micro aerial vehicles
<table>
<thead>
<tr>
<th>CONTENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From the Dean</td>
<td>1</td>
</tr>
<tr>
<td>Engage &amp; Inspire</td>
<td>2</td>
</tr>
<tr>
<td>Professor of Practice Andrew Jackson</td>
<td></td>
</tr>
<tr>
<td>Robot Hockey Scores Big</td>
<td>5</td>
</tr>
<tr>
<td>Building Better Fuel Cells</td>
<td>10</td>
</tr>
<tr>
<td>Analyzing Life at the Molecular Level</td>
<td>16</td>
</tr>
<tr>
<td>The Driving Force</td>
<td>20</td>
</tr>
<tr>
<td>Cultivating Innovators for the Emerging Economy</td>
<td>24</td>
</tr>
<tr>
<td>Flying Robots</td>
<td>27</td>
</tr>
<tr>
<td>Customized &amp; Cooperative</td>
<td></td>
</tr>
<tr>
<td>Engineering a Better World</td>
<td>30</td>
</tr>
<tr>
<td>The Science of Play</td>
<td>36</td>
</tr>
<tr>
<td>School News</td>
<td>38</td>
</tr>
<tr>
<td>Pop Quiz with Helen Anderson</td>
<td>40</td>
</tr>
</tbody>
</table>

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A professor delivering a lecture may be physically in the classroom or perhaps appear on a computer screen in front of an array of slides. Regardless of the format, we expect him or her to be effective and inspiring. But we also know that lecturing is just one part of the rich and complex process of providing a complete education.

This crucial distinction must be kept in mind in the face of the current arrival on the educational scene of some seemingly disruptive technologies. Online lecturing, which is here to stay, is coming at us from four sources: peer institutions, non-profit academies, for-profit universities and companies that market great lectures.

No, these are not the four horsemen and it’s not the Apocalypse. Online lecturing does not signal the end of great universities. It is a valuable new resource that will lead to a richer and more perfect market in higher education, and will increase our impact in the world. This spring, Penn will begin to deliver materials online while also partaking of great lectures produced by others.

Yet, even if we were to assume that all lectures will be commoditized and available online for free, it is not “the end of higher education as we know it,” simply because we also know about the countless other things we do to impart an education. We know of and take pride in our rigorous and enlightened admissions process that allows each of our students to be immersed in a stimulating cohort. We offer our students opportunities to work in teams and to learn collectively. The undergraduate cohort is the keeper of the culture of the School, of its ethos. It is the means through which we instill ambition and creativity.

To be sure, the day-to-day life of our students consists of many lectures and quite a few exams. But the Penn Engineering experience is also strongly punctuated by creative experiences like the Mechatronics Robockey competition, featured in the pages that follow. These are experiences our students will remember forever, and what makes a Penn education so much more than the sum of its lectures. 🏅
Andrew Jackson doesn’t have a teaching philosophy so much as an educational mission: “I want to prepare engineering students for the challenges and possibilities of the world beyond academia.” With 35 years of industry experience and major contributions to the field of tribology, Jackson, Professor of Practice in the Department of Mechanical Engineering and Applied Mechanics, is a passionate believer in applying engineering to solve real-world problems, from improving a power generation system to developing innovative lubricants for Formula 1 race cars.

Making His Own Mark

Born in the United Kingdom, Jackson received both a B.Sc. in Engineering and a Ph.D. in Tribology, the study of interacting surfaces in relative motion, from Imperial College, London. He joined Mobil’s Pennington, New Jersey research facility, drawn in by the company’s investment in research and innovation. “At the time, Mobil was unique in its development of synthetic lubricants,” he says. “Lubricants are a $70 billion a year business. Efficient lubrication can save energy, money and environmental waste.”

Jackson’s research resulted in 15 patents, over 45 external papers, 90 internal proprietary reports and awards from the American Chemical Society, the American Society of Mechanical Engineers and the Society of Tribologists and Lubrication Engineers (STLE). He was named president of STLE in 1995 and served as editor of its technical journal, *Tribology Transactions*, from 2002 to 2009. In 2009, Jackson retired from his senior scientific advisor role at ExxonMobil. That same year, he was elected to the National Academy of Engineering.
Out of the Lab
As Jackson advanced professionally, he fostered an equally fulfilling personal life. He and his wife, Dr. Lillian Rankel, a research chemist and later a high school teacher at Hopewell Valley Central High School in Pennington, NJ, are the proud parents of a physician, a mechanical engineer and a science teacher, and dote on their two grandsons. In 2007, Jackson and Rankel led 15 high school students on a life-changing expedition to Kenya. After visiting a remote village, they formed a nonprofit called the Hopewell-Keroka Alliance and have raised over $50,000 to provide the villagers with infrastructure, health and educational support. Jackson and Rankel returned there privately in 2009, and in 2010 led a party of 18 students to Kenya in what is becoming a tradition at the high school.

From Industry to Academia
Ready for a new intellectual challenge, Jackson began teaching at Penn in 2010. His class, EAS 250: Energy Systems, Resources and Technology, is a fundamental overview of the global demand for energy and its supply in the face of climate change. “The objective is to look at real energy solutions for the long term,” Jackson says. EAS 250 is now offered each semester, attracting students from Penn Engineering, Wharton and elsewhere at Penn.

Jackson has also taught MEAM 210: Statics and Strength of Materials, and this spring he’s gone back to his roots to offer a class on tribology, focusing on bearings, gears, friction and wear. As an advisor for senior design projects, Jackson has worked with students to develop a solar cooker and a nanotechnology-based water filtration system—projects that might have applications in developing countries such as Kenya.

On the Ground With Students
Teaching comes naturally to Jackson, and he enjoys the classroom dialogue. His open-door office policy encourages students to discuss coursework and their options after graduation. “Industry needs well-trained people, so I’m glad I can play a role in helping to shape their careers.”

Roshan Rai (MSE’13) has been one such student. “I’ve taken two classes with Dr. Jackson and they have only further propelled my interest in the subjects,” Rai says. “His industry experience adds tremendous value to his teaching, and he helps students understand their true potential.”

Jackson may be inspiring his students on a daily basis, but the feeling is mutual. “I consider this to be a new career and it’s very rewarding. I’m looking forward to continuing to contribute in whatever way I can.”
Robot Hockey Scores Big

By Jana Moore

The auditorium reverberated with ’80s stadium rock: “We will, we will, ROCK YOU.” Members of the standing-room-only crowd screamed themselves hoarse and stomped their feet. Students unable to get into the auditorium crowded around a screen outside. All eyes were focused on six small robots battling for control of a 3-inch puck.

Welcome to Robockey 2011, a tournament that culminated MEAM 410/510: Design of Mechatronic Systems, a Mechanical Engineering and Applied Mechanics course, considered among Penn Engineering’s most challenging. Following his Ph.D. at Stanford University, senior lecturer Jonathan Fiene introduced Robockey in 2008 as a way to meld the practical and theoretical. Despite the difficulty of the subject and the staggering number of hours the course consumes, enrollment has grown from 26 students in 2008 to 82 last semester.

Master’s students Neel S. Shah and Rajeev Kumar Jeevagan (both ROBO’13) and Siddharth Ramanathan (MEAM’13) won the 2011 Robockey competition. Shah explains the popularity: “It’s a combination of the practical and just plain fun. It was the best course I have ever taken in my life.”
After the crowds went home for the night, a digital SLR camera captured a shot of the rink while two teams of robots played in the pitch-black auditorium.

Mission Impossible?

On the first day of the five-week final project, Fiene handed out an overwhelming assignment: build three small robots and program them to autonomously play hockey with an infrared-emitting puck in a 4-by-8-foot rink. The assignment required the students to design, fabricate, assemble, program and debug the robots, all equipped with wireless communications, infrared sensing and on-board computation. The challenge demanded substantial knowledge in mechanical design, electronics and programming. Few students were well-versed in more than one of those areas.

“I’m a proponent of big projects, especially with today’s always-connected students,” Fiene says. “They start off saying, ‘There’s no way I can do this.’ But the tournament drives them forward, and they dig in. By the end of the project they are extremely proud of what they have accomplished.”
Racing Toward the Tournament

Throughout the semester, students acquired about half of their knowledge from traditional lectures and written assignments. The other half came through a series of small practical projects.

To support the course, Fiene has designed and built an array of hardware, including a custom microcontroller platform. Wanting to provide on-board position sensing for the robots, he had a brainstorm last summer that left him spending hours recovering tiny cameras from inside Wii controllers. He then positioned infrared LEDs above the rink, allowing the students to determine the robots’ locations by decoding the resulting camera data. He even built the rink, designed the puck and wrote the behind-the-scenes software. “If I ask my students to do something hard, I need to support it with failsafe infrastructure,” Fiene says.
After conquering the mechanical and electrical systems, the students faced their most formidable test: embedded programming. Accomplishing the basics proved challenging enough for many teams, but a few were able to add complex game strategy.

The rest was up to the students. They needed to design the robots with an on-board power source, sensors to track the puck and a strong steering platform. They had the option of adding a “kicking” mechanism, in effect allowing the robots to make slap shots from mid-ice, a feat that delighted the crowd. After conquering the mechanical and electrical systems, the students faced their most formidable test: embedded programming. Accomplishing the basics proved challenging enough for many teams, but a few were able to add complex game strategy.

After countless sleepless nights, the teams squared off on December 9 for the first round of the double-elimination tournament; 22 teams advanced. Three days later, 250 pumped-up fans packed Wu and Chen Auditorium in Levine Hall to watch the consolation games and finals.

Everyone Leaves a Winner

The MEAMple Leafs team entered Wu and Chen devastated from their first-round loss through a technical glitch, but were determined to sweep the consolation bracket and advanced into the championships. Shah and his teammates managed the team of Ed, Edd n Eddy (named for cartoon characters popular a decade ago), who also arrived determined but with an advantage: they started the night undefeated.

The Leafs did sweep the consolation matches, quickly becoming the night’s Cinderella story, only to lose 1-0
early in the finals. The crowd moaned. “But we weren’t disappointed about losing at all,” says Nick McGill, (ROBO’14), a Leaf. “We felt very accomplished.”

Shah and his teammates were luckier but not without nail-biting moments. In the semifinals, the Eds battled another undefeated team to a 2-2 tie in regulation play and traded goals in penalty shootouts. Ed, Edd n Eddy pulled out the 4-3 victory with a goal in the second sudden-death shootout.

The same teams met for the championship. The Eds’ opponents took the first game 3-2, but faced another round in the double-elimination tournament, and the Eds took home the cup with a 5-1 victory. Fist-pumping, chanting and foot-stomping ended Robockey 2011.

Fiene believes the format of the class cements knowledge in a way that no exam could, and the students agree. Jimmy Paulos, a doctoral student in MEAM and a member of the second-place team, noted the benefits of Fiene’s emphasis on active learning. “I don’t feel like I mastered the subject, but I know the kind of questions I need to ask,” he says. “If I need to improvise any part, I know where to start.”

To view video of the tournament, visit http://bit.ly/xPBBDe
Fuel cells have been called the environmentally friendly energy source of the future because they generate electricity while producing fewer harmful emissions than coal-fired power plants. Solid oxide fuel cells in particular are very efficient, requiring much less fuel than an internal combustion engine to produce the same amount of energy, and they can handle a broad range of cleaner-burning fuels, including hydrogen and methane.

For the last 15 years, Raymond Gorte, the Russell Pearce and Elizabeth Crimian Heuer Professor of Chemical and Biomolecular Engineering and Professor of Materials Science and Engineering, and John Vohs, the Carl V. S. Patterson Professor of Chemical and Biomolecular Engineering, have been collaborating to design more efficient, durable and versatile solid oxide fuel cells. They have improved the materials making up these devices by studying their nanoscale structure and electrochemical properties.

Their efforts could help the United States transition toward using technology that can run on alternative fuels. This is an important goal, given that we annually produce about 6 billion metric tons of carbon dioxide emissions, the vast majority of which comes from burning fossil fuels, such as coal and oil. Electric power generation accounts for the most greenhouse gas emissions, which not only reduce air quality, but can also impact human health and ecosystems through climate change.
"The work that has been carried out by Gorte and Vohs has revolutionized solid oxide fuel cell research in that they have developed a new method for fabricating fuel cells that allows electrodes to be made from a much wider range of materials," says Kathleen Stebe, the Richer and Elizabeth Goodwin Professor and Chair of Chemical and Biomolecular Engineering.

**Ideal Ingredients**

Solid oxide fuel cells are made up of a dense, ion-conducting layer known as the electrolyte, which is sandwiched between two electrodes—or electrical conductors—called the anode and cathode. Oxygen gas is channeled through the cathode, where electrons react with the gas to create oxygen ions. These ions travel through the electrolyte to the anode, where they react with gaseous fuel to produce electricity.

One way that Vohs and Gorte have improved solid oxide fuel cells is by replacing problematic metals in the electrodes. Nickel, for instance, is a traditional component of electrodes, but it causes the formation of carbon deposits when exposed to hydrocarbon fuels at high temperatures, which are required by solid oxide fuel cells. As a result, the electrodes become corroded and do not function properly. By swapping nickel for a conductive oxide and then adding dopant levels of a catalyst such as platinum, the scientists have reduced carbon buildup in the electrodes. "I like to say that nickel is not on my periodic table," Gorte says.

The researchers have also introduced a novel way of fabricating electrodes that allows them to precisely control and optimize the materials. They infiltrate salt solutions into a porous scaffold layer made of yttria-stabilized zirconia—a ceramic material used to make cheap jewelry—add catalysts, and apply heat to create electrodes with high electrical conductivity. This infiltration process reduces wasted energy and enhances the power output of ceramic fuel cells.

"Gorte and Vohs have gone above and beyond other experts in the field to advance solid oxide fuel cell technology using innovative approaches," says Eduardo Glandt, Dean of the School of Engineering and Applied Science.

**Flexible Fuels**

Most fuel cells are powered by hydrogen, which is extracted from hydrocarbon fuels with steam and high temperatures in an external device called a reformer. "The system that you have to develop to produce the hydrogen is far more complicated than the fuel cell itself, and there’s energy lost in all sorts of stages during that production," says Gorte, who arrived at Penn in 1981, soon after receiving his Ph.D. in Chemical Engineering from the University of Minnesota.

Gorte and Vohs focus on solid oxide fuel cells because these devices do not require the external reforming process and can run on carbon-based fuels. "One major goal of our work has been to develop electrodes that will allow us to oxidize any combustible fuel," Gorte says, explaining that "carbon-based fuels are available, whereas hydrogen does not grow on trees."

"A hallmark of Penn Engineering is fostering the interdisciplinary nature of research, getting people in different fields talking to each other, and having co-advised students," says Vohs.
One way the duo has met this goal is by replacing solid electrodes in fuel cells with molten electrodes—made of the metal antimony—that can operate on a variety of carbon-containing solids, such as sugar char, rice starch, graphite, and pyrolysis oil, “the gunk that messes up your chimney when you put logs on the fire,” Gorte explains. “Grabbing a log and throwing it into the system and developing electricity is a much simpler process than a lot of what’s going on to develop biofuels.”

These robust fuel cells generate a substantial amount of power, and their electrodes have very high electrical conductivity. Gorte plans to work with a company to commercialize the devices into applications such as portable generators, which have a huge market in third-world countries lacking stable power grids. “I’m optimistic that they will find applications, initially in smaller-scale systems, particularly in places where electricity is expensive,” he says.

Fueling Future Innovators

A recipient of the 2007 Catalysis Club of Philadelphia Award, Vohs uses sophisticated spectroscopic techniques to study the properties of fuel cells, while Gorte, who received the R. H. Wilhelm Award in Chemical Reaction Engineering in 2009, uses relatively simple approaches. “It has actually worked out well because we have methods of study that are very different and very complementary, so the collaboration has been extremely useful,” Gorte says. “Our labs are essentially attached, so our students move freely between rooms.”

“A hallmark of Penn Engineering is fostering the interdisciplinary nature of research, getting people
in different fields talking to each other, and having co-advised students,” says Vohs, who joined the faculty in 1989, soon after earning his Ph.D. in Chemical Engineering from the University of Delaware. “The most satisfying part is actually working with these graduate students and seeing them succeed and go on to work in industry or take jobs in academia.”

Vohs will soon have more opportunities to cultivate the next generation of Penn students and enable them to address the world’s energy challenges, with the establishment of a new program that he is co-directing with Andrew Rappe, professor of Chemistry. The Vagelos Integrated Program in Energy Research (VIPER), endowed by Roy Vagelos (C’50) and his wife Diana, is a dual-degree program for talented and motivated undergraduates in the School of Engineering and Applied Science and the School of Arts and Sciences.

The selected students will receive instruction on energy science and engineering and mentoring from faculty affiliated with the Penn Center for Energy Innovation (Pennenergy). They will also participate in research to prepare for pursuing advanced degrees and eventually establishing their own research careers that focus on developing sustainable ways to harvest, convert and use energy.

“Energy and energy-related environmental issues are important global problems right now,” Vohs says. “If we’re going to solve these types of problems, we need well-educated scientists and engineers who have backgrounds in the technical fields needed to address these issues, so our goal is really to get students started on doing that as soon as possible.”
In the world of molecular biology, a discovery always leads to another question. Finding that RNA helps develop protein leads one to ask what else RNA could do within a cell. Leveraging questions to make new discoveries requires a scientist who can employ the organizational properties and concepts of mathematics and physics in order to analyze the patterns of life at the molecular level.

For Penn Engineering, that scientist is Arjun Raj. As an assistant professor of Bioengineering, Raj combines those particular skills with a proclivity to ask a lot of questions. He also has a penchant for establishing a research environment in which biologists, chemists, engineers, physicists, computer scientists and mathematicians all work together to develop new experimental methods to take an even closer look at the inner workings of the cell.

An Unconventional Approach Leads to Discovery

By his own admission, there is nothing conventional about how Raj applies scientific inquiry. “I don’t set out to look at something specific. I jump in and stay alert,” he says.

In his lab, Raj and fellow researchers use an in situ RNA-detection method he developed. They hybridize many fluorescent molecules to the target RNA, rendering it visible as a small spot in a fluorescence microscope. On any given day, a researcher may look into that microscope and observe something that no one else has seen before inside a single cell.

This process has resulted in numerous findings, including the discovery that the size and shape of chromosomes, which are often disrupted in cancer, can
Arjun Raj’s work recently garnered attention from the National Institutes of Health and resulted in a $1.5 million New Innovator Award. With the funding, Raj will concentrate on developing and applying new microscopic imaging tools to reveal how the physical organization of the genetic code determines the manner in which the cell reads the code itself.

profundely change the way the cell reads out genes encoded on the chromosome itself. “I saw this first in only one cell and was willing to change what I was searching for and, in seeing this interesting difference, went looking for something else,” Raj says. His discovery has helped other scientists better understand unappreciated differences between cancer and normal cells. “I don’t know yet what the implications are, but I am very interested in pursuing this question,” Raj notes.

Collaborating for Enhanced Results
Raj’s arrival into bioengineering was circuitous. After earning his undergraduate degrees in Math and Physics from UC Berkeley, he took a year off and played in a band. Once the muse was quieted, he began his doctoral studies at NYU, and considered pursuing biomathematics as a way to apply organizational properties and concepts to help biologists discover more about the nature and properties of living organisms.

“I visited a biology lab and looked into the microscope, and was captivated with the science of imaging.” From that point on, Raj sought out other scientists who could collaborate in the quest, one of whom was Dr. John L. Rinn, assistant professor in Stem Cell and Regenerative Biology at Harvard University.

“Within months of working together he made an immediate impact,” says Rinn, whose collaboration began when Raj was doing his postdoctoral research. “A good scientist is someone who can excite and interest researchers around their vision. Raj is the consummate collaborator.”
Carving Out a Niche at Penn

Raj joined the faculty at Penn in 2010 and instantly found an affinity with his fellow colleagues. While he was drawn to Penn because of its collegial cadre of like-minded and dedicated scientists, his expertise in combining math and physics with biology has resulted in a niche within the Penn research community.

“At Penn we have a lot of people devoted to trying to understand how the cell works,” says David Meaney, Solomon R. Pollack Professor and Chair of the Department of Bioengineering. “Arjun takes a quantitative and rigorous approach to discovering more about the physical structure of chromosomes and how genes are regulated.”

Meaney considers Raj’s scientific curiosity and interest in collaborating with others to be one of his greatest attributes. “He asks questions, works well with other scientists and works incredibly hard to bring new understanding about how RNA functions,” says Meaney.
Raj's work recently garnered attention from the National Institutes of Health and resulted in a $1.5 million New Innovator Award. With the funding, Raj will concentrate on developing and applying new microscopic imaging tools to reveal how the physical organization of the genetic code determines the manner in which the cell reads the code itself.

While the microscopic worlds of molecular biology are his passion, Raj is equally enthusiastic about sharing that world with his students in the lab and his classroom. “Dr. Raj provides great advice on how to manage a project that involves creating a new tool to study cell biology,” asserts Marshall Levesque, a Ph.D. student in Bioengineering. “He is also just as encouraging in the classroom, where he asks students pointed questions and takes time to help them develop their thinking process.”

Opening up the world of possibility in bioengineering for his students is what Raj considers his calling. “I had some great teachers and I hope to be able to inspire students,” he says. “I absolutely love my job because I get to work with young people who work hard, think hard and really care about science.”
Sitting next to a state-of-the-art atomic force microscope, Robert Carpick and doctoral student Xin Liu carefully steer a sharp silicon tip 1/5,000th the thickness of a human hair, making it slide across a one-atom-thick sheet of graphene—the material found in pencils. The tip deflects as it presses against the thin flakes, measuring minuscule forces between itself and the surface. The two scientists marvel at the resulting image: a honeycomb lattice of densely packed carbon atoms.

“When you see incredible, unusual and interesting behavior, like the way atoms arrange themselves on a surface, these are very beautiful things, and it’s enjoyable to share that with others,” says Carpick, Professor and Chair of Mechanical Engineering and Applied Mechanics (MEAM) and Professor of Materials Science and Engineering.

Coupling microscopy with modeling, they found that the friction of the graphene sheets decreased as the number of layers within them increased. When the sheet contains a single layer, it crumples around the tip because it’s so flexible, similar to a sheet of paper. But with more layers, the thick sheet is similar to a hardback book, so the tip slides more easily across the surface. “Nobody had seen this before, nobody had measured it, and nobody had predicted it,” Carpick says.

This novel nanoscale property of friction was evident in all sorts of materials, and it could have implications for designing better data storage devices, semiconductors, and nanoelectromechanical systems. The discovery earned Carpick and his collaborators a coveted Science publication in 2010.

“Carpick has a strong track record of elucidating key physical principles at the atomic level, which could lead to the construction of more robust materials and devices,” says Eduardo Glandt, Dean of the School of Engineering and Applied Science.
"When you see incredible, unusual and interesting behavior, like the way atoms arrange themselves on a surface, these are very beautiful things, and it’s enjoyable to share that with others," says Robert Carpick, Professor and Chair of Mechanical Engineering and Applied Mechanics.
Beyond encouraging active participation, Carpick accommodates different learning styles by clearly explaining complex, abstract principles in as many ways as possible—through visualizations, equations, and especially real-world applications.

Making a Difference
To share his sense of wonder at the nanoscale world with students in the classroom, Carpick actively engages them. He poses questions using the Socratic method and provides students with remote clickers to allow them to respond to multiple-choice problems without putting them on the spot. “I want to challenge them and I enjoy seeing them succeed, whether it’s in the classroom or in the laboratory,” says Carpick, who won the 2003 American Society for Engineering Education (ASEE) Outstanding New Mechanics Educator Award.

Beyond encouraging active participation, Carpick accommodates different learning styles by clearly explaining complex, abstract principles in as many ways as possible—through visualizations, equations, and especially real-world applications. “The students are hungry to see how what they’re learning matters, and how they then can use it themselves to make a difference,” he says.

As a child growing up in Winnipeg, Canada, Carpick was a natural math whiz who wanted to make a difference. Eager to apply his knack for numbers to solving problems, he studied physics at the University of Toronto and later earned a Ph.D. in Physics at the University of California, Berkeley. That’s where he became intrigued by friction, by means of his advisor, Miquel Salmeron, Director of the Materials Science Division at the Lawrence Berkeley National Laboratory, who was investigating the origins of this mysterious force. “I found it amazing that friction is such a common phenomenon, but we did not understand it well and we weren’t able to predict it,” Carpick says. “I got excited about addressing fundamental questions and providing answers that could potentially have a very beneficial impact by reducing wasted energy and making materials last longer.”

Call to Duty
After studying friction for seven years at the University of Wisconsin-Madison, Carpick joined Penn in 2007, and last summer became department chair. In anticipation of next year’s opening of the Krishna P. Singh Center for Nanotechnology, Carpick is tasked with hiring faculty in the areas of energy research and nanotechnology. “The facility will be a great magnet to draw more top-name people to Penn,” Carpick says.

In addition to recruiting professors, one of Carpick’s primary goals is to promote diversity among faculty and students. Penn Engineering is already ahead of the curve, with this year’s entering class consisting of about 37 percent women, compared with about 20 percent nationally. “I want to continue to ensure that all underrepresented groups have opportunities here, feel welcome, and know that the excellence that we have to offer is available to everyone,” he says.

Moreover, an important part of Carpick’s duties is to sing Penn’s praises. “It’s my job to promote MEAM and our vision to the greater community within Penn and to the science and engineering community externally,” he says. “That’s not hard to do, because there are so many incredible people here and so many great accomplishments to brag about to the outside world.”

Ultimately, the role of department chair is about supporting current faculty and students at Penn. Carpick is charged with overseeing the tenure process and improving the curriculum based on feedback from students. “I try to create and foster an environment where the incredibly talented members of our faculty and the extremely bright and motivated students and postdocs in our midst can be as successful as possible,” he says. “It’s a wonderful service to be called to do.” 

▼
“Skills that solve real-world challenges and keep pace with the exponential curve of technology innovation.”

That’s the enduring value of an engineering degree, says Ofer Nemirovsky (EE/W’80), managing director of Boston-based private equity investment firm HarbourVest Partners and member of Penn Engineering’s Board of Overseers.

When Nemirovsky joined HarbourVest in 1986, he focused on investments in software industry startups, a scope he later expanded to companies that were integral to the dawn and rapid expansion of the Internet economy. “Being on the forefront of several waves of technology and cultural change has been exciting,” says Nemirovsky, who also holds an MBA from Harvard. “We managed to invest in leading companies that generated good returns for our investors.”

Today, Nemirovsky focuses more on later-stage investments in Internet, software and e-commerce firms.

“We invest and share in the successes of the most creative, interesting and dynamic people who are starting companies in the technology space,” he says. “As I assess investment opportunities, I draw on my engineering background, which informs my understanding of whether an idea is possible and whether it may be of value because it introduces new efficiencies or renders other solutions obsolete.”

Upside in a Down Economy

Because future technological change is inevitable yet unpredictable, Nemirovsky says, “Undergraduate engineers should get as broad an exposure as possible to the landscape of opportunities and challenges in engineering. Take time to socialize and have fun, as well.”
“There has been an upsurge in interest in engineering triggered by a back-to-basics movement,” says Nemirovsky. “People entering the job market want to design and build tangible products that keep pace with technology innovation and solve significant problems such as resource constraints on global food, water and energy.”

He notes that the stalled economy has attracted more applicants to Penn Engineering, in part due to keen interest in recent curriculum innovations. “There has been an upsurge in interest in engineering triggered by a back-to-basics movement,” says Nemirovsky. “People entering the job market want to design and build tangible products that keep pace with technology innovation and solve significant problems such as resource constraints on global food, water and energy.”

“Penn Engineering is at the forefront of developing new courses for the times in which we live,” says Nemirovsky. The Overseers have provided enthusiastic support to the development of new engineering curricula for the emerging economy such as the Digital Media Design program and the Rajendra and Neera Singh Program in Market and Social Systems Engineering. The Board is also focused on goals related to the planned completion of the Krishna P. Singh Center for Nanotechnology in 2013, which will establish Penn as a regional powerhouse for nanotechnology.

Paying It Forward

Life has come full circle for Nemirovsky, who credits scholarship and work-study support with making it possible for him to obtain dual undergraduate degrees from Penn Engineering and Wharton. His parents, a mechanical engineer and a nurse, moved his family from Israel to the United States when he was four years old. By the time he was ready to apply to college, they initially thought community college made sense financially, in part due to unfamiliarity with the American college admission and financial aid process. One of his teachers at the Bronx High School of Science urged him to apply to the best schools in the nation instead. Fortuitously, Penn’s financial aid package and proximity to his family in Queens, NY, made it an ideal choice.

Several years ago, Nemirovsky and his wife, Shelly, endowed the GWE Scholarship, named for the initials of their three children’s names. The scholarship helps defray four years of tuition costs at any undergraduate program at Penn, including engineering. “Remembering the support that I received, it gives me great satisfaction to help others along this path,” says Nemirovsky.

More recently, he and his wife decided to endow the deanship at Penn Engineering. Nemirovsky explains, “This gift reflects my great respect for Dr. Glandt and my gratitude to Penn Engineering for the education and growth I enjoyed here. These experiences enriched my life and helped launch my career.”
Flying Robots

Customized & Cooperative

By Jessica Stein Diamond

Academic engineers worldwide have a new resource for accelerating discoveries in the science of agile and cooperative flight by small, unmanned robots.

KMel Robotics, a company founded in late 2011 by two graduates of Penn’s General Robotics, Automation, Sensing and Perception (GRASP) Laboratory, customizes quadrotors, flying robots with four propellers that weigh between 50 grams to 4 kilograms. Co-presidents and Penn Engineering alumni Alex Kushleyev, M.S., an electrical engineer, and Daniel Mellinger, Ph.D., a mechanical engineer, offer expertise needed by scientists and engineers to refine these devices for research that will advance algorithms, sensing capabilities and control mechanisms for group cooperation and autonomous flight.
“We’re the first ones ever to fly so many vehicles in formation at the same time,” says Alex Kushleyev, M.S., an electrical engineer and KMel co-president. “Nobody else has been able to do that. It takes great accuracy and precision of control for positions in space and time. Our customers can now harness the creativity we have to offer.”

Aerial Circus

After a video posted online by the firm went viral (see sidebar) in early 2012, non-academic customers, particularly in environmental monitoring and search and rescue, also became keenly interested in KMel’s capabilities. In the video, viewed by 6 million people within two months, a team of 20 quadrotors perform like an aerial circus, executing a double flip in a half second and a sequence of complex aerial formations including figure eights.

“We’re the first ones ever to fly so many vehicles in formation at the same time,” says Kushleyev. “Nobody else has been able to do that. It takes great accuracy and precision of control for positions in space and time. Our customers can now harness the creativity we have to offer. Once they tell us their exact needs and research goals, we will design, build and program custom quadrotors that will accelerate their path toward success.”

Harnessing Creativity

Situated a mile from the Penn campus in West Philadelphia, KMel is clearly positioned for growth as a subcontractor or prime contractor on research partnerships with universities worldwide, including Penn.

“They’re developing high-end platforms and are the best team to help us go from theory to algorithms to practice,” says Vijay Kumar, UPS Foundation Professor of Mechanical Engineering and Applied Mechanics (MEAM), Deputy Dean for Education and GRASP Lab member. “We are naturally eager to have them involved in collaborative research. There are things only they can do at this point.”

KMel customizes far beyond the capabilities of off-the-shelf quadrotors used primarily by electrical, mechanical and computer engineers. Its technology is not used for surveillance or military applications, and is fundamentally different in scale and autonomy from military drones that require a flight crew, are remotely piloted and fly at high altitudes.

Distinguishing Factor

While other graduates of the GRASP Lab have achieved research breakthroughs with similarly marketable technologies, Kumar says, “Ultimately it’s about the creativity of the students and their will to make something big out of it. That’s the distinguishing factor here. When companies are spun off by universities, it’s often the students who do it because they have the energy and will to make it happen.”

Kumar is an advisor to KMel but has no financial stake. “One of the reasons I continue to stay in academia is the impact I have mentoring students who will go out and become leaders in their own right,” he says.

Mellinger can speak to the value of that approach. “I’m really lucky to have worked with Dr. Kumar these past few years. He’s been a huge supporter of our work,” he says. “Plus, the GRASP Lab integrates every type of robotics expertise needed and offers a range of research projects that really prepare engineers for life after Penn.”

To facilitate future GRASP and Penn Engineering spinoffs, Kumar is helping to develop a short course for doctoral students on intellectual property that will help them pursue valuable ideas beyond academic publication. “Success is contagious,” he adds. “We should celebrate their achievements and cultivate that path for others.”

“SPRING 2012  |  28
www.seas.upenn.edu
Whirled in Motion: Penn’s Quadrotor Sensation

Seven palm-size quadrotor robots that zoom through the air to play the *James Bond* theme song on a keyboard, drum set and guitar have become an Internet sensation and unexpected ambassador for Penn’s General Robotics, Automation, Sensing and Perception (GRASP) Laboratory.

The world’s first flying robot rock video was a fitting finale for an unusually high-profile talk about robotics breakthroughs by Vijay Kumar, Deputy Dean for Education and GRASP Lab member, at the influential Technology, Entertainment and Design conference, TED2012. Kumar spoke in February before 2,500 people as thousands more listened online. Within a month, more than a million people viewed Kumar’s talk via TED.com and another nearly 3 million saw the Bond video on YouTube.

The implications of reaching the largest audience of Kumar’s career are unfolding as those numbers soar, triggering unprecedented press coverage. “When you have a scientifically powerful story to tell, it’s unusual to have news media seek you out,” says Kumar. “Something interesting is going on here with science and technology reaching new audiences.”

High school teachers frequently email Kumar to say how the Bond video has sparked student interest in robotics. Kumar credits the creativity of Daniel Mellinger, Ph.D., and Alex Kushleyev, M.S., GRASP graduates who created it and founded KMel Robotics, a GRASP Lab spin-off. Their prior YouTube video featuring quadrotor stunts went viral with 6 million hits within two months and even appeared on *The Colbert Report*. Asked how they’ll top that, Mellinger says, “Stay tuned.”
Penn Engineering students are changing our world. Juniors Amanda Culp, Eric Berdinis and Jeff Kiske exemplify Penn students—intelligent, articulate and creative. Culp is using her knowledge and expertise to cultivate future engineers. Berdinis and Kiske are engaging in outreach through innovation, increasing access to the world for individuals who are visually impaired. While still a year from graduation, Culp, Berdinis and Kiske are already engineers in the purest sense, using knowledge to transform the world.

InnoWorks 2012

When Amanda Culp was momentarily at rest one day in February, she took some time out to answer questions about life as a dual Engineering/Economics major and community outreach volunteer. At the same time energized and focused, Culp, a Chemical and Biomolecular Engineering junior, appears to have struck the perfect balance between academic achievement and extracurricular leadership.

Culp’s activities define a packed schedule. On the executive board of AWE (Advancing Women in Engineering), a volunteer for Penn GEMS (a summer camp in engineering, math and science for middle school girls), Secretary for the Penn chapter of the American Institute of Chemical Engineers (AIChe), an Orientation Peer Advisor, a volunteer for Habitat for Humanity, and a member of Theta Tau, Culp’s pet Penn project is clearly InnoWorks, which she is co-directing this year.

InnoWorks, a national collegiate initiative, was created to cultivate the interest of middle school students in science and engineering. With chapters at CalTech, MIT and Duke, among others, InnoWorks at Penn has been active since 2007.

About 40 Philadelphia-area 6th through 8th graders will gather at Penn for a week this summer and immerse themselves in projects and “friendly competitions” that will advance their knowledge outside the traditional classroom. The University provides activities led and supervised by Penn students, along with meals, all at no cost to the campers.

As co-director with Corey Patz (CBE’14), Culp is charged with student recruitment and curriculum design. This summer, students will be Making Sense of the Senses through experiments and games organized to involve and amuse. Currently, her resourcefulness is fully engaged as she works with the Graduate School of Education and Civic House to find children with the interest and motivation to benefit from the program.
Amanda Culp works with a student.
Be the Change

If it is possible, as Gandhi advised, to be the change you want to see in the world, Culp is doing her part to bring inclusiveness, curiosity and, above all, fun into the elementary and middle school educational system. A volunteer in summer school special needs programs while in high school, Culp has witnessed the transformation that mentoring and one-on-one encouragement can produce.

Each InnoWorks “graduate” receives a certificate commending his or her unique talent, quality or contribution. Likewise, Culp is inspired daily by a poster that hangs in her room, filled with thank you notes and heartfelt appreciation from last year’s InnoWorkers.

Fueled by six hours of sleep a night and the satisfaction her extracurricular endeavors bring, Culp is successful in her own academic path. She envisions her future in the world of finance, well-outfitted with her engineering skill set grounded in critical thinking. It is not likely that her professional life will be all work and no volunteering, however. A glance under her desk in a couple of years might just turn up a Habitat for Humanity hard hat. There are, after all, houses to be built, and Amanda Culp will no doubt be on the job.
Kinesthesia

Hacking is a good thing. Or can be a good thing. As defined by Eric Berdinis and Jeff Kiske, two Computer Engineering juniors, hacking is the repurposing of a system or a device. In the case of their project, Kinesthesia, the result was an award-winning invention that enables the visually impaired to navigate through open space.

A new major developed by André DeHon, associate professor of Electrical and Systems Engineering (ESE), Computer Engineering spans and mines the divide between hardware and software technology. Along with five other undergraduates, Berdinis and Kiske are helping to shape the program by the very choices they make among the rich array of computer science and electrical engineering courses. (They prefer the term “pioneers” to “guinea pigs.”)

And pioneers they are. Kiske, a self-taught programmer from St. Louis who began creating and selling video games early on, and Berdinis, a self-described “tinkerer” from Houston, Texas, met as brothers in Penn’s Theta Chapter of Zeta Beta Tau (ZBT). They soon found themselves in many of the
Berdinis and Kiske’s take-away lesson from the adventure was the idea of invention as a series of tries and retries ideally free from the labels of success or failure. The team of two is quick to point out and marvel at the specialized expertise, some of it bordering on esoteric, that they were able to find among their classmates.

same courses at Penn Engineering and their fate as collaborators was sealed in ESE 350: Introduction to Embedded Systems, taught by Rahul Mangharam, Stephen J. Angello Term Assistant Professor in ESE.

The Assignment

Mangharam’s design challenge for the spring 2011 semester was to create a medical device that would improve the health and/or well-being of an individual. Berdinis and Kiske imagined their task at hand to be assisting the visually impaired to move about more easily. To that end, they set about hacking a Kinect, a motion-sensing apparatus used in video gaming. The result was Kinecthesia, which uses the belt-mounted Kinect to detect objects in a user’s path and relay the information by vibration.

Berdinis enjoys telling the story of a final-hour fail and a last-minute save as he and Kiske readied Kinecthesia for their project presentation to Mangharam. A down-to-the-wire purchase of a Kinect USB cable at GameStop was soldered onto the system as a last resort. Murphy’s Law was finally thwarted and disaster averted.

Berdinis and Kiske’s take-away lesson from the adventure was the idea of invention as a series of tries and retries ideally free from the labels of success or failure. The team of two is quick to point out and marvel at the specialized expertise, some of it bordering on esoteric, that they were able to find among their classmates. Their project found completion with a synergy and intellectual generosity that defines this group of Penn Engineers.

Kinecthesia ultimately did meet with success, and in unexpected ways—at least to Kiske. On a solitary mission, Berdinis entered their project into Google’s Zeitgeist Young Minds Americas 2011 competition. Berdinis uploaded a minute-long entry video pitching Kinecthesia’s potential positive impact on the world. When it came time to reveal his secret, the news was even better: they had won the competition.

National Attention

Google delivered: Berdinis, as the applicant, was flown to Arizona to attend Google’s Zeitgeist Conference, an invitation-only “thinkfest” featuring speakers and notables like Ariana Huffington, Mark Cuban, and the executive director of Google, Dr. Eric Schmidt. Seemingly confident in their ability to improvise and think on their feet, Google notified Berdinis only on his arrival in Arizona that he would be on the Spirit of the Time panel moderated by Chelsea Clinton. Watch his impressive contribution on YouTube: http://bit.ly/yCOktf

As they focus on refining Kinecthesia, Berdinis and Kiske are also involved in securing funding for its development. The entrepreneurial team will again be taking their show on the road in early May, when they will compete as finalists in the Cornell Cup, a national-level contest in which they have made the final cut. With their great working relationship and respect for one another’s strengths and talent, Berdinis and Kiske are already winners.

Editor’s Note: Additional congratulations to Eric Berdinis and Jeff Kiske for Kinecthesia’s first-place finish at the Intel Innovators Competition!
PLEASE JOIN THE MANY INDIVIDUALS who have helped to shape the character of Penn Engineering through a planned gift. A planned gift can ensure that your philanthropy not only maximizes the benefit of available tax incentives, but creates a lasting legacy, ensuring that you make a difference in areas important to you and for future generations.

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The Science of Play
By Amy Calhoun

According to Stuart Brown, psychiatrist and Founder of the National Institute of Play, “nothing excites and stimulates the brain as completely as play. Play is a basic biological necessity. Humans are uniquely designed by nature to enjoy and participate in play throughout life.” Play makes us smarter, happier and more productive. Mark Palatucci (CIS’00) knows this, which is why he created Anki, Inc., a company with the goal to apply the best minds and the latest technology to one of life’s necessities: play.

The Penn Connection
In the fall of 1999, Palatucci enrolled in Engineering Entrepreneurship, taught by Thomas Cassel, Professor of Practice in Mechanical Engineering and Applied Mechanics. “That class had an enormous impact on my future,” notes Palatucci. “When I came to Penn, the notion of entrepreneurship wasn’t even on my radar. I had never considered running my own business, but once I learned the vocabulary and culture of entrepreneurship, I was empowered.”

Upon graduation, Palatucci followed his passion and created Copera, Inc., a software engineering company with fellow Penn alumnus Stuart Eichert. Copera flourished initially, but struggled as the economy of Silicon Valley crashed in 2001. In a last-ditch effort to save his company, Palatucci took the final $1000 in the coffers to buy exhibition space at a trade show. The ploy worked. Copera got new clients, and Palatucci established his reputation as a successful entrepreneur.

In 2004, with the business functioning smoothly, Palatucci was eager for a side project, so he volunteered with the Stanford University robotics team, working on ‘Stanley,’ Stanford’s entry into the Defense Advanced Research Projects Agency (DARPA) Grand Challenge autonomous vehicle race. There he met the head of Stanford’s Artificial Intelligence lab, Sebastian Thrun, a former faculty member at Carnegie Mellon University’s (CMU) Robotics Institute.

Palatucci and colleagues began developing an idea for a toy that would incorporate all of their acquired knowledge in robot autonomy, including path planning, perception systems, obstacle avoidance, motion planning, sensor integration and multi-robot coordination.
Thrun encouraged Palatucci to consider pursuing a Ph.D. in robotics. Palatucci struggled with the decision, but decided to seize the moment, applying for and winning a National Science Foundation fellowship and admission to CMU’s Robotics program. While at CMU, Palatucci studied machine learning, pattern recognition and robotics. When Palatucci won an Intel Corporation fellowship, he began working in the Intel Research lab on campus, a place which encouraged the blending of business and academic culture.

“Most Ph.D. students have never worked outside of a university, so they rarely give thought to design simplicity or price constraints,” notes Palatucci, “but you must if you’re going to apply research to a business venture. As predicted by Moore’s Law, the price of hardware continues to plummet, which allows us to take the complex algorithms of the research environment and apply them to a new class of low-cost consumer products.”

Smart Toys for Smarter Consumers
Palatucci and CMU colleagues began developing an idea for a toy that would incorporate all of their acquired knowledge in robot autonomy, including path planning, perception systems, obstacle avoidance, motion planning, sensor integration and multi-robot coordination. In early 2010, while finishing their dissertations, they developed a prototype, and formed the company Anki, Inc. Palatucci noted that his previous entrepreneurial experience was “invaluable as they created a new business model in the dicey market of toys.”

Next year, the company will produce and market a new kind of interactive toy. “We’re trying to amaze people and change their expectations about what’s possible in a physical toy,” said Palatucci. Anki, Inc. plans to take cutting-edge technology out of academic research labs and use it to build the smartest toys on the planet. 🎅
Honors and Awards

Kostas Daniilidis, Professor of Computer and Information Science and Director of the General Robotics, Automation, Sensing and Perception (GRASP) Laboratory, was elected a 2012 IEEE Fellow.

Dennis E. Discher, Robert D. Bent Professor of Chemical and Biomolecular Engineering, has been elected to the National Academy of Engineering for his “elucidation of the effects of mechanical forces on cell physiology and stem cell development.” This is among the highest professional distinctions accorded to an engineer.

Christopher Fang-Yen, Assistant Professor of Bioengineering, has been awarded a 2012 Sloan Research Fellowship. These two-year fellowships are awarded to early-career scientists and scholars of outstanding promise in recognition of distinguished performance and a unique potential to make substantial contributions to their field.

Howard Hu, Professor of Mechanical Engineering and Applied Mechanics, has been elected to the 2011 Fellowship Class of the American Physical Society.

Aravind Joshi, Henry Salvatori Professor of Computer and Cognitive Science, and Mitchell Marcus, RCA Professor of Artificial Intelligence, both in Computer and Information Science, have been named Fellows by the Association for Computational Linguistics.

Bruce Kothmann, Senior Lecturer in Mechanical Engineering and Applied Mechanics, has received the 2012 Provost’s Award for Teaching Excellence, which is given annually in recognition of distinguished teaching by associated faculty or academic support staff. One student noted, “The first thing that anyone will notice about Dr. Kothmann is his contagious enthusiasm for engineering; it is nearly impossible to resist being swept up in his undying excitement for what he does.” Through his experience as an industrial aerospace engineer, he specializes in “posing practical engineering problems and challenging students to think outside the box” and thereby “brings real-world engineering into classroom instruction.” His students consistently praise the combination of rigorous standards, applications, accessibility and enthusiasm that he brings to his teaching.

Boon Thau Loo, Assistant Professor of Computer and Information Science, is the 2012 recipient of the Young Investigator Award from the Air Force Office of Scientific Research.

Rahul Mangharam, Stephen J. Angello Term Assistant Professor of Electrical and Systems Engineering, has been selected as a speaker on automotive architecture at the 2012 NAE Frontiers of Engineering Symposium.

Christopher B. Murray, Richard Perry University Professor and Professor of Materials Science and Engineering, has been selected as Fellow of the 2012 Class of Materials Research Society.

Camillo José (C.J.) Taylor, Associate Professor of Computer and Information Science, has been awarded a Christian R. and Mary F. Lindback Award for Distinguished Teaching, the University’s highest teaching honor. Dr. Taylor has taught at Penn since 1997. His extraordinary contributions to the curriculum include developing the two-semester introductory course sequence in Scientific Computing and reorganizing the computer science requirements. Students repeatedly testify to his ability to combine academic rigor with personal approachability, as he “sets an atmosphere for intellectually challenging but enjoyable learning in all his courses” and “strikes the perfect balance between being approachable and motivating his students to work independently.” They report that he “inspires students to work at becoming not only better programmers, but better thinkers.”

Karen I. Winey, Professor of Materials Science and Engineering, was selected as the 2012 recipient of the George H. Heilmeier Faculty Award for Excellence in Research for her “innovative methods in the fabrication and processing of polymer-based nanotube composites.” Dr. Winey’s lecture “Electrical Properties in Polymer Nanocomposites,” was presented on March 13, 2012.

Beth Winkelstein, Professor of Bioengineering, and Jennifer Lukes, Associate Professor of Mechanical Engineering and Applied Mechanics, have been named 2012 Penn Fellows. The program provides leadership development to select Penn faculty members in mid-career, including opportunities to build cross-campus alliances, think strategically about universities and university governance, and consult with Penn’s senior administrators.
Penn Engineering 2012 Teaching Awards

The recipients of the annual Penn Engineering teaching and advising awards are selected directly by our students after thoughtful consideration. Penn Engineering is filled with gifted educators and we continue to be inspired by their dedication and excellence.

Jonathan Fiene, Senior Lecturer and Director of Laboratory Programs in Mechanical Engineering and Applied Mechanics, has received the Dean’s Award for Excellence in Teaching in the Lecturer and Practice Professor Track. Dr. Fiene received his B.S. in Mechanical Engineering from the University of Nevada, Las Vegas in 2001 and his master’s and Ph.D. degrees in Mechanical Engineering from Stanford University in 2003 and 2007, respectively. A student writes that, “Dr. Fiene’s presentation is intuitive, clear, and interesting, and his unconventional assignment descriptions go straight to the essence of learning, focusing on real and meaningful features.”

Alejandro Ribeiro, Assistant Professor of Electrical and Systems Engineering, has been awarded the S. Reid Warren, Jr. Award, which is presented annually by the undergraduate student body and the engineering Alumni Society in recognition of outstanding service in stimulating and guiding the intellectual and professional development of undergraduate students. Dr. Ribeiro received M.Sc. and Ph.D. degrees in Electrical and Computer Engineering from the University of Minnesota in 2005 and 2007, respectively, and earned his B.Sc. degree in Electrical Engineering from the Universidad de la Republica in Uruguay in 1998. One student states, “In my four years, I have not met a more motivated professor who strives to make the classroom an engaging experience. Dr. Ribeiro shows outstanding concern for the academic development of every student.”

Jan Van der Spiegel, Professor of Electrical and Systems Engineering and Associate Dean for Education, has been awarded the Ford Motor Company Award for Faculty Advising. The award recognizes dedication to helping students realize their educational, career and personal goals. He earned his Ph.D. in Electrical Engineering in 1979, his M.E. in Electro-Mechanics in 1974, and his undergraduate degree in Engineering in 1971, all from the University of Leuven in Belgium. One student notes, “Dr. Van der Spiegel really knows the curriculum and is the embodiment of a true scholar. He wants to help students learn all they can, to the best of their abilities.”

Wayne L. Worrell, 74, Professor Emeritus of Materials Science and Engineering, died on February 18, 2012, at his home in Penn Valley, Pennsylvania.

Dr. Worrell established an international reputation for high temperature materials research through his work on corrosion mechanisms of nickel and cobalt studies of high temperature oxidation resistant composites and coatings, and the electrochemical behavior of oxide components in solid oxide fuel cells. His work led to more than 110 papers, 10 patents and 26 doctoral theses. As a professor he mentored over 40 graduate students and 30 postdoctoral fellows and visiting professors. Dr. Worrell also served terms as Chair of the Department of Materials Science and Engineering and Associate Dean of Graduate Education and Research.

In addition to his research contributions to electrochemical science, Dr. Worrell was very active with the Electrochemical Society. He served as president in 1992, vice president and executive committee member from 1989-1992 and was a member of the board of directors and served on several of their committees. The Society has recognized his research and service through numerous awards. These include the Carl Wagner Memorial Award; the Solid State Science and Technology Award and the Edward Acheson Medal, the highest award offered by the Society. Dr. Worrell was also Fellow of the American Ceramic Society and ASM international (the Materials Information Society).

Dr. Worrell received his Bachelor of Science degree in 1953 and his Ph.D. in 1963 from MIT, both in metallurgy. After two years as a postdoctoral fellow and lecturer at the University of California, Berkeley, he joined the University of Pennsylvania as an assistant professor of metallurgy in 1965. He was promoted to associate professor in 1967 and to full professor of materials science and engineering in 1974.

Dr. Worrell is survived by his wife Judy; children, Fred and Caroline; and six grandchildren, Marion, William, Peyton, Daniel, Lauren Grier and Lauren Elizabeth.

Memorial gifts may be sent to the attention of Mr. George Hain, Vice Dean for External Affairs, 220 South 33rd Street, 123 Towne Building, Philadelphia, PA 19104-6391. For questions, please contact George at ghain@seas.upenn.edu.
Helen Anderson

Helen Anderson, IT Senior Director of Computing and Educational Technology Services (CETS), has worked for Penn Engineering since 1986. Helen manages computing and networking for the School and is the administrative director of the Wolf Nanofabrication Facility.

What is the function of an IT Senior Director? I support the ongoing mission of the School through information technology (IT), including oversight of classroom technology, teaching labs, productivity infrastructure, academic support databases, network access, security and research computing support. I strive to anticipate the engineering community’s future information technology needs. For example, in research applications, we are moving from clusters to cloud computing. I plan and implement technology projects which are critical to continued excellence in education and research in the School.

What is your role in the Wolf Nanofabrication Facility? The Wolf Nanofabrication Facility is a laboratory serving the nanofabrication needs of the Penn community as well as those of external users. As the administrative director, I work to provide shared nanofabrication capability for researchers. Thanks to a generous gift from the family of Jack Keil Wolf and investments by Penn, the facility has undergone a major renovation and now houses state-of-the-art tools and additional clean space.

What brought you to Penn? I came to Penn as an undergraduate! I earned two bachelor’s degrees from the University of Pennsylvania, a B.A. in Biology and B.S.E. in Civil and Urban Engineering. Post graduation, I worked for the Marcus Hook Sun Oil Refinery as a project engineer, specializing in piping and environmental remediation projects. I returned to Penn for a Master of Science in Engineering in Computer and Information Science. I worked in the General Robotics, Automation, Sensing and Perception (GRASP) Lab, and then moved into computing support. As an alumna, it’s a pleasure to be able to provide emerging technology services to my former professors.

You have beautiful quilts hanging on the walls in your office. Is this a hobby of yours? No, these were all gifts from my mother, an accomplished quilter. I treasure these quilts and I never tire of the colors and patterns. 🧵
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<table>
<thead>
<tr>
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