’t as tied to career and academic success like it is in the United States.”

Of the 33 engineering students who studied abroad in the 2014-15 school year, most spent one semester outside the United States. Aside from the Oxford-Princeton Exchange in Engineering, Princeton offers its engineering students five bilateral exchanges with foreign universities.

Michael Chang, a junior in computer science who participated in the ETH Zurich exchange in Switzerland last spring, saw studying abroad as an opportunity for broadening his perspective. “As the only Princeton student in Switzerland, I didn’t meet another American for three weeks,” he wrote by email during his exchange. “I made a lot of Swiss friends, and because they’ve been really obliging, I’ve really been able to see Switzerland in depth so far.”

Chang added, “Having to adapt to an environment with no one to rely on except myself has really helped me develop as a person.”

Morena said. “Then I was able to take departmental electives and humanities classes abroad.”

Morena also noted that Princeton was flexible with her schedule and that she was able to take her final exams abroad and without a proctor due to Princeton’s Honor Code policy.

Erica Portnoy BSE ’15 studied abroad in the fall of her senior year in Princeton’s exchange program with the Aquincum Institute of Technology in Budapest, Hungary.

“Senior year turned out to be a good time to go abroad,” said Portnoy, “not only because I was able to have more time to apply to jobs and fellowships, but because I was able to see current issues such as the shooting of Michael Brown from a European perspective.”

For Christiana Elford BSE ’15, going abroad was a chance for her to develop her Spanish skills. Elford, who graduated in June with a degree in mechanical and aerospace engineering, studied at the University of Cantabria in Spain. Although all her engineering classes were taught in English, outside of class she was able to interact with the larger university community using only Spanish. She also joined the volleyball team, where none of her teammates spoke English.

“Maybe there were days I was sad I was missing out on activities such as lawn parties, but there was never a time I thought, ‘I wish I wasn’t abroad,’” said Elford. “I met amazing friends I wouldn’t have known otherwise. And in addition to fulfilling requirements at Princeton, I was able to take a class on coastal engineering.”

Elford said that before she left for Spain, she worried about everything she would miss at Princeton.

“But looking back,” she said, “I should have been more afraid of missing out on going abroad.”
A hallmark of research at Princeton Engineering is connecting deep investigations of fundamental science with innovative solutions to societal problems. Graduate students work at the heart of that connection. Here are just a few examples of students delving deep into chemical, physical, technological and mathematical problems – all with an aim to improving human health, the environment, energy sources, and computer and financial systems.

BOMYI LIM
CHEMICAL AND BIOLOGICAL ENGINEERING
Hometown: Seoul, South Korea
Previous institution: University of Pennsylvania
Lim focuses on quantitative analysis and real-time construction of the chemical signals of ERK, a molecule responsible for tissue development and maintenance in living beings from flatworms to humans. ERK activation at the wrong place or time, or a change in the activation level, could lead to diseases and harmful conditions such as cancer or congenital heart defects. Analysis of this activation, both in space and time, is key to a better understanding of ERK and possible routes to cures. Lim is studying biogas capture and harmful conditions such as cancer or congenital heart defects. Analysis of this activation, both in space and time, is key to a better understanding of ERK and possible routes to cures. Lim is studying biogas capture

DAVID PAL
CHEMICAL AND ENVIRONMENTAL ENGINEERING
Hometown: South Brunswick, New Jersey
Previous institution: Rutgers-New Brunswick
While an undergraduate working on an international development project in Thailand, Pal became interested in water quality and treatment. That experience led him to study wetlands, exploring the effects of dissolved hydrogen gas on methane production and how plants contribute to this cycle. Rice paddies, which are similar to wetlands, emit methane, which is a significant driver of climate change. Pal believes this can be controlled through better management practices stemming from a deeper understanding of the chemical processes. As a fellow in the Program in Science, Technology and Environmental Policy (based at the Woodrow Wilson School of Public and International Affairs), Pal also is studying biogas capture and usage from wastewater treatment plants.

STEVEN GOLDFEDER
COMPUTATIONAL SCIENCE
Hometown: Spring Valley, New York
Previously at the Center for Information Science and privacy research group members of the Department of Computer Science’s security and privacy research group.

YANQI ZHOU
ELECTRICAL ENGINEERING
Hometown: Hunan Province, China
Zhou is inventing specialized ways of configuring computer hardware and software for future cloud computing services. She designed and implemented a computer architecture that enables better matching of workloads to resources. Her work allows the core processing units of computers and their many subcomponents to be combined and recombined, as needed, into “virtual machines” depending on the tasks they are required to perform. She also designed a mechanism for controlling at a fine level how a computer allocates its memory resources across multiple programs running at once for better overall performance and fairness.

SILI DENG
MECHANICAL AND AEROSPACE ENGINEERING
Hometown: Beijing, China
Deng’s research focuses on the fundamental combustion processes of both traditional hydrocarbon fuels and biofuels, including the chemistry and transport coupling in combustion engines. She also closely studies the formation of soot from combustion and how to control it. Her goal is to learn ways to guide the fuel and combustion process design for power machines to make them safer, cleaner and more efficient.

ALEXANDER FURGER
OPERATIONS RESEARCH AND FINANCIAL ENGINEERING
Hometown: Wausau, Wisconsin
Furger is attracted to both the exactness of statistics and data, and the excitement of trading and finance. Combining these interests, he is studying how to use high-frequency data — data that is taken at intervals of less than one trading day — to improve the performance of existing trading strategies and the risk-forecasting ability of managed portfolios.
Francis Doyle recently served as associate dean for Engineering and Applied Sciences. Doyle moves to Harvard from the University of California-Los Angeles. Cook received a BSE in chemical engineering at Princeton and was elected to serve as an eight-year charter trustee. An orthopedic surgeon, Connelly was most recently planning as Coca-Cola establishes its largest bottling operation in Africa in Port Elizabeth, South Africa. Akin was named engineering alumni Laura Forese BSE ’83 and Paul Maeder BSE ’75 to its Board of Trustees effective July 1. Forese earned a BSE in civil engineering at Princeton and was elected to serve as portfolio manager and head of the company’s institutional clients business as well as the Citi Private Bank. Forese graduated from Princeton with a BSE in electrical engineering and computer science from Princeton. Princeton named engineering alumni Laura Forese BSE ’83 and Paul Maeder BSE ’75 to its Board of Trustees effective July 1. Forese earned a BSE in civil engineering at Princeton and was elected to serve as a four-year term. Maeder is the founding partner of the venture capital firm Highland Capital Partners, where he specializes in investments in online higher education, robotics and software. At Princeton, he earned his bachelor’s degree in mechanical and aerospace engineering. Florence Hudson BSE ’80 has been hired as senior vice president and chief innovation officer by Internet2. Founded in 1996 by U.S. higher-education institutions, Internet2 provides the nation’s research and education community with a network that fulfills bandwidth requirements necessary for large data transfers. Previous, she was at IBM for 33 years. Hudson earned a BSE in mechanical and aerospace engineering. She currently serves the University as a member of the Department of Environmental Engineering’s Advisory Council. Ajay Kapoor BSE ’72 is the CEO of Kadenze, a MOOC (Massive Online Open Course) platform offering courses in art, design, music and creative technology. Kadenze fills a gap in online learning by providing creative arts education. The company’s offerings are slated to include “Reinventing the Piano,” a course led by Princeton Professor of Music Dan Trueman. Kapur received a BSE in computer science. Anna Protopapas BSE ’86 was named president and chief executive officer of Mersana Therapeutics, a company that engineers antibody-drug conjugates to maximize the potential of new and established cancer-fighting drugs. Prior to this appointment, she was president of Millennium Pharmaceuticals. Protopapas has a BSE in chemical engineering.