



# Penn Engineering



*inventing  
the future*

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Penn Engineering / Fall 2014  
University of Pennsylvania  
School of Engineering and Applied Science

**"One of the advantages of being a scientist at Penn is the compact campus brimming with fantastic expertise and ideas across the full gamut of disciplinary fields."**

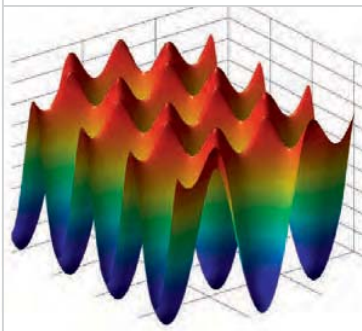
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## Penn Engineering Magazine

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Eduardo D. Glandt/Nemirovsky Family Dean

## Involve me and I learn

Just flip through the pages of *Penn Engineering*. The strong visual evidence of the changes that have swept through the engineering complex is compelling. This issue captures the notion of engineering as a profession, as an activity with “deliverables.” These practitioners must not just understand scientific principles but also be passionately engaged in developing innovative solutions, products, processes and code. An engineer delivers such results just as an artist delivers a painting. We are judged not only by our knowledge but especially by the quality of our output.

The dedication of the Towne Building in 1906 was a major event. Sixteen senators made the trip from Washington, D.C., for the occasion and a giant turtle was boiled to make the turtle soup served at the banquet held at the Union League in Center City Philadelphia. (Thankfully, we now live in much more enlightened times!) The Towne Building was worthy of so much attention because it was a daring experiment, a building conceived as a place to learn “with one’s hands” by doing, by experiencing, in shops, labs and museums.

Eventually, the educational pendulum swung the other way. “Engineering science” made its big entrance in the 60s, spurred by Sputnik, and our engineering programs became scientifically rigorous and firmly rooted in fundamentals. All wonderful, of course, but in the process our culture lost some of its appreciation for innovation and for impact.

Times are different and innovation is back! This issue is testimony to our renewed focus on impact, one of the tenets of the Penn Compact 2020, the University’s strategic plan. This attitude is reflected in every one of our activities, in the design our curricula and in our admissions criteria, in faculty hiring and in faculty activities, in the wonderful frenzy of PennApps and in the activities housed in the University’s new Pennovation Center. The level of engagement of the students, faculty and staff is boundless.

It feels right, all around. As always, Ben Franklin said it best: “Tell me and I forget. Teach me and I remember. Involve me and I learn.” 🍷

# Visualizing the Future of Robotics

By Janelle Weaver

On a sunny summer day in 2000, Camillo Jose Taylor and several of his students visited a U.S. Army training site in Fort Benning, Georgia. Soon after they arrived, three helicopters suddenly appeared above, and soldiers started to rappel down to the ground. Then they heard gunfire and became enveloped by plumes of smoke from simulated grenades that landed nearby. In the midst of the mayhem, the students remained focused on their one mission: to program a team of robots to diligently collect data about the scene. “It was not the usual environment for successful programming, but the students performed very well,” says Taylor, professor in Computer and Information Science (CIS) at Penn.

The training operation illustrates one way that robots may be used in the future, according to Taylor’s grand vision. By assembling themselves into communication networks, teams of robots can relay messages to one another to optimally position themselves for efficient data collection in dangerous places. “It’s hard for individual robots to understand everything about the surrounding scene. But when they form social networks or swarms and start gossiping with each other, they can develop a better understanding of the environment to solve complicated problems,” Taylor says.

As a member of Penn’s General Robotics, Automation, Sensing and Perception (GRASP) Laboratory, Taylor has set his sights on making robots smarter. He is developing algorithms that will allow robots to efficiently recognize objects so that they can respond to commands such as “fetch the keys on the table”

and dexterously manipulate different items coming down a conveyer belt in a factory. “Currently, robots are good at not bumping into things, but they can’t tell the difference between a garbage can and a person,” Taylor notes. “For a long time, computer vision researchers were trying to figure out how to program robots to avoid obstacles. Now we’re starting to ask the next level of questions to allow them to build a detailed 3D representation of the environment.”

Taylor is also using his expertise in computer vision to build compelling virtual experiences. Working with Ph.D. student Ryan Kennedy, he has developed an extremely fast algorithm to create 3D models of objects that have been videotaped with a webcam. Additional algorithms make sense of building interiors through the construction of high-resolution 3D models from image data and the interpretation of data from depth cameras such as the Kinect™ sensor.

Ultimately, Taylor envisions combining these approaches with virtual reality technology to allow users to visualize and edit complex 3D shapes and environments. This kind of technology could be used to speed the design of complex shapes such as dental molds or medical implants, which could be sculpted in a virtual environment and then manufactured on a 3D printer. “With the current generation of systems, it’s very tough to visualize what’s happening in 3D,” Taylor reports. “In the long run, we hope to produce systems that are a lot more intuitive and simpler to use.”



***Camillo Jose Taylor***





## Sharing the Spirit of Fun

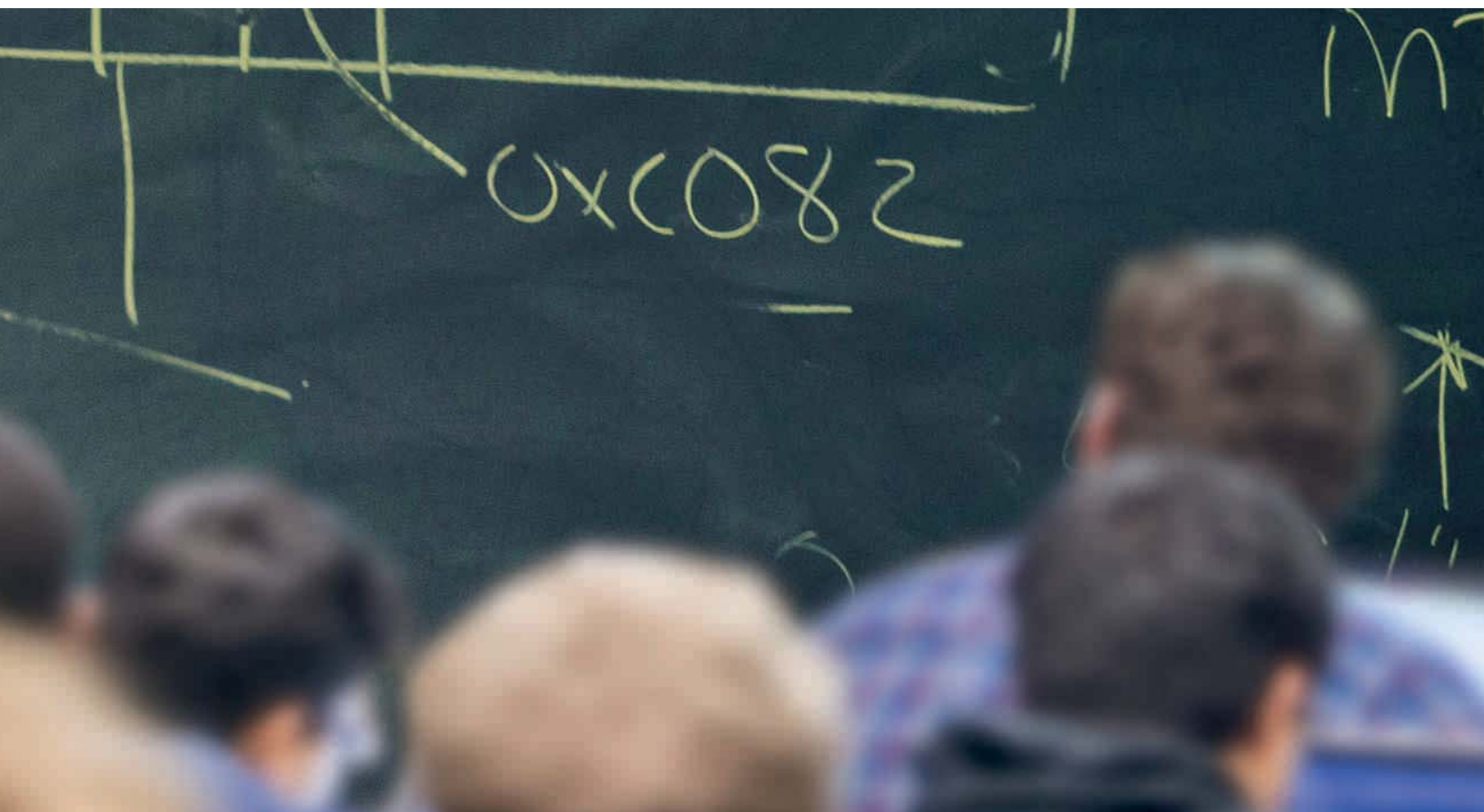
One of Taylor's earliest robotics experiences set the stage for his current research interests. As a Ph.D. student working on a project with Daniel Koditschek, who was then at Yale but is now the Alfred Fitler Moore Professor in Electrical and Systems Engineering at Penn, Taylor developed algorithms that allowed juggling robots to track Ping-Pong balls. "That project got me thinking about the problems of robotics and computer vision, and inspired me to focus my work in those areas," Taylor recalls.

Toward that end, Taylor was enticed to join Penn in 1997, in large part because of the world-class GRASP Lab and its top-notch faculty. Now as a professor, he has brought the spirit of fun from his graduate school years into the classroom. For example, he teaches the C programming language to students taking CIS 240: *Introduction to Computer Architecture* by having them program video games such as Tetris, Space Invaders and Frogger. "Professor Taylor likes to trick his students into learning something," says David Mally (CIS'15), who

was a teaching assistant for the course. "He not only effectively communicates the information he intends in lecture, but is also incredibly witty and funny along the way."

This sense of humor has even spread to exam time. Some of Taylor's most memorable test questions have asked students to respond to the harebrained schemes of their cousin "Crazy Eddie," a feckless computer scientist who does things the quick and dirty way. "Crazy Eddie typically makes a big mess, which you are left to clean up," Mally says. "Professor Taylor definitely enjoys being more than a little evil in his classes. Once, he came to the midterm exam dressed as the Grim Reaper, complete with a scythe, and menacingly walked up and down the rows of Towne 100."

What stands out to Evelyn Yeung (CIS'16) as she reminisces about taking CIS 240 are Taylor's creative analogies, such as, "C is like a chainsaw. You can cut through much more, but if you don't know what you're doing, you'll end up in a world of hurt." Taylor makes the course material come to life through a refreshing



Professor Taylor clarifies a concept in CIS 240: *Introduction to Computer Architecture*.

combination of energy, humor and wit, notes Yeung. “He strikes a great balance between detailed explanation and relevant humor, making him approachable.”

### Promoting Progress at Penn

Through engaging lectures in the classroom and patient explanations during office hours, Taylor has earned the Christian R. and Mary F. Lindback Award for Distinguished Teaching at Penn. He has also helped to develop two new courses: Engineering and Applied Science (EAS) 105: *Introduction to Scientific Computing*, which focuses on programming and computational thinking and has been adopted by many departments; and EAS 205: *Applications of Scientific Computation*, which aims to provide a solid foundation in both the theory of linear algebra and its application to important problems in robotics, computer vision, graphics and machine learning.

When he is not developing course material or conducting research, Taylor stays busy with leadership activities. He was the undergraduate chair of the Computer and Information Science department, and now he directs the GRASP Lab’s master’s program in Robotics and is a member of the faculty oversight committee for the Computer Engineering program. Taylor, who was born in Jamaica, also serves as a member of the faculty diversity committee at the School of Engineering and Applied Science.

Through his interactions with other faculty involved in shared leadership activities and research projects, Taylor is reminded of what originally lured him to Penn. “It’s a great place to work because I know that if I have a question or an idea, my colleagues are always happy to talk with me,” Taylor says. “We benefit a lot from sharing different ways of thinking between disciplines, and with this wonderful mix of ideas, there’s no problem we can’t attack.” 🍷

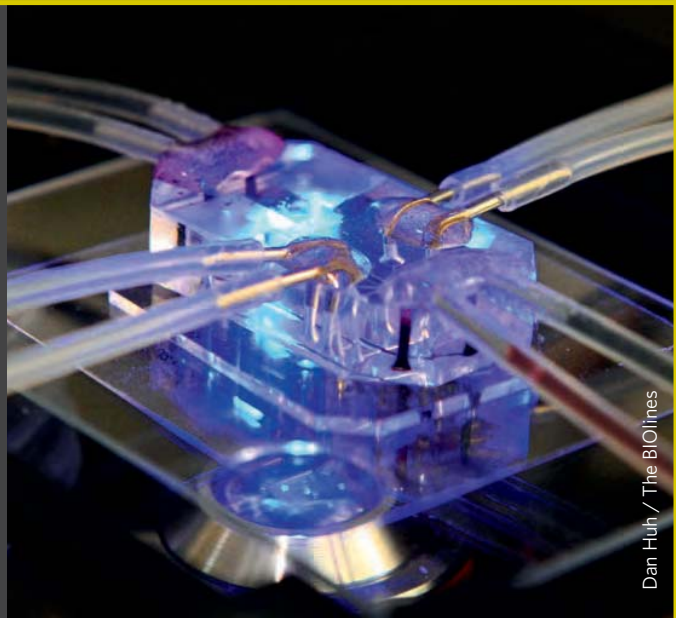
# Through the Lens

## Research Images from Penn Engineering

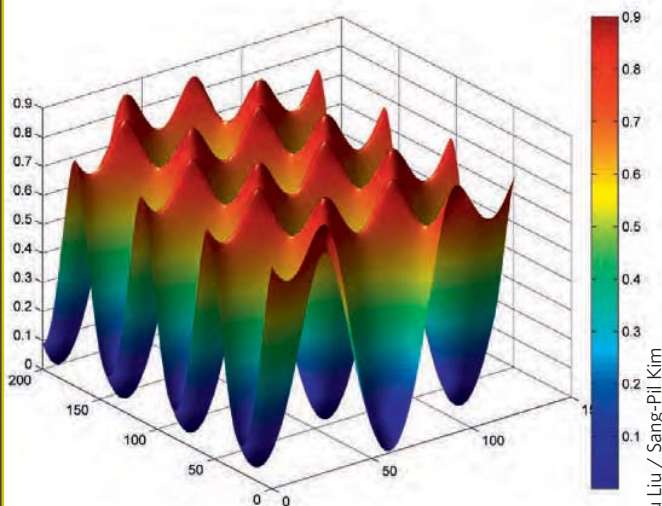
### Creating a "lung-on-a-chip"

Tiny microfluidic devices are being used to help researchers better understand the progression of chronic lung diseases, including asthma, and formulate effective therapeutics against them. Developed by **Dan Huh**, Wilf Family Term Assistant Professor in Bioengineering, this "organ-on-a-chip" is composed of living human tissue on a flexible polymeric scaffold in a three-dimensional microfluidic device. Huh's group designs these devices to model human disease with the goals of enhancing basic physiological research and improving drug testing and environmental monitoring.

*A "lung-on-a-chip" device uses microfluidics to simulate the mechanics of a living organ.*



Dan Huh / The B(OL)ines



Xin-Zhou Liu / Sang-Pil Kim

### Manipulating friction for two-dimensional materials

Unlike with "slippery" materials at the macroscale, such as Teflon, adding fluorine to carbon-based materials at the nanoscale, like graphene, vastly increases the friction experienced when sliding against the material. A collaboration between the laboratories of **Robert Carpick**, John Henry Towne Professor and chair of Mechanical Engineering and Applied Mechanics, and **Vivek Shenoy**, professor in Materials Science and Engineering, has discovered the mechanism behind this surprising finding, which could help researchers better design and control the surface properties of new materials.

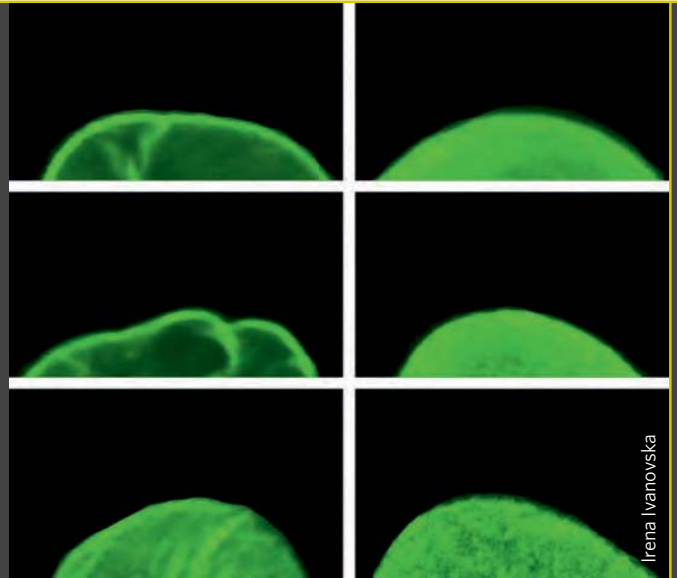
*The energy corrugation of a sheet of fluorinated graphene shows great electronic roughness, leading to friction at the nanoscale.*



## Finding the key to cell differentiation

Lamin-A, a protein found in the nuclei of all adult cells, plays a key role in how a generic cell develops into a specific cell. The research group of **Dennis Discher**, Robert D. Bent Professor in Chemical and Biomolecular Engineering, has found that higher levels of lamin-A were correlated with greater protection of DNA and with added rigidity. Manipulating its levels could be broadly important to human health, and these findings could pave the way for more effective regenerative medicine techniques and better drug targets.

*Cells grown on a soft matrix (left) have a wrinkled nuclear lamina, but when grown on stiff matrix (right), it is smoothed, regulating gene expression.*

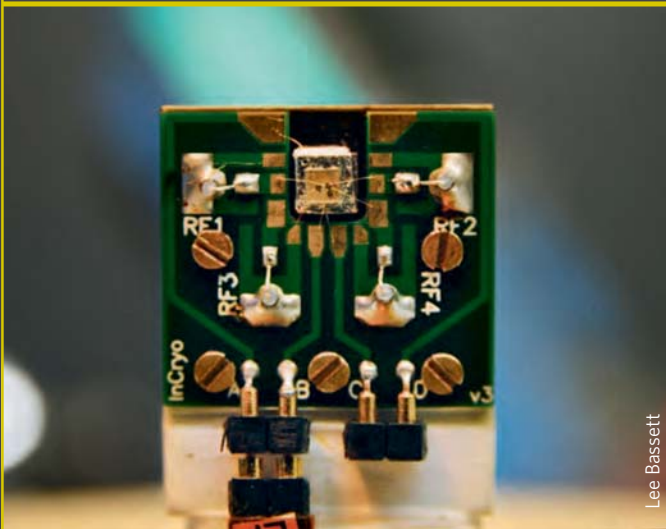


Irena Ivanovska

## Controlling a single electron

A collaboration involving **Lee Bassett**, assistant professor in Electrical and Systems Engineering, has developed a way to control the quantum mechanical behavior of individual electrons trapped in an atom-scale defect in diamond. Using fast pulses of light, Bassett recorded snapshots of the electron's "spin" as it evolved in time. This work contributes to the emerging science of quantum information processing and could accelerate development of quantum computing devices and the extra computing power that would come with them.

*A diamond crystal, seen as a small square in the center of the image, is mounted for optical and electrical measurements.*

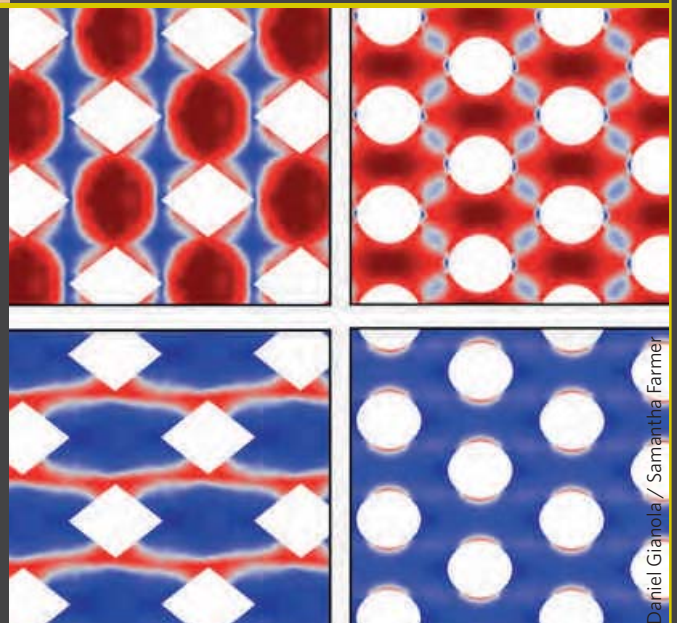


Lee Bassett

## Strain engineering for energy conversion

Nanostructured silicon (Si) has attractive properties for direct thermal-to-electrical energy conversion such as relatively high efficiency, unprecedented mechanical strength, earth abundance and non-toxicity. Research from **Daniel Gianola**, Skirkanich Assistant Professor of Innovation in Materials Science and Engineering, shows that elastic strain engineering of Si nanomeshes results in tunable electrical and thermal transport, highlighting the promise of future energy conversion devices. The color variation in the nanomeshes shows the amplification and complex patterns of strain that develop during use.

*"The Red and the Blue" in this case demonstrate how strain can be used to tune electrical and thermal conductivity in nanomesh samples (red=high strain, blue=low strain).*



Daniel Gianola / Samantha Farmer

# Fast Forward

## A Father-Daughter View of Penn Engineering's Evolution

By Jessica Stein Diamond

*Paul and daughter Susan Greenberg's experiences as undergraduate engineers at Penn span more than three decades and illuminate the increasing centrality of engineering at the University and in the global economy. As a Penn Engineering Overseer, Paul Greenberg (WG'87, EE'83), CEO and founder of Lutetium Capital, has witnessed Penn's major institutional investments in engineering with its recent building boom and curriculum expansion.*

*In this Q&A, Paul and Susan discuss decades of change at Penn Engineering and its first-of-its-kind Networked & Social Systems (NETS) program, which prepares leaders for the emerging networked economy. Susan will graduate from NETS' inaugural class in 2015. According to Michael Kearns, NETS faculty founder and National Center Professor in Computer and Information Science, "She has been the nexus of the NETS community to whom students and faculty alike look for advice and leadership as she has helped us refine this curriculum. It's extremely rare to have an undergraduate like Susan with her quantitative abilities and inquisitiveness, and courage to major in something that didn't previously exist."*

### *What attracted you to Penn?*

**Paul:** How I ended up here was probably 50 percent choice and 50 percent brainwashing. Both my parents went here. When I was growing up they took me to homecoming games and brought me to campus libraries to research papers in high school. Penn appealed to me because I could go to its engineering school but be friends with people who weren't engineers.

**Susan:** I was also brainwashed to a certain extent. While my dad also began taking me to homecoming games when I was seven, I have to say NETS is the reason I'm at Penn. I was on the USRowing Junior National team in high school and was recruited to row for Princeton, which has a top-ranked team. I decided that the opportunity to understand the logic behind the newly emerging technologies that I grew up with, like the Internet, social media, and social and consumer networks that had never existed before, appealed to me more. To see the explosive growth of these technologies, how they're built, how they work and how they're interconnected is the most amazing thing I can think of. Coming to Penn and doing NETS has been the best decision I've made in my life so far.

### *How has Penn Engineering shaped your career?*

**Paul:** Overall, engineering instills you with this sense of wonderment about the world, of what's new and how it works. It also gives you a framework to solve problems. As a fundamental research investor, I'm always looking at how companies work and how they make money. I have to figure out the five things that are important to the success of the company out of 100 data points. The hard part is figuring out which five are important. My engineering training gives me the ability to hone in on those details very quickly.

**Susan:** Like my dad, I learned how to break down large problems into manageable pieces, translate them into a format computers understand, and use logical steps so everything works. After I graduate, I will join Igneous Systems, a startup in Seattle, Washington. Over the past three summers, I assisted Professor Kearns in developing a Coursera course called *Networked Life*, worked in technology development at Morgan Stanley, and last summer worked at Amazon Web Services after taking the course *Scalable and Cloud Computing*. That has been my favorite class because I learned skills that felt magical. I can now crunch vast amounts of data and quickly get results that are meaningful.





*Susan Greenberg (CIS'15) and her father Paul Greenberg (WG'87, EE'83) share stories about the decades of change at Penn Engineering.*

**"I decided that the opportunity to understand the logic behind the newly emerging technologies that I grew up with, like the Internet, social media, and social and consumer networks that had never existed before, appealed to me. To see the explosive growth of these technologies, how they're built, how they work and how they're interconnected is the most amazing thing I can think of. Coming to Penn and being part of NETS has been the best decision I've made in my life so far." Susan Greenberg**

### *Biggest challenge at Penn?*

**Paul:** For me, sophomore year was when the rubber hit the road. My GPA really went down. That was my wake-up call that 90 percent effort is not good enough. You have to give 100 percent. That's when I figured out that if you want to be successful, it's an all-out effort. Everyone has to hit that hump sometime in their life. I'm just happy I hit it when I was 20.

**Susan:** Feeling like I deserved to be at Penn. My freshman year I spent a lot of time wrestling with the thought that maybe the reason I got into Penn was because of my dad. I took *Mathematical Foundations of Computer Science* first semester freshman year. This proof-based class was more mathematically rigorous than any of my high school classes. Before the last preliminary exam, I went to Professor Max Mintz's office hours with a group of friends. When everyone stood up to leave, he asked me to stay. All I could think was, "Uh oh, he's going to tell me I'm failing." He just asked me, "Are you okay? You seem really stressed. You're going to be fine. I know you're smart. You just need to relax."

### *Changes between then and now?*

**Paul:** Engineering felt far from the center of the academic universe during my undergraduate years. It felt more like we were out around Neptune relative to Wharton and the Perelman School of Medicine. Today, the world has changed to the point where people see engineering as pretty important. The best change by far is the number of women professors and students. When I was an undergraduate, my classes had either one woman or zero women. The intellectual assets of women were being underutilized.

**Susan:** Penn is among the engineering schools with a better male-to-female ratio with 34 percent women undergraduates. The women on campus are a great community. It's nice to get a break from all the testosterone. Still, time and again when guys meet me and ask what school I'm in, they're in shock when I say I'm an engineer. Having other women there to laugh at that silliness is helpful. We say: "We're here to stay. We're going to take over. Don't worry about it!"

One of my dad's favorite things to say is that he's never met anyone who didn't love their time at Penn. That's the biggest thing that's the same. And I hope that never changes. Everyone I know here truly loves Penn. ☺





# Global Connections

## Forging a Partnership in Rwanda

By Robert DiGiacomo

**Impact.** One of three key tenets in Penn President Amy Gutmann’s Penn Compact 2020, “Impact” captures University-wide efforts to engage “locally, nationally and globally to bring the benefits of Penn’s research, teaching and service to individuals and communities at home and around the world.” Engineers, at heart problem-solvers, are perhaps best poised to do so as they apply their unique skillsets to bring about solutions to some of the world’s most pressing problems.

When Michale Goldberger (EE’16) applied to Penn’s International Internship Program for an opening at the Gashora Girls Academy of Science and Technology in Rwanda, she had a specific goal: to find out firsthand about life in the developing world and how she could align her skills to both be a role model for women and find out what problems are most in need of engineering solutions. Goldberger, along with Rebecca Baumher (CIS’16), spent a busy two months at the upper-secondary boarding school, helping students to launch interest

groups for robotics and alternative energy, prepping them for the SAT exam and advising them on college essays. Their stay wasn’t all work—they also bonded with their peers over a shared love of Facebook and American movies. In exchange they received a crash course in African pop culture. “The young women at Gashora are awesome,” Goldberger says.

## Collaborative Solutions

Wanting to assess directly how Penn could make the biggest impact on Gashora, a group of University faculty, staff and students first visited the school last spring. From those conversations emerged a consensus to implement a project to make Gashora less dependent on Rwanda’s overburdened energy grid, which cannot always support the school’s computer lab. As a result, next spring this collaboration will integrate a solar energy project into a Penn class to be taught by Jorge Santiago-Aviles, associate professor in Electrical and Systems Engineering. Following the class, a team of

Scale 1:51,400,000  
Cylindrical Equal-Area Projection

800 Kilometers  
500 Miles

Boundary representation is not necessarily authoritative.

more than a dozen students from Penn and the Agnes Irwin School, a private preparatory school for girls and young women located in Bryn Mawr, Pennsylvania, plan to travel to Rwanda to implement it.

In addition to the onsite activities, the collaboration has resulted in an online mentoring program in which 20 Penn students email regularly with their peers at Gashora. Future plans include the possible implementation of a post-graduate fellowship for one to two Penn students to spend one year at Gashora following graduation. Fellows would devote their time assisting with SAT prep and general awareness about college in the U.S., along with overseeing Penn's onsite projects.

Goldberger is one of the first students to travel to Rwanda to engage in the partnership between Penn's School of Engineering and Applied Science and Gashora. This multifaceted initiative is the first such international program at Penn to focus on women, according to Michele Grab, director of the Advancing Women in Engineering Program at Penn Engineering. "It reflects what our students are telling us. They want more international opportunities, particularly for women," Grab notes.

"Gashora's goals line up with our School's educational mission and our values, as well as our outreach to girls and women for engineering and our global service agenda," says Joseph S. Sun, vice dean for academic

affairs and director of the Office of Academic Programs at Penn Engineering. "They are an excellent example of an all-female school that wants to effect change."

## New Perspectives

What impressed Goldberger the most was the Gashora students' dedication to improving their circumstances in ways both big and small. Though it has been 20 years and these students were not yet born, the 1994 genocide that claimed 1 million lives still has a lasting and strong impact on Rwanda as a nation. The entire school, for example, spends the last Saturday of each month doing community service, and its students are determined to earn college degrees overseas and bring their knowledge back home in order to improve Rwanda's future. "It was amazing to hear how they want to change their country and build it up; they are so devoted," Goldberger says. "It was inspiring. Science and engineering are difficult fields no matter where you are being educated. In a country facing so many challenges, you have all of these women who are willing to work as hard as they can to improve their country in tangible ways."

Beth A. Winkelstein, associate dean for undergraduate education and a professor in Bioengineering, noted that the Gashora program gives Penn students a critical, real-world view of what it's like to collaborate at the international level. "The engineers of today need to be







able to understand the global setting,” Winkelstein says. “The African experience is very different from many of our students’ perspectives. When they go through design and engineering projects at Penn, and we tell them about the challenges that engineers face when abroad, it’s very different for them to think they understand what those challenges mean and to actually experience it.”

## Finding Inspiration

For Gashora, the connection to Penn offers a way to broaden its intensive curriculum beyond the borders of Rwanda, according to Peter Thorp, executive director of the U.S.-based Rwanda Girls Initiative, which runs the school in conjunction with the Rwandan government. Situated in a rural area, the school reflects an ongoing commitment to improving conditions for women. Rwanda boasts the only parliament in the world with majority female representation—nearly two in three lawmakers are women—yet just 13 percent of its young women attend secondary school. Gashora’s first class

of 90 students graduated last year, with about one in three attending top schools in the U.S. and Canada, including a student who is part of Penn’s Class of 2018. “The pairing with women in engineering gives our students access to role models and advice from young women at Penn who are a few steps ahead of them in the process, but following the same path,” Thorp says. “It’s a pragmatic resource, but more importantly, an inspirational connection that’s already had a profound impact on our school.”

As Goldberger resumes her regular schedule of classes and campus activities, she is still processing her Rwandan experience and believes it will inform coming decisions about her future. “I’m trying to figure out exactly what I want to do,” Goldberger says. “I learned so much about many different kinds of people and how best to interact with them. It concerns me that we have countries in the world that get forgotten. It made me feel passionately that I can work in alternative energy and address this very global need.”





**Danielle Bassett**



# Danielle Bassett

## Giving Creativity Free Reign

By Janelle Weaver

Danielle Bassett's love of research began in childhood. Homeschooled by her mother, she was encouraged to develop her own curriculum focused on research questions. "I had an insatiable appetite for discovery, which she encouraged with extensive freedom. I was hooked, and have remained so ever since," says Bassett, now the Skirkanich Assistant Professor of Innovation in the Departments of Bioengineering and Electrical and Systems Engineering.

Lured by the potential for discovery, Bassett embarked on a research career after graduating from Penn State University. She earned her Ph.D. in Physics at the University of Cambridge and was a postdoctoral fellow at the University of California, Santa Barbara, where she branched into the brain sciences.

Making a seminal contribution to the growing field of network neuroscience, Bassett and her collaborators discovered that people whose brain regions interacted flexibly in different combinations learned better than individuals with more rigid brain networks. "Viewing the brain in this way stands in contrast to the traditional emphasis on the role of single brain regions, and instead emphasizes the pattern of interactions between many brain regions as the fundamental driver of thought," she notes.

### Inspiring Investment

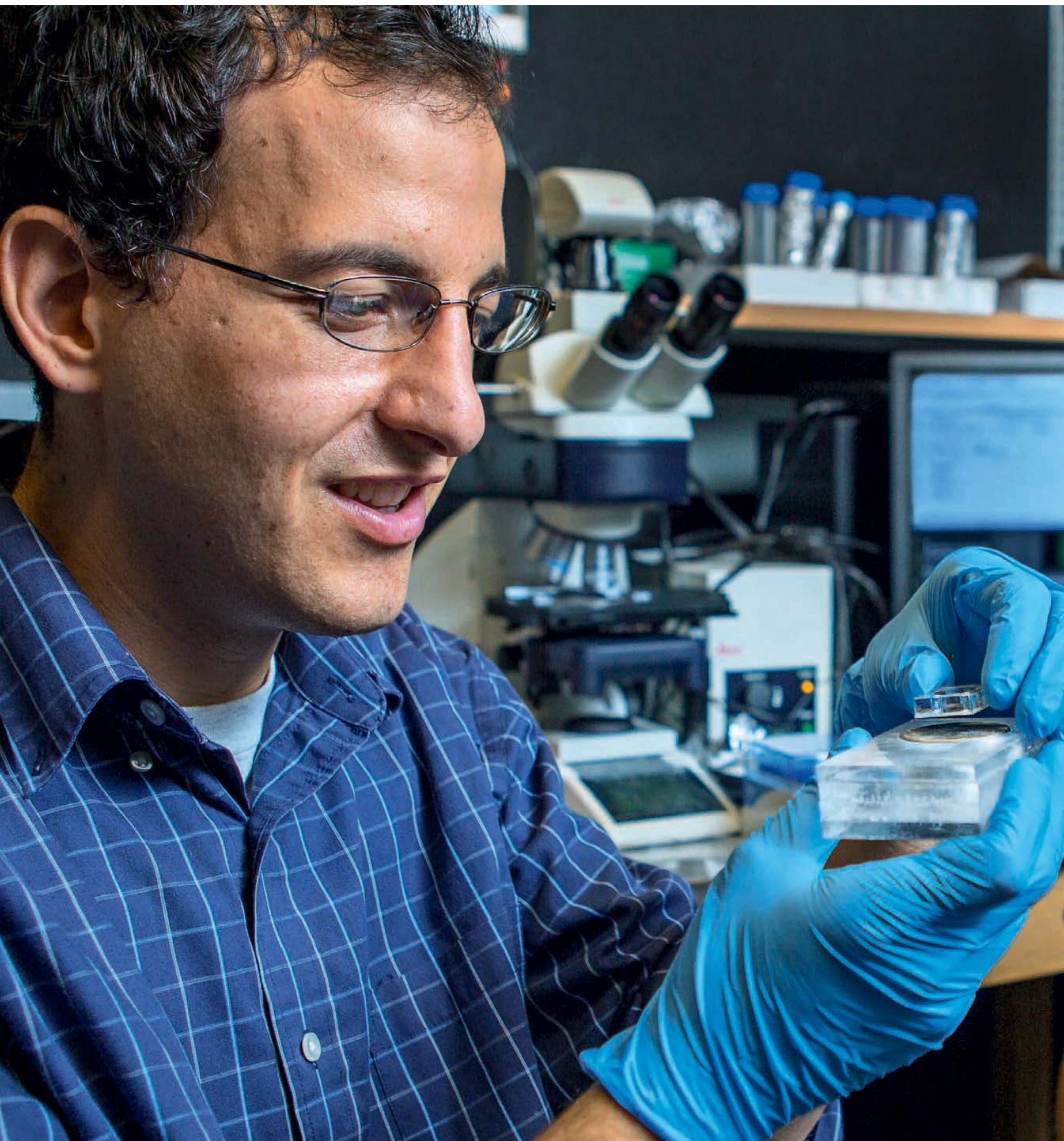
For such displays of extraordinary insight and originality, Bassett received a prestigious MacArthur Fellowship in September. The so-called "Genius Grant" provides unrestricted awards to talented individuals who show exceptional creativity and promise for important future advances. "Receiving this award is one thing: inspiring," Bassett states. "I am inspired to give creativity free reign in my scientific inquiry, and to extend my efforts in translating my work for the betterment of humanity."

Having joined the Penn faculty only one year ago, Bassett is continuing her quest to understand complex networks by collaborating with researchers across four schools and eight departments. "One of the advantages of being a scientist at Penn is the compact campus brimming with fantastic expertise and ideas across the full gamut of disciplinary fields," she reports. "It is the most fantastic sandbox I could imagine!"

### Boosting Brain Health

Currently, Bassett's group is developing mathematical tools to understand how brain networks reconfigure over time, shedding new light on human learning, language, motor behavior and psychiatric disease. By examining the disruption of normal connectivity patterns in individuals with schizophrenia or brain injuries, Bassett hopes to optimize treatments and rehabilitation strategies. "Many of my projects are focused on gaining knowledge directly relevant to mental health, leading to better diagnoses, more accurate prognoses and innovative treatments."

With the goal of improving mental health, Bassett is now puzzling over many questions: How can we tune learning environments in the classroom or workplace to enhance brain network flexibility? What treatments increase brain network flexibility? Is there such a thing as too much flexibility? "We have so many ideas that we are ready to implement, and the MacArthur Fellowship enables us to tackle those ideas immediately," Bassett says. "That said, it is difficult to imagine what questions I might be addressing five to ten years from now. The swift pace of scientific inquiry is one of the things I find most exciting and intoxicating about my job." ▾



*David Issadore works on a magnetic micropore device that will be engineered to detect, with extremely high sensitivity, HIV virus in a patient's blood.*



# Miniature Devices, Life-size Impact

By Manasee Wagh

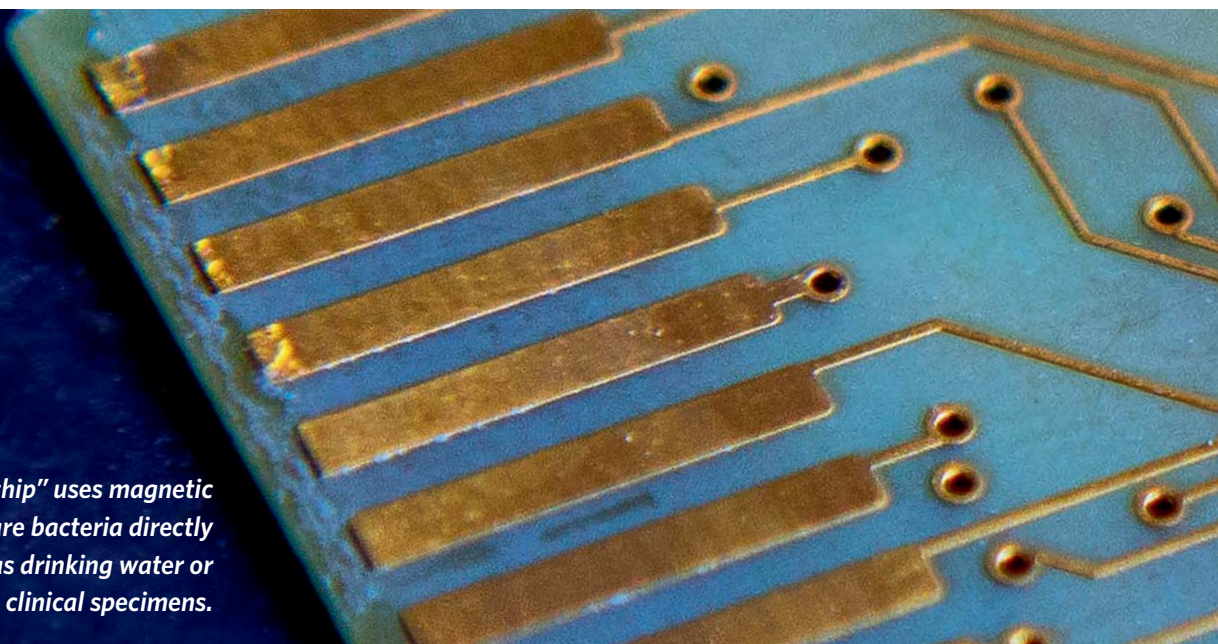
Before joining the Penn Engineering faculty, David Issadore was immersed in a quantum mechanics problem at Harvard University. However, during this time he found his mind wandering to the lab next door, which was building miniaturized diagnostic tools for disease. After talking with the students in that lab about their research, he was hooked, and decided to switch from studying theoretical electron behavior to studying a way to design a portable disease-detection tool.

“It’s very appealing to work on projects that are both interesting and could have an enormous impact in helping people,” says Issadore, assistant professor in Bioengineering. After graduating from Harvard in 2009 with a Ph.D. in Applied Physics, he has been focused on revolutionizing medical tools and hasn’t looked back.

At Penn since 2012, Issadore has built a microchip that marries technologies from the fields of microelectronics, nanomaterials and microfluidics in order to measure biomarkers for conditions such as tuberculosis, flu, cancer and traumatic brain injury with a simple test. Issadore hopes the design of this “lab-on-a-chip” and its hand-held reader will do for medical diagnostics what cell phones have done for telecommunications: bring a sorely needed service to people living anywhere, even in remote and developing areas of the world where full-scale laboratory operations are not yet feasible.

“The type of semiconductor technology we are using allows us to build extremely complicated things at low cost,” Issadore notes. “Patients in some areas have to wait days to receive medical test results. But if you’re able to take that process and put it into a package that looks like a cellphone, you can bring the diagnostics to the doctor’s office, the pharmacy, or even the patient.”





*Issadore's "lab-on-a-chip" uses magnetic micropores to isolate rare bacteria directly from samples such as drinking water or clinical specimens.*

## A Beautiful Technology

One of Issadore's goals is to detect rare cells, such as cancer cells that circulate in the blood and are hard to differentiate from healthy cells. His project deals especially in pancreatic cancer, which can spread early and aggressively and evades most modes of detection. "By developing a new tool that can measure pancreatic cancer cells in blood, there is a great opportunity to both catch the disease earlier and to understand it better," Issadore says.

His diagnostic chip picks out the cancer cells with the help of magnetic iron oxide nanoparticles, which are engineered to stick only to the cancer cells' distinct surface proteins in a blood sample. Magnetic field sensors identify these cells using a technique similar to a computer's hard drive scanning data. Additionally, he and his group are developing a chip to isolate pancreatic cancer cells so that each of these cells can be studied one at a time. As the cells move one-by-one over the sensors, strong magnetic traps pull them aside from the rest of the blood for a closer look.

In collaboration with the Perelman School of Medicine's Ben Stanger, associate professor of Medicine in the Division of Gastroenterology, and Erica Carpenter, director of the Circulating Tumor Material Center, Issadore is applying his diagnostic device to samples from mice engineered to carry human pancreatic cancer.

The team hopes they will be able to translate what they learn to clinical trials in about a year.

Combining microfluidics, microelectronics and nanomaterials in this way results in a "beautiful" technology, Issadore notes, because it's compact and accesses biological matter previously too tiny to measure.

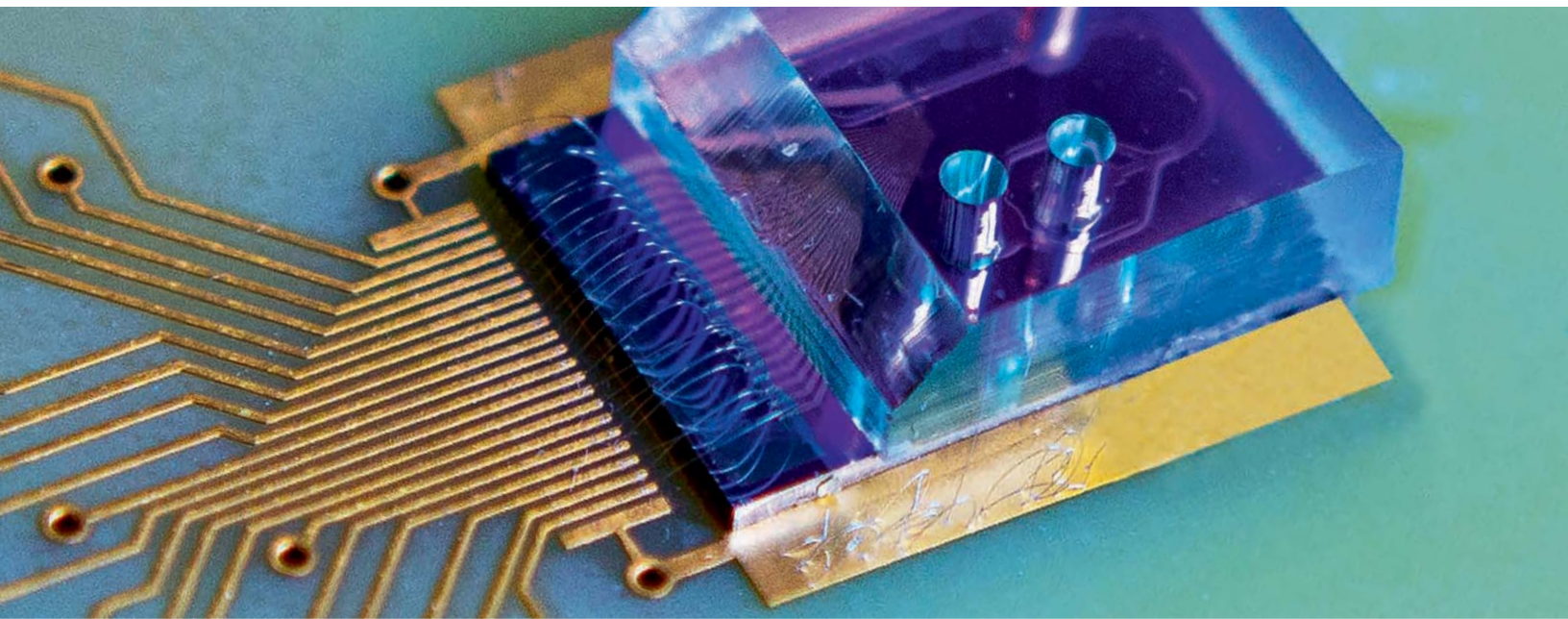
## Discovering Hidden Solutions

Enter exosomes, tiny lipid membrane spheres about 100 times smaller than cells. Previously, scientists thought they were simply cell debris, but it turns out that exosomes, which circulate throughout the body, carry a wealth of information from the cells that shed them.

"The great thing about exosomes is they're so small they just get everywhere. In a blood sample, you can find exosomes originating from all over the body," Issadore notes. Using his technique for exosome detection could enable diagnostics for cancers in hard-to-access deep tissues, such as ovarian or brain cancer, without the need for invasive procedures. They also can carry markers for brain injury, a condition that's hard to diagnose.

The team is also working on detecting infectious diseases, mainly tuberculosis, whose bacteria are present in phlegm. An effective and inexpensive test for its early detection is hard to access in developing countries, where the disease spreads rapidly and can resist antibiotics.





*Rare pathogens (right) captured on one of Issadore's chips.*

The Penn Center for AIDS Research and the Abramson Cancer Center at Penn have both facilitated his collaboration with the Perelman School of Medicine, Issadore remarks. "Penn is the best place in the world for this work. We're a great engineering school, but what makes us unique is that we're right next to this enormous medical education and research complex. None of this work would be possible without combining brains and resources."

Issadore's style encourages teamwork, says David Meaney, Solomon R. Pollack Professor and chair of Bioengineering. "David's research is a wonderful example of everything that Penn offers to each of us: meaningful collaborations with scientists and clinicians on focused problems that would have great clinical impact if they were solved."

### **A Teacher at Heart**

Issadore's talents aren't confined to the lab. Both undergraduate and graduate students praise his ability

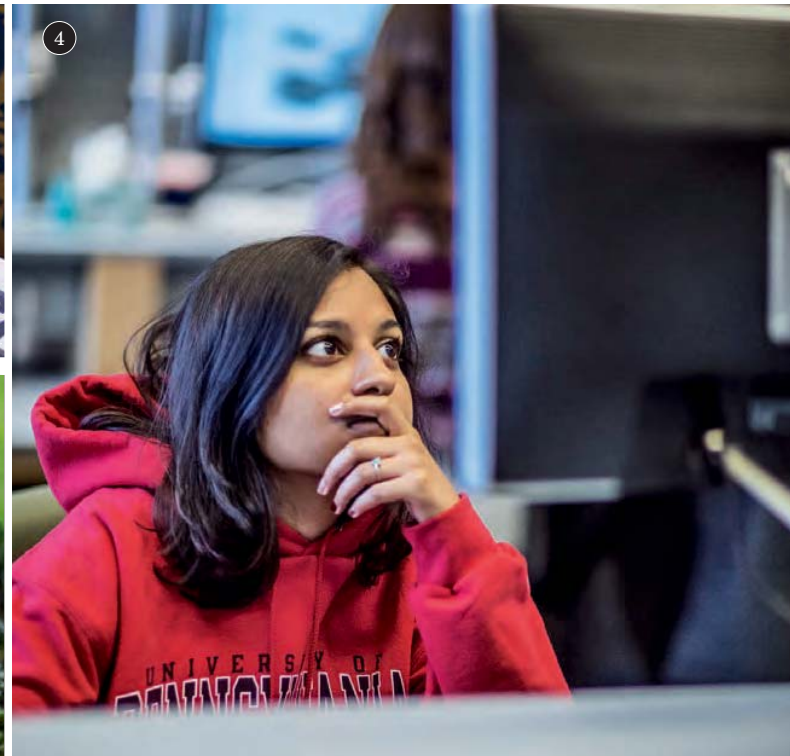
to break down difficult concepts and his genuine interest in helping others grow intellectually and professionally.

Max Wasserman, an undergraduate student, is part of Issadore's team. He's impressed by the professor's mentorship and dedication to helping students expand their learning outside of the classroom. "At any time of the day, you know he's willing to talk about any of your ideas or questions without hesitation," Wasserman says.

Issadore is currently teaching freshman chemistry and a junior lab course on bioinstrumentation. This past spring, the undergraduate student body and the Engineering Alumni Society presented Issadore with the S. Reid Warren, Jr. Award, given annually in recognition of outstanding service in stimulating and guiding the intellectual and professional development of undergraduates.

"He encourages his students and is easy to work with," notes doctoral candidate Jin A. Ko. "He is highly involved in the lab's work, and this motivates me to work hard." ▾



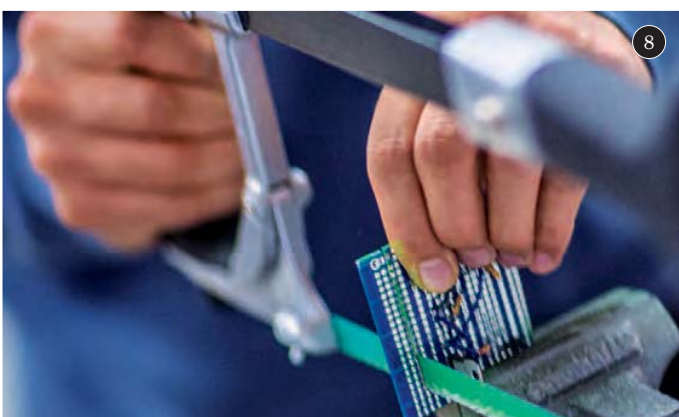


# On Our Camera Roll



**1/ Penn Engineers prepare to host PennApps, the world's largest student-run hackathon. 2/ Enjoying a fall day outside the Towne Building. 3/ Students perform calculations to design a microfluidic device. 4/ Analyzing the data from an electrocardiogram (ECG) signal. 5/ Undergraduates relax at lunch in the Quain Courtyard.**





**6/** The search is on for the right cable to use in the GRASP Lab. **7/** Sophomore Alissa Johnson recharges her iPhone at one of Penn Engineering's newly installed charging stations. **8/** Using a hand saw in the Detkin Lab to shape a protoboard. **9/** An early morning on campus. **10/** The Grand Opening of the AddLab, a new additive manufacturing facility that will feature a suite of state-of-the-art 3D printing tools.





# The Hexagon Society

## Inspiring Future Quakers

By Patricia Hutchings

The adage is well known: You don't get a second chance to make a first impression.

This is precisely the reason that Penn Engineering's Hexagon Society provides an invaluable service to the School and the University. Sometimes called the "student recruitment arm" of Penn Engineering, members of the 104-year-old Hexagon Society serve as campus tour guides for high school juniors and seniors and their families during the college selection process, providing information and insight into life at Penn to prospective Quakers.

"Hex" members are, quite literally, "the face of Penn Engineering," says Ellen Eckert, associate director of Admissions and Advising at Penn Engineering.

They represent the School in often memorable and lasting ways, such as helping to staff Quaker Days, a weekend-long event held for accepted regular-decision students in April. There they share their academic and extracurricular experiences and are available to address questions, the answers to which may be key to a student's decision to choose Penn.

### Highly Involved, Outgoing Students

A Penn Engineering senior society, Hexagon was established in 1910 to create unity and social interaction across the engineering majors. It is an association of volunteers, whose members are "tapped," or identified, by other members, usually in the spring of their junior year. Hexagon's website states that the





Society “seeks highly involved, outgoing students” for membership. They certainly got what they were looking for—and more—with Miranda May and Daniel Langer, co-vice president and president, respectively.

Miranda May (EE'15) exudes contagious enthusiasm for all things Penn and Penn Engineering, and even aspired to become a college tour guide while still in high school. When looking at schools herself, May was aware of the prevailing advice not to base one's opinion of an institution on the person leading the tour, but she also understands firsthand just how influential a student representative can be.

May and the other Hexagon guides strive to give a balanced, inclusive presentation to which a diverse

group of visitors can relate. Penn prospects might easily envision having an engaging and accessible student like May as a classmate or friend once on campus. Also a member of Penn's Kite and Key Society, she conducts tours of the entire University campus.

May's keen interest and aptitude in math and the sciences as a high school student in Washington, D.C., earned her early acceptance at Penn, where she is a dual degree candidate in Electrical Engineering at Penn Engineering and in Business at Wharton. She first learned of the Hexagon Society as the only freshman member of the Engineering Dean's Advisory Board (EDAB), in which fellow members mentored and supported her.



**Penn Engineering's Hexagon Society provides an invaluable service to the School and the University. Sometimes called the "student recruitment arm" of Penn Engineering, members of the 104-year-old society serve as campus tour guides for high school juniors and seniors and their families during the college selection process, providing information and insight into life at Penn to prospective Quakers.**

This past summer, May interned at Microsoft as a program manager, and found her niche and possible profession in bridging her engineering and people skills. It's no surprise she's been invited back.

## Hands-on Impact

A self-described "techy kid," Daniel Langer (CIS'15) knew early on that he would not be following his father's career path into law or his mother's into medicine. When he visited the Penn campus during his junior year spring break tour, he was sure it was the place for him the moment he set foot on Locust Walk.

A native of Chicago, Langer was attracted to the "controlled chaos" of the campus and has not once regretted his decision. He has changed his mind about one thing though—after an inspirational survey course in computer and information science, Langer changed his major to Computer Science with a minor in Engineering Entrepreneurship. He is looking forward to entering the startup world, where he can have a hands-on impact on a growing business.

In his junior year, Langer was tapped for the Hexagon Society by a friend. A member of the Zeta Beta Tau fraternity, he believes that the relationships built in

college are of the utmost importance, and was attracted to the idea of meeting a new and diverse group of engineering students. He immediately signed up.

## A Unique Presentation

After shadowing seasoned Hexagon members, new guides usually lead their first tour with a senior, but Langer's first experience was unexpectedly solo: Penn Engineering had drawn an especially large crowd that day and doubling up wasn't an option. Tours are generally not scripted; guides create unique presentations shaped by their personal experiences and knowledge of the School. Langer's love of Penn and his confident, easy-going enjoyment of "showing off" Penn Engineering no doubt made him a natural.

Penn Engineering received close to 8,000 applications for admission to the Class of 2018, a 34 percent increase over the previous year, and it is projected that May and Langer and the 36 other members of the Hexagon Society will have another busy year. If their "Pennthusiasm" and talent for recruiting others can be factored into the metric, Penn Engineering can only continue to grow in popularity and reputation. ▾



WillowTree's new official NCAA sports app allows users to follow college sports at their favorite schools, including Penn.

# Tobias Dengel

## App-titude for Surfing the Mobile Wave

By Jessica Stein Diamond

Today's global mobile economy didn't exist and could scarcely be imagined in 1994 when Tobias Dengel graduated from the Jerome Fisher Program in Management & Technology at Penn.

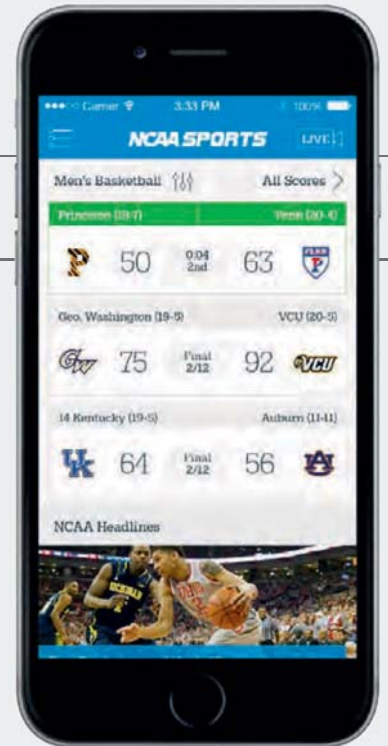
Dengel remembers that just one of his classmates used a cell phone the year he obtained a joint degree in Finance and Systems Engineering; that was also when AOL began widespread marketing for direct consumer access to the Internet. Today, the mobile economy has grown to two percent of the world's GDP. And Dengel, CEO of WillowTree Apps, leads a mobile application development firm that ranks among the fastest-growing private companies in the United States with 2013 revenues of \$8.2 million.

"To be successful in many types of business, you really have to understand technology, how it's created, how it changes, and how to help drive that change," says Dengel. "I'm a huge believer that value in companies and societies is driven by innovation."

### Value of Agility

Over the past two decades, Dengel has deftly navigated the rapidly evolving networked economy, which has thwarted many a startup and once-mighty company. After graduating, he spent two years at a management consulting firm and then joined AOL as an analyst. Dengel describes his first four years there as one of the greatest jobs in the world. Then, between 2001 and 2003, he says, "AOL was in free fall because it became difficult to talk internally about the problems we were facing without being labeled disloyal or not on board. I learned there how quickly you can get caught off guard if you're not ready for change."

Dengel's 2003 startup, Leads.com, was sold nearly two years later to Web.com where he next worked as a senior vice president. When Dengel co-founded WillowTree in 2009, he prioritized responsiveness to employee feedback. "I learned early on that you have to be intellectually honest with yourself about what's going on





**Tobias Dengel**



**“I learned early on that you have to be intellectually honest with yourself about what’s going on in the marketplace,” says Tobias Dengel. “You need to remain inquisitive and constantly question in a positive way what you’re doing and be open to reworking solutions to problems.”**

in the marketplace,” he says. “You need to remain inquisitive and constantly question in a positive way what you’re doing and be open to reworking solutions to problems.”

Each of the more than 80 employees at WillowTree’s Charlottesville, Virginia-based office works in an open space with no doors, including Dengel. “That’s really important because it facilitates communication,” he says. “One of the first things I tell new employees is that if you ever have an idea or criticism, feel free to walk up and talk to me about it. A lot of the folks here are way smarter than I am when it comes to what they’re working on every day. My job is to leverage that.”

## Open-door Policy

“We urge employees to speak up if they see a new business opportunity, if they think we’re not doing something the right way, and when a development is a threat,” says Dengel. That philosophy has helped WillowTree pursue new clients and make difficult strategic decisions, such as expanding its Apple-only development team beyond iOS to Android, and more recently, expanding its services to developing apps for tablets and mobile computers that currently account for a third of mobile experiences.

So far, WillowTree has developed more than 250 memorable and useful applications for iOS, Android and mobile devices. The firm’s app for Barclays Center offers benefits such as instant personalized replays exclusively within the Brooklyn arena. WillowTree also developed an app for Johnson & Johnson’s BabyCenter

site currently used by seven out of ten pregnant women in the United States to track pregnancy milestones.

WillowTree’s client list includes GE, Time Warner Inc., AOL and the Department of Justice. Its fastest-growing area of business is developing enterprise applications used internally by companies to boost productivity. For example, an iPad app WillowTree developed for a firm whose employees repair and restock more than 300,000 vending machines has yielded an estimated 20 times return on investment. This factors in hardware and productivity savings and a streamlined process for ordering parts, billing customers and scheduling repairs.

## Cautionary Souvenir

In a photo hanging in his office, Dengel sits on an empty cardboard box while negotiating one of the company’s first deals, a cautionary souvenir from WillowTree’s precarious first year when on a few occasions the firm’s bank account dropped to zero. “It was hard to start a company during the recession, especially when a couple of large client deals were delayed or were smaller than expected,” he recalls.

WillowTree was founded more than a year after Apple opened the iPhone to independent developers in 2008. At the time, Dengel worried the firm was late to market. “What I’ve learned since is that if it’s a five- to ten-year technology wave, you’re still going to be early in the grand scheme of things. You don’t have to be the first one there. You can wait to see how some of these waves evolve.”





*Alvin, who traveled to RoboCup 2014 in Joao Pessoa, Brazil, practices a push pass.*



# World Champions!

## RoboCup 2014

By JoAnn Greco

This July, hot on the still-kicking heels of the 2014 FIFA World Cup, another group of soccer players took Brazil by storm. They played for just a week, stood just shy of five feet, and were made not of blood, sweat and tears, but of metal, motors and cables. Divided into 150-plus teams from 45 countries, they came to Joao Pessoa to compete in RoboCup, an annual event since 1997 that has pitted robots against one another. They come to win, of course, but are also in pursuit of the largest goal of them all: beating the human winners of the World Cup by 2050.

For the fourth year in a row, a team from Penn Engineering's General Robotics, Automation, Sensing and Perception (GRASP) Lab took home a first-place trophy. "I don't know if there's a secret sauce," laughs Stephen McGill, who captained the Penn team. "We test and test and test, and we use what we know is going to work." But, he adds, once the game starts, it's up to the robot. "We just stand there helplessly on the sidelines. The robot can tell us what it's thinking, but we don't have the input to correct it."

### Rising to the Challenge

To up the ante this year, the team, which also included students Larry Abraham, Chris Akatsuka, Dickens He, Karen He, Jianqiao Li, Sagar Poudel and Junda Zhu, and research staff member Seung-Joon Yi, decided to compete in the "AdultSize Humanoid League," wielding larger and much more expensive robots. "Robotic soccer is a great way of bringing together a lot of different engineering skills," says Daniel Lee, professor of Electrical and Systems Engineering, who coached the team and is director of GRASP. "It was a challenge competing in a new division, but the students did a great job preparing the new hardware and software."

In the KidSize league, in which Penn scored its three prior victories, the robots play three-on-three, are only about 18" tall, and kick around a tennis ball. "They're fairly quick and nimble; they can get up if they fall," says McGill. Penn's AdultSize competitors, Alvin (and his "brothers" Simon and Theodore), however, are much more costly and difficult to fix. "If Alvin had toppled, it would have been a huge disaster. But nothing went terribly wrong."

The team did have to make some programming adjustments for the one-on-one play in the AdultSize division. "We had to train the robot to kick an actual soccer ball and to do so more accurately. If he missed it by a slight bit, the ball would run into one of the fixed obstacles on the field."

### Plotting New Moves

Having Alvin pause before he made a move was one of the key challenges facing the programmers, McGill adds. The ability of people to pinpoint their vision so they can distinguish between a yellow goal post and someone in the stands wearing a yellow T-shirt is one of the greatest advantages that humans currently have over humanoids.

What else will it take for someone like Alvin to beat someone like David Beckham? "It will take both hardware and software improvements," says McGill. "We're going to need motors that allow robots to actually run with both feet leaving the ground. We're going to need better awareness so they can deal with light changes and other extenuating circumstances." As for Alvin, McGill adds, "he really needs to work on his defense." ▾





Frank White

**Alex Krueger**



# Alex Krueger

## A Diverse Education Fuels Success in the Energy Industry

By Janelle Weaver

As a child growing up in San Antonio, Texas, Alex Krueger (ENG'96, W'96) was heavily influenced by his two grandfathers. One was a chemical engineer and the other an accountant, and it turned out that Krueger himself naturally excelled in both math and science. "I was brought up hearing about the world of engineering and the world of business at the same time, so I decided to apply to schools that were good at both," he says.

The Jerome Fisher Program in Management & Technology at Penn lived up to Krueger's expectations. He loved having exposure to two entirely different fields: chemical engineering and finance/statistics. "I enjoyed the experience so much that I even dabbled with the idea of pursuing academia as a career," says Krueger, who now sits on Penn Engineering's Board of Overseers. "But I eventually realized the business world fit my personality better."

After graduating nearly 20 years ago, Krueger decided to move back to the South to be closer to his family. Soon he started working in the energy group

of Donaldson, Lufkin & Jenrette in Houston, convinced that he would be a career employee for the now-merged investment bank. But one day he received a phone call from the chairman and chief executive officer of First Reserve, a global energy-focused private equity and infrastructure investment firm headquartered in Greenwich, Connecticut. "They caught me at a moment of weakness, and I thought it would be a good time to try something different," Krueger says.

### Road to Success

Krueger moved to Greenwich in 1999 and joined as an associate at First Reserve, where he moved up the ranks and eventually became co-head of Buyout. He moved to the newly opened London office in 2008 to oversee operations and expand the firm's global footprint. Due in part to Krueger's hard work, the firm and its portfolio have experienced substantial growth since he first joined. "One of the most personally gratifying accomplishments was combining three different coal businesses at a time when the

**“One thing that has always motivated me is the people side of business. It’s incredibly important to me to create an environment where people want to come to work every day,” says Alex Krueger. “I credit my Penn education with a lot of my practical and people skills, especially problem solving and teamwork.”**

coal industry was not doing well,” he says. “Out of the ashes, we helped to build a thriving business that now employs thousands of people and delivered great returns for investors.”

Two years ago, Krueger became president of the firm and assumed greater responsibility for the development and management of the Buyout investment team. He also sits on both the Buyout and Infrastructure funds’ investment committees, in addition to maintaining responsibilities for investments in the global energy industry, with particular expertise in the natural resources sector.

“First Reserve’s hallmark has always been to build value by building companies, and it is a privilege to have been doing that on behalf of our investors throughout the firm’s three decades,” Krueger says. “But one thing that has always motivated me in this endeavor is the people side of business. It’s incredibly important to me to create an environment where people want to come to work every day.”

## Overseeing Innovation

Now that Krueger has achieved such a high level of success, he is eager to give back to causes that have

helped him along the way. “I credit my Penn education with a lot of my practical and people skills, especially problem solving and teamwork,” he says. Krueger has stayed close to the faculty over the years, and he learned about the chance to serve on the Board of Overseers when he reconnected with his former advisor Eduardo Glandt, Nemirovsky Family Dean of the School of Engineering and Applied Science. “I was excited about the opportunity to contribute to Penn Engineering’s strategy and support Eduardo in his mission,” Krueger says.

Since joining the board three years ago, Krueger and the other members have witnessed the construction of the Krishna P. Singh Center for Nanotechnology. “We were all very supportive of Dean Glandt’s vision to make sure that the School has the best resources available to support current faculty and attract leading minds from around the world,” Krueger says. “I’m also a huge fan of his focus on joint programs. From firsthand experience, I see immense value in broadening students’ perspectives by fostering an incredibly deep understanding of two fields that approach problems entirely differently.” ▾



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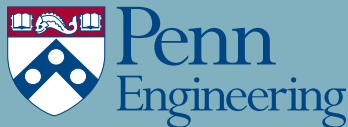
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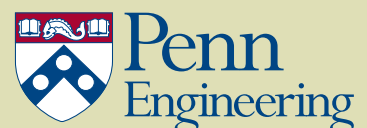
As an Alumni Mentor, a first-year student is matched with you for one year, expanding perceptions of a career field and receiving your personal and professional career guidance.

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The Engineering Alumni Society offers alumni other opportunities to get involved with the School and the University. Visit our website at [www.seas.upenn.edu/alumni/alumni-society/index.php](http://www.seas.upenn.edu/alumni/alumni-society/index.php)



GREAT FACULTY

**New Faculty**



**Sue Ann Bidstrup-Allen**

*Professor in Chemical and Biomolecular Engineering*

Ph.D. in 1986 in Chemical Engineering  
 University of Minnesota  
 Postdoctoral position at the Georgia Institute  
 of Technology

Dr. Bidstrup-Allen’s research group works at the interface of chemical engineering and materials science, focusing on the design and synthesis of polymeric materials for a range of electronics, optical and biological applications. The development of new dielectrics for microelectronics and packaging has been of primary interest. This work has been extended to the fabrication of low-cost MEMS packages. More recently, micromachining techniques have been developed to produce high-performance current collectors with controllable architectures for energy storage devices.

**Honors & Awards**



**Portonovo Ayyaswamy**, *Asa Whitney Professor of Dynamical Engineering in Mechanical Engineering and Applied Mechanics*, has been selected as the 2014 recipient of the prestigious ASME/AIChE Max Jakob Memorial Award, for his “outstanding contributions to the science and art of heat and mass transfer.”

“The Max Jakob award is considered to be ‘the Nobel Prize in Heat Transfer,’” notes Eduardo Glandt, Nemirovsky Family Dean of Penn Engineering. Preceding Dr. Ayyaswamy, two other Penn Engineering professors, Dr. Stuart W. Churchill (1979) and Dr. Benjamin Gebhart (1993) also received this distinguished honor.

The award will be presented at the ASME 2015 International Mechanical Engineering Congress and Exposition in Houston, Texas, in November 2015.



## Honors & Awards



**Joseph Bordogna**, *Alfred Fitler Moore Professor in Electrical and Systems Engineering and Penn Engineering Dean Emeritus*, has been honored by the Board of Directors of Ben Franklin Technology Partners of Southeastern Pennsylvania with a resolution acknowledging his more than 30 years of dedicated support of the organization, and his nine years of service on its Board of Directors.



**Nader Engheta**, *H. Nedwill Ramsey Professor in Electrical and Systems Engineering*, is the recipient of the Balthasar van der Pol Gold Medal from the International Union of Radio Science (URSI) for "groundbreaking contributions and innovations in electromagnetic theory and applications of composite materials, metamaterials and nanoscale optics, bio-inspired imaging and sensing, and material-based optical nanocircuitry."



**Cora Ingram**, *Director of Multicultural Programs in Penn Engineering*, is the recipient of the Special Recognition Award at the 2014 Women of Color STEM Conference as a professional in higher education who leads successful, timely programs to generate interest in STEM among women.



**Robert W. Carpick**, *John Henry Towne Professor and Chair in Mechanical Engineering and Applied Mechanics*, has been named Fellow of the American Vacuum Society (AVS) for "bringing fundamental insights into the origin of friction and wear at the nanoscale."



**Dan Huh**, *Wilf Family Term Assistant Professor in Bioengineering*, is a recipient of the NIH New Innovator Award. The highly competitive award will provide Huh with \$1.5 million during the next five years to develop "organs-on-chips," tiny, three-dimensional models of living human organs that mimic diseased human lungs.



**Vijay Kumar**, *UPS Foundation Professor in Mechanical Engineering and Applied Mechanics*, was awarded the Engelberger Robotics Award, the industry's highest honor, at a special ceremony on June 2, 2014, in Munich, Germany.

## Honors & Awards



**Duygu Kuzum**, *Postdoctoral Fellow in Bioengineering*, is being honored as one of *MIT Technology Review's* annual "Innovators Under 35" for her graphene-based brain electrodes that can simultaneously record the activity of neurons and image their behavior.



**Arjun Raj**, *Assistant Professor in Bioengineering*, is the recipient of an NSF CAREER Award for his proposal, "Unraveling Homeostatic Mechanisms in Gene Expression Regulation: Integrating Research and Scientific Communication."



**Vukan Vuchic**, *UPS Foundation Professor of Transportation Engineering Emeritus in Electrical and Systems Engineering*, has been selected as the 2014 recipient of the Lifetime of Academic Distinction Award. This award, presented by the American Public Transportation Association, is given to an individual who has greatly influenced the transportation industry.



**Jennifer Phillips-Cremins**, *Assistant Professor in Bioengineering*, has been awarded the Robertson Investigators Award by the New York Stem Cell Foundation. Phillips-Cremins will receive \$1.5 million, which will be disbursed over the next five years, to help train other scientists and expand the 3-D Epigenomics and Systems Neurobiology Laboratory.



**Kevin Turner**, *Gabel Family Term Associate Professor in Mechanical Engineering and Applied Mechanics*, is the recipient of the 2014 Sia Nemat-Nasser Early Career Award from the American Society of Mechanical Engineers (ASME) for "outstanding research in experimental and theoretical solid mechanics, particularly for advancing the understanding of interfacial mechanics with applications to microscale and nanoscale manufacturing, wafer bonding, layer transfer processes, failure and reliability in microsystems, and advanced lithography."



**Beth Winkelstein**, *Professor in Bioengineering and Penn Engineering Associate Dean for Undergraduate Education*, has been named Fellow of the Biomedical Engineering Society (BMES) for the class of 2014. Fellow status is awarded to Society members who demonstrate exceptional achievements and experience in the field of biomedical engineering, and a record of membership and participation in the Society.



## IN MEMORIAM

**George Heilmeier** (EE'58), engineer and inventor of liquid crystal displays (LCDs), died April 21, 2014 at the age of 77 in Plano, Texas.

Dr. Heilmeier earned his undergraduate degree in Electrical Engineering from Penn Engineering in 1958 and his master's and Ph.D. degrees in Solid State Electronics from Princeton University in 1962.

During the 1960s, he helped to invent a screen display that used liquid crystals to project images—technology that is now used in telephones, digital watches, computer monitors and flat-screen televisions.

In 1970, he became a White House Fellow, working with the Department of Defense. After serving a year as a special assistant to Secretary of Defense Melvin Laird, he was appointed assistant director of Defense Research and Engineering, where he worked at the Pentagon on projects including space lasers and stealth aviation. Dr. Heilmeier was chairman emeritus of Telcordia Technologies (formerly Bellcore), the research and development unit of the regional telephone companies formed following the 1984 breakup of AT&T, and long-time chief technology officer at Texas Instruments Inc.

Dr. Heilmeier held 15 patents. For his invention of LCDs, he was awarded the National Medal of Science by President George H. W. Bush in 1991, the IEEE Medal of Honor in 1997, and the Kyoto Prize in 2005 for "pioneering contributions to the realization of flat-panel displays using liquid crystals." He was inducted into the National Inventors Hall of Fame in 2009. He served as a member of the Board of Overseers of Penn Engineering from 1989 until his death. Heilmeier Hall in the Towne Building was named in his honor in 1999, and Penn Engineering established the George H. Heilmeier Faculty Award for Excellence in Research in 2001.

Among high-tech researchers, Dr. Heilmeier was known as the steadfast creator of "Heilmeier's Catechism," a set of questions to clearly convey the goals of any research project, including "What are you trying to do?" and "Who cares?" Dr. Heilmeier developed the series in the 1970s during his time as the director of the Defense Advanced Research Projects Agency (DARPA). The system continues to be widely respected in the research community.

Dr. Heilmeier is survived by wife Janet Faunce, daughter Beth Jarvie, and three grandchildren.

**Abraham Noordergraaf**, professor emeritus in the Department of Bioengineering, died May 24, 2014 at the age of 84.

Dr. Noordergraaf earned his undergraduate degree in 1953, his master's degree in 1955 and his Ph.D. in the physical basis of ballistocardiography in 1956, all from the University of Utrecht in The Netherlands.

After receiving his doctorate, he immigrated to the United States to join the faculty of the University of Pennsylvania. Beginning as a visiting fellow in 1957, he was appointed an associate professor in 1964 and was a founding member of the Department of Bioengineering. He served as its first chair from 1973 to 1976.

Dr. Noordergraaf was a popular figure on campus and a celebrated teacher and mentor. He also held an appointment at the School of Veterinary Medicine and occasionally taught courses in Dutch Culture.

Dr. Noordergraaf was known for his work in cardiovascular dynamics. His research included such highlights as quantitative theory on the origin of the ballistocardiogram and the design and development of a special purpose circulatory analog computer. His mathematical studies had many applications, including in the treatment of hypertension on vein collapse, and in the ways to measure the efficacy of cardiopulmonary resuscitation. He published widely, and his textbook *Blood in Motion* was a classic in cardiovascular science.

Dr. Noordergraaf is survived by his children Annemiek Young, Gerrit Jan Noordergraaf, Jeske Noordergraaf and Alexander Noordergraaf; ten grandchildren; and many nieces and nephews.

## Sean Holleran

Sean P. Holleran, Ph.D., is a Senior Lecturer in the Department of Chemical and Biomolecular Engineering at Penn Engineering.

**What brought you to Penn?** I knew throughout graduate school that I wanted an academic career with a rigorous focus on undergraduate teaching and advising. At Penn since 2007, I have found in Chemical and Biomolecular Engineering (CBE) a like-minded faculty, highly motivated undergraduates, and an exciting and engaging curriculum.

**What courses do you teach?** I teach two courses each term, with my current courses being *Fluid Mechanics* and *Process Design* during the fall and *Material Balances* and *Thermodynamics of Fluids* during the spring. Because these represent one course typically taken by each student year, this means I interact with all of our CBE undergraduates each year, which allows me to develop and maintain connections with the students.

**What about advising students?** I am the faculty advisor for all of the CBE freshmen each year. As a department, we like how this concentrates the advising experience during the first year, when many students have a lot of common advising concerns. We have also established *CBE Freshmen Wednesdays*, a program which has been a tremendous success. I meet with the CBE freshmen on the first Wednesday of each month in a more social setting, and it is a great chance for them to meet one another. We have a rotating collection of topics to discuss, from student societies, undergraduate research, CBE careers and courses. I feel we have been able to develop a sense of community among our undergraduate students.

**How do you spend your time off campus?** My wife and I have two young boys; Connor is three years old and Declan is six months. It has been fun watching them grow. Parenting two children is (maybe) more challenging than handling the various engineering courses I teach. Also, for the past five years, I have run the Philadelphia Half-Marathon each November and sometimes I find a few minutes to work on my FIFA game in the evenings. ☺



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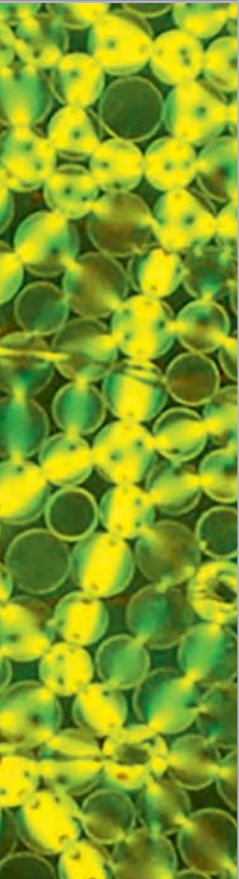


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