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Can Innovation be Taught?

Innovation cannot be taught; it is instilled. There is no believable heuristics, no textbook, no material one could copy on a blackboard that would credibly turn our students into more creative individuals. To impart technological creativity we rely explicitly on a process of "cultural contagion." Personalities are shaped by immersion in a group of creative mentors and peers. Subconscious and, yes, also conscious imitation serve to excite and to motivate, effectively to infect our students’ minds with the spirit of innovation.

The same statement can also be made for other traits that are otherwise hard to teach: ethics, leadership, ambition. These are not just desirable, they are crucial, yet cannot be transmitted in the same ways we teach mechanics, circuits or databases. In relying on the culture of a student’s cohort we are effectively harnessing peer pressure, a fantastically strong biological force.

I am not arguing that teachers and parents can afford to sit back and simply trust the supposedly beneficial effect of young people’s peers; we do play crucial roles. The power of a School is many-fold; a most important one is embodied in the criteria used for admissions, in the process used for putting together a freshman class.

I have witnessed how it is done at Penn and I am extremely proud that our colleagues at the Undergraduate Admissions Office, under the direction of Dean Lee Stetson, have both the insight and the fortitude to look beyond academics, to pore over every application with excruciating care looking for tangible evidences of character, creativity, and leadership. Resisting our natural inclination to rely only on scores is not easy. (I must confess it is painfully hard for an engineer!) But our collective resolve is strengthened when we see the results, every time we marvel at how unselfconscious our bright students are, at how well they relate to each other and to their faculty, at Penn’s noted identity as the foremost “happy-to-be-here” institution.

The School’s next responsibility is, of course, to bring students together in the appropriate venues and to expose them to role models, to charismatic and compelling examples of creativity and innovation. Penn’s Weiss Tech House (http://www.tech-house.upenn.edu/), happens to be physically located within the Engineering complex. Under the direction of Professor Karl Ulrich, the Tech House provides a wonderful space and an effective format. Its “PennVention” harnesses other natural instincts, teamwork and competition. The results are admirable.

However our most important tool, the term of strongest order in this equation, is academics: faculty and curricula. Innovation drives our every curriculum and transforms the fundamentals of what our future engineers should be—and are—learning. They are inspired by such exceptional professors as Chris Chen of Bioengineering, Shu Yang of Materials Science, and Mark Yim of Mechanical Engineering. These faculty members are featured in these pages because they, like so many others, think big about a myriad of exciting engineering things, about the manipulation of cells, about photonics, microlenses, robotics, and microprocessors. They spark grand ambitions and ideas in our students. Read about them and you will share our excitement.

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Living cells corralled onto microscopic circles, squares, triangles and tetrahedrons at the scale of a human hair and smaller create a visual narrative to Christopher S. Chen’s scientific discoveries.

These meticulous arrangements illustrate Chen’s pioneering adaptation of technology from the semi-conductor industry to reveal new biological insights. “Many of the tools and basic science behind how to control, pattern and organize materials for electronics turned out to be equally important for figuring out how to engineer surfaces to study cells in culture,” says Chen. “Most barriers to discovery are on the technique side, so that’s where I focus my research. We’re designing new tools that can reveal a wide range of biological and mechanical interactions occurring at the cellular level.”

Chen’s seminal findings illuminate the influence of micro-environmental cues on stem cell differentiation, cellular adhesion to extracellular matrix and neighboring cells, vascularization of engineered tissues, and cellular navigation. “We’re trying to understand how cells form tissues, and how they’re affected by their surroundings,” he says. “Cells live within a community just as we do. They adapt based on what other cells are doing around them. Cells aren’t robots that follow pre-set programs. We’re trying to figure out the ways that cells talk to each other, and how and when they make decisions based on that input.”

Chen joined Penn’s Bioengineering Department in late 2004 as the Skirkanich Associate Professor of Innovation, adding to the intellectual ferment of the community of Penn scientists working at the interface between cells and materials. “Our proximity to each other here at Penn has a huge impact on our research,” says Chen, who works closely with Penn faculty in Physics, Material Science, Chemistry, Chemical and Biomolecular Engineering, Electrical Engineering, Pathology, Orthopedics and Cell Biology.

“We’re in a period of scientific discovery that requires us to bring people from different vantage points together to look at problems,” says Chen. “Having people from so many different angles looking at the interface between cells and materials is very exciting. None of us as individuals are deep enough in all of the relevant disciplines to make much progress at this multidisciplinary interface. Collaborations are a way to accelerate progress in very complex areas.”

That his research has appeared on the cover of many scientific journals, and that Chen, M.D., Ph.D., age 38, already has more than 50 publications, some of which are profiled in journals such as Science, Molecular Cell, Nature, and the Journal of Cell Biology, points to the beginning of a promising career. He holds a B.A. in Biochemistry from Harvard, an M.S. in Mechanical Engineering from MIT, and a Ph.D. from MIT’s Health Sciences Technology Program. Next, after completing his M.D. at Harvard, he spent five years on the faculty of Johns Hopkins University.
“It’s obvious that Chris will do great things,” says colleague Sangeeta Bhatia, M.D., Ph.D., MIT associate professor and Director of MIT’s Laboratory for Multiscale Regenerative Technologies. “But what’s not so obvious is exactly which field he’ll make his impact in because he’s working in so many. It could be in cancer, stem cell biology, or tissue engineering. The thing about Chris is that he’s interested in a million things. His diversity of interests and his intellectual ability are what make his research so exciting and his publication record so rich.”

Chen’s priorities extend beyond his research interests. “Inspiring interdisciplinary research and training the next generation of graduate students are just as important and rewarding as making discoveries that could lead to a therapeutic for improved human health,” he says.

Colette Shen, an M.D./Ph.D. student in her second year at Penn who holds a B.A. in Bioengineering from Harvard, says she selected Chen’s lab because, “He works at the interface of important areas in medicine, science and technology such as stem cells, tissue engineering, and microfabrication. Plus, he’s a great mentor. He asks each of his students what our long term goals are in terms of whether we want to go into academics, industry, or medicine. He advises us and gives us opportunities accordingly that really help with our own career advancement while giving us freedom to take our projects in the direction we want.”

Chen credits his friends and family with pushing him to direct his scientific curiosity toward research that could ultimately have an impact on human therapeutics. “My parents are pragmatists,” he says of his mother and father, a mathematician and mechanical engineer, respectively. “My wife is in the pharmaceutical industry, and is always looking to translate discoveries to practice. We’re all working for a time when our children will live long and happy lives. Technologists such as engineers and physical scientists play a key role in this scientific process, by developing critical tools to answer the questions we need to answer in order to improve human health.”

“Cells live within a community just as we do. They do things based on what other cells tell them to do. They aren’t just robots. We’re trying to figure out the ways they talk to each other, and how and when they make decisions based on that input.”
If you’re riding a cardboard bike, you have to hope it doesn’t rain.

Mark Yim, Gabel Family Term Junior Professor in the Mechanical Engineering and Applied Mechanics department, doesn’t mention what the weather was like when his mechatronics students went to deliver newspapers. He does say that their bikes were about “99% cardboard.”

Yim came to Penn a year and a half ago from the Palo Alto Research Center where he worked on modular reconfigurable robots, a continuation of his PhD work at Stanford. The “paperboy on a paper bike” project was one of four that he has come up with to enliven his hands-on mechatronics course for junior, senior, and first-year grad students.

“Mechatronics” (a term reportedly coined by Japanese engineer Tetsuro Mori in 1969) is hardly a household word, but in engineering it has a fairly straightforward meaning, “Mechatronics is basically electromechanical systems—electronics from a mechanical engineer’s point of view,” explains Yim. “It involves some mechanical engineering, some electrical engineering, and some computer programming. Small, embedded processors are tied together with motors and sensors.” Think of it as giving electromechanical systems a bit of computer-based intelligence.

“Mechatronics is seen in a wide variety of consumer products,” he adds. “Cars would be considered mechatronic today, because they have lots of microprocessors,” which control functions like anti-lock brakes. Cell phones, autofocus cameras, CD-players, refrigerators, and washing machines also employ mechatronics. As Yim emphasizes: “Computers are everywhere. Robotics is a classic example of mechatronics.”

His one-semester course, MEAM 410/510, though based in SEAS, has aroused interest elsewhere on campus, especially among architecture and design students. “Lots of people in the architecture school are interested in mechatronics. I’ve given several lectures to them. Architects are getting more and more interested in things that move.”

Yim, who has taught the course twice so far, intends it to be more practical than theoretical. “It’s geared to making the students able to actually do things,” he says. That basic learning is taken care of in the first half of the course, which involves a variety of labs. The doing comes in the two projects that highlight the second half.

His very first project was “paperboy on a paper bike,” in which the students had to build a bike out of cardboard that could support the weight of a person. Though called a “bicycle,” the rules allowed it be made like a rickshaw, so that it could be pulled or pushed. “One team tried to make pedals, but that didn’t quite work,” Yim recalls. Still, “most of the teams did almost everything out of cardboard. They could use some non-cardboard pieces—bearings, tinfoil, pieces of plastic—but there would be a large penalty for that.”

That construction provided the mechanical side. For electronics, the student teams were required to devise a sensor that could tell how far the bike had gone and to include an on-board computer that could talk to another computer. The delivery path for the newspapers was fixed, and the bikes measured how far they had traveled along the path to determine house addresses.

Prior to each run, an external computer, networked by cable to the bike’s on-board computer, downloaded the delivery addresses and was then detached. During the run, the on-board
The golfers later evolved into sumo waiters: “We'd put two of those guys in a ring with a beacon on each vehicle, and each would have to try to knock off the other guy's cup.”

Obviously, the course in mechatronics requires a lot of work, a good head for detail, and a sense of how to put disparate parts together. Could someone in architecture or design, if accepted, navigate the course? Yim thinks they could, with some difficulty: “The main thing is the programming. Some engineering students came into the course without much programming and struggled a bit, but it was OK in the end.”

The other projects he designed for the course were equally intriguing and offbeat. The second project during the first year was a robotic golf putter. “We mounted flashing beacons around a putting green and put their device randomly somewhere on the green,” recalls Yim. “It would sense where the beacons were, triangulate from the beacons to determine where the hole was, then putt golf balls into the hole. That had a good combination: Triangulation has a significant amount of processing, and the teams have to build the motors and sensors and put everything together.”

For the coming year, Yim is looking at ways of both expanding the course’s base and making it work better for all involved. “In the past, the only graduate students allowed were first-year students. I’d like to see if it can be opened up to all undergrads and grads.”

In a broader area of outreach, Yim and the chair of his department, Vijay Kumar, are working on the development of a design program that would involve the Design School, SEAS (mechanical engineering), and Wharton. The deans of all three schools are supportive, says Yim, but plans are still highly tentative. The program would most likely start with a masters curriculum that would include a mechatronics course.

And who knows what might come of such an undertaking—maybe a house that fetches its own newspaper?”
Indeed, the woman who has founded, guided, and sold three highly successful companies and holds more than 20 patents in the laser, fiber-optic, thermal imaging, and glucose sensing fields, has demonstrated the wisdom of that advice many times over. Fortunately for Penn, the SEAS Overseer has her mind on the future of Penn Engineering — and, through her leadership and a $500,000 gift, the School will be doing a lot more in the years ahead.

“Kathy is a visionary in the finest sense of the word,” says Dean Eduardo Glandt. “Her energy and imagination, coupled with determination and hard work, explain a lot about her past success and her current focus. Like our School, she’s a pioneer in the engineering profession, and she brings that perspective to everything she does.”

“Staggering,” is how Dr. Crothall describes the possibilities for nanotechnology. The sentiment explains in part why this entrepreneur extraordinaire has directed her recent contribution to the Dennis Discher Biophysical and Polymer Engineering Laboratory, the research from which will inform and help shape the Nano/Bio Interface Center. Inaugurated in November 2004, the Center is focused on the future, and as Dr. Crothall sees it, “wisely leveraging Penn’s strengths in the biological sciences and biomedical engineering with its developing strength in nanotechnology.”

A fierce advocate for building up Philadelphia’s technology base and entrepreneurial environment, Dr. Crothall sees a broad benefit to this swiftly emerging industry. “There is no question in my mind that nanotechnology will ultimately have the same impact on the world as the silicon microelectronic technology has had over the last 40 years. My hope is that Penn’s nanotechnology efforts spawn a number of companies that could potentially benefit the entire Philadelphia region.”

Dr. Crothall explains that her confidence and support is inspired by the clarity of Dean Glandt’s vision for the School. “Rather than trying to become all things to all people, SEAS has focused on a few key areas and [tapped into] existing strengths,” she says. “As an entrepreneur, I’m impressed by that kind of focused planning and execution.”

Personal experience contributes as well. Though 35 years have passed since Kathy Crothall graduated from Penn, she has only good things to say about Penn Engineering faculty. “I found the faculty, as did my daughter [Gayle Laakmann, C’05, ENG’05], to be highly committed to teaching. I still keep in touch with a handful of faculty who taught me back in the seventies.”

She also guides today’s students. Twice a year she visits Tom Cassel’s Engineering Entrepreneurship class in the hope of encouraging would-be entrepreneurs to follow their dreams—and to not be put off by a “bumpy ride.”

“I tell students that if they want it enough, and they are willing to work hard enough, they can probably succeed at anything. And with a bit of luck,” she adds, “they just may well settle in the Philadelphia area.”

“If you really put your mind to it,” Dr. Katherine D. Crothall, EE’71, tells students, “there is very little you can’t do.”
By the time John Hagan, CSE ’84, matriculated in 1980, most of ENIAC had long since moved to other locales. But what was left became a daily sighting. One time, while Hagan was a student at Penn, he visited the Smithsonian Institution. Part of ENIAC was on display there, in front of a photo that showed the entire behemoth. “It was all behind glass,” he recalls. “I was laughing,” he says. “I thought to myself, back at Penn, I can walk right into it.”

Years ago, Hagan heard a talk by Kay Mauchly, a mathematician on the ENIAC project and widow of John W. Mauchly, who invented ENIAC along with J. Presper Eckert, Jr. “She talked about those days,” Hagan says. “About how they were passionate. That’s what hasn’t changed—the challenges are exciting, and they keep changing. People who want to do this work have fun coming up with those solutions. You develop a product and six months afterward it’s out there, changing the world.”

“It was an inspiration and an honor to be allowed to learn right next to this great invention. It didn’t teach me anything—it wasn’t a professor—but its presence was felt.” Now it is a piece of history; then it was part of my experience. I had an opportunity to treat it like a friend.”

After graduating, Hagan worked for the University, first as a network engineer and ultimately as the director of operations for PennNet, the University’s computer network. Today he is the principal owner of Trilon, Inc., which provides IT services to small businesses in the Philadelphia area. Although ENIAC “is enshrined in pretty much the same spot it was in then,” he says, “it’s been fun to watch its historical importance wash over the world.”

Hagan’s appreciation of the machine has changed since his student days. “Its importance was not clear to me at the time,” he says. “I was focused on my education—learning all about computers.

“It was a great accomplishment by a few individuals who believed in what they could do,” Hagan says. “It was an exciting place where I saw people doing things I wanted to do. I wanted to be part of that. To me it was an inspiration to be at the institution that built ENIAC and treated it as ordinary. That’s what drove me to choose Penn.”

“I thought: They did it right here. I’m right here. Why can’t I do something great?”

**MILESTONE FOR ENIAC**

More than 17,000 vacuum tubes, 70,000 resistors, 150,000 watts of electrical consumption, a weight of 30 tons.

Yes, ENIAC, the world’s first fully functional electronic computer—invented at Penn’s Moore School of Electrical Engineering—boasted some notable numbers.

And now another: This year, ENIAC, like the first wave of baby-boomers, celebrates its 60th birthday.
A Blast from the Past

Putting together a history of your life to share with your children and grandchildren is something one may often ponder. But just as often procrastination rears its head and the oral history never finds its way into words. Not the case with Richard Denison, ME’50, who recently compiled his personal history which includes his years at Penn Engineering and the Navy from 1945-1950. Richard met up with Dean Glandt a couple of years ago at an event in Los Angeles and mentioned to him how different (and better) Penn Engineering is today compared to when he attended. Here is an excerpt from Richard’s history. Read the full story on our web site at www.seas.upenn.edu/whatsnew/2006/looking_back.pdf Perhaps he’ll inspire you to pen your own memoirs.

Freshman at Penn then in the Navy “By taking Economics and Physics in summer school, I was able to graduate from Central High in January 1945 instead of the scheduled June 1945.

I started Penn in February majoring in Mechanical Engineering. Everyone in our family was in business and virtually everyone went to Wharton School, but I chose engineering because in the Depression most small businesses had a rough time. On the very first day of school I met Bob Gross, ME’49, (future Dean of Engineering at Columbia University) who was starting ME also. Bob was such an enthusiastic young man that I was able to overlook the fact that he had just graduated from Northeast High School which was an all boys school like Central and its arch rival. I did not know at the time that through his influence I would become a counselor at Indian Lake Camp, go to Harvard Graduate School, and meet my future wife, Vicki….
They are Penn Engineering students who regard classes as only one facet of their education. They venture out of the classroom into local and global communities to share their interests, skills, and time. A heavy load of classes and labs make the latter no small sacrifice yet nearly thirty percent of Penn Engineering students participate in some meaningful community service activity. Indeed, time management is critical and many find that its mastery is one of the unforeseen and lasting benefits of community service.

Engagement in community service initiatives conforms agreeably to the Penn Compact laid out by President Amy Gutmann, according to Joseph Sun, Director of Academic Affairs for the School of Engineering and Applied Science. “It enables our students to include in their Penn education learning experiences that go far beyond the classroom,” says Sun. “Our students will be prepared to enter into high level jobs but at the same time, there are those for whom engaging in relatively simpler technologies provides a very meaningful professional and personal experience that improves the neediest communities.”

This year, three dynamic community service initiatives have captured the interest and energy of Penn Engineering students: (1) the FIRST Robotics Competition, (2) the development of a sustainable water system in Honduras, and (3) the 2006 Illumination Tour for the Solar Racing team. While each project has a faculty advisor in some capacity, the students are basically in charge—business and management skills go hand in hand with technological expertise.

The FIRST Robotics Competition is a multinational contest that teams professionals and young people to solve an engineering design problem. The various contests held around the country are high-tech spectator sporting events, designed to demonstrate the many opportunities in technology and to stimulate interest in the basic concepts of science, math, engineering, and invention.

Recently, students from Penn Engineering mentored a group from neighboring West Philadelphia High School (WPHS) who had six weeks to build a robot for the competition. Together, they brainstormed the features needed to succeed—the mobility, speed and power range that would enable the robot to launch a sponge rubber ball about the size of a volleyball into a goal that was 8 feet off the ground. With design in hand, the WPHS team set off to build the robot in their automotive lab. Penn students provided support by fabricating certain small parts in their machine shop and offering technical assistance.

Working with the students was Jim Keller, project engineer in the GRASP Laboratory and part-time doctoral student in...
mechanical engineering and applied mechanics with a 20-year career in the helicopter industry behind him. Says Keller, “The WPHS team had a good comfort level with fabrication but when it came to designing the part that makes the robot shoot balls, they needed support from us with the more sophisticated programming.”

Kristin Condello ME’07, who spent several hours a week with the WPHS team, felt challenged by the experience. “It forced me to apply what I’ve learned and to explain it clearly because the kids looked to me to help evaluate if they were on the right path, if their ideas were good, and how to improve them. It definitely made me more interested in robotics than I was before,” she says, “and it gave these kids exposure firsthand to a robot. When we demonstrate the dynamics and depth to robotics building, it gets them to think on a different level and to see what a university can offer.”

According to Simon Hauger, site administrator for The Academy for Automotive and Mechanical Engineering at WPHS, the robotics partnership is invaluable. “We’ve had a long standing relationship with Penn’s engineering school, with college students volunteering here for the past eight years. Hopefully, the exposure to university students influences our kids to go on to college. This partnership brings in additional support for us and meets needs that we cannot,” says Hauger.

To meet unmet needs is also the motivation behind the current international project of the Penn chapter of Engineers without Borders (EWB), the non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. Founded in 2004, PennEWB’s dual efforts focus on educating the local greater Philadelphia community about engineering and sustainable development, and helping developing communities worldwide with their basic engineering needs through real, hands-on engineering projects.
UNDER THE GUIDANCE OF ADJUNCT PROFESSOR ANTHONY SAUDER, PENNEWB HAS INITIATED A CLEAN WATER PROJECT IN THE SMALL HONDURAN FARMING VILLAGE OF TERRERITOS (“LITTLE PIECE OF EARTH”). ONE-THIRD OF THE HOUSES ARE NOT CONNECTED TO A RUNNING WATER SUPPLY, AND MOST OF THOSE THAT ARE DO NOT RECEIVE AN ADEQUATE AMOUNT OF WATER, LEAVING SOME RESIDENTS WITH WATER TAPS THAT PROVIDE NO WATER AT ALL OR WATER FOR ONLY BRIEF PERIODS OF TIME AT INCONVENIENT TIMES OF THE DAY OR NIGHT.

PennEWB is working with FUCOHSO, a sustainable harvest international non-governmental organization in Honduras, and numerous other organizations to raise logistical and financial support for building and maintaining the sustainable water system so desperately needed for adequate health and sanitation. Terreritos has demonstrated its stake in the project by contributing manual labor, local natural resources such as stone and wood, and housing and food for volunteers.

Although PennEWB’s daily local operational costs are covered by the Engineering Student Activities Council and the Weiss Tech House, the club is looking to raise $20,000 to fund the international project and is seeking much-needed corporate or individual donations. To this end, the students have prepared a briefing document on the project. The project represents the first student-initiated project abroad for SEAS—previous community service projects abroad have been organized by faculty members who worked in the communities being served or who otherwise knew people on the ground.

Alex Mittal, MSE’07, president of PennEWB, went on a site assessment trip last summer with Sauder (himself a Honduran). Sounding like a seasoned global worker, Mittal says, “We met with the whole community in Terreritos because we wanted to make certain that we had full support for the project. They voted almost unanimously in favor of it. Each family pledged a certain amount of money and donated their labor to help build the system.”

This summer, fourteen students will travel to Terreritos to build a distribution tank and a protection box to ensure that the water goes directly from the spring into the pipes. The group will also look at other needs of the community—the majority of houses don’t even have pit latrines. Mittal adds, “Anyone who goes on
this trip will be taking away a tremendous amount, not just about volunteering but about working as a team, learning the culture as well as new skills.”

MEMBERS OF PENN SOLAR RACING TEAM (PSR) ARE ALSO EXPANDING THEIR SKILL SETS. A SEAS TRADITION SINCE 1989, THE TEAM HAS ADDED COMMUNITY OUTREACH TO ITS ORIGINAL PURPOSE OF DESIGNING AND BUILDING A SOLAR POWERED CAR TO RACE IN THE BIENNIAL AMERICAN SOLAR CHALLENGE (ASC). IN 2004, THE TEAM TOOK ITS CAR ON THE ROAD ON THE FIRST SUMMER ILLUMINATION TOUR. Sponsored by Lockheed Martin, the tour of several Pennsylvania schools was designed to inspire students to become the great innovators of tomorrow; to encourage education in science technology, engineering, math and science; and to raise awareness about alternate fuels. Zach Kirkhorn, M&T’06, one of the current team leaders, was wowed by the sophisticated questions. “A second grader asked us to explain how we used arithmetic to make the car,” he recalls. Team leader Noël Camacho, BE ’07, was surprised that middle-school students knew about drag coefficients.

The 2005-07 team is preparing for the 2nd Illumination Tour this summer, focusing on Philadelphia area middle-schools in order to provide a more intensive experience with an expanded curriculum.

Kirkhorn is enthusiastic about his venture into community service, “The classroom can be kind of boring sometimes but when you see the applications, it’s really a rewarding experience.” Having had a taste of leadership and realizing the changes a well-oiled organization can stimulate, Kirkhorn adds, “I can see myself running a small business someday.”

As Penn Engineering students witness the positive results of their service contributions to local and global communities, they are also discovering a more intrinsic reward—the ability to dream larger dreams of their own.
Blazing Internet speeds. Synthetic microlenses that “see.” Robots that have legs with tunable motion. Three seemingly disparate topics—yet they do have something in common. All three depend on properties of materials. And all are under the microscope of Shu Yang, Skirkanich Assistant Professor in Materials Science and Engineering.

Yang, who majored in polymer chemistry and physics at Fudan University in Shanghai, China, came to the United States for graduate study at Cornell. She worked at Bell Labs from 1999 to 2003 and joined the Penn Engineering faculty in 2004.

In 2002, the National Academy of Engineering honored her as one of the nation’s top 100 young engineers. In 2004, MIT’s Technology Review selected her as one of the world’s top innovators under the age of 35.

Photonics

Using a brilliantly designed PowerPoint presentation, Yang first demonstrates some of her research in photonics. The goal of the work is to develop new concepts and materials that offer more complex functionalities than conventional optical devices, such as optical fibers, which have fostered much of the high-speed transmission of data over the Internet in the past 15 years.

“The continuing miniaturization of feature sizes in integrated circuits has led to significantly improved device performance and higher packing densities in microelectronics,” Yang says. “At the same time, the explosion of the Internet creates demands for smaller, faster, and more sophisticated optical integrated circuits to carry massive amounts of information.”

Conventional integrated circuits are produced by two-dimensional photolithography. Yang’s technique uses three dimensions. “A 3D photonic crystal with periodically alternating high- and low-dielectric-constant materials offers extraordinary control of the propagation of photons,” she says. “It reflects light from all directions within a specific range of frequencies.”

Essentially, the 3D crystal traps light. Defects, intentionally introduced into the material, steer the light in desired directions. “The ability to create such 3D photonic crystals with controlled defects,” Yang says, “has potential applications for waveguides, lasers, optical filters and switches, and high-density data storage.

“Although significant progress has been made in 2D microfabrication, entirely new protocols must be developed for mass-producing 3D microstructures with tailored shapes, fine features, and chemistries.”

Yang has pioneered a procedure called multibeam interference lithography, which splits one visible laser beam into four. The four beams interfere with each other within a few seconds to create a periodic 3D pattern that is free of defects over a large area (several square millimeters).

The technique, Yang says, “is found to be extremely efficient and versatile. We are searching for new 3D structures and novel materials—such as responsive polymers and organic-inorganic hybrids—to increase the functionality as well as the structural complexity.”

The advances in materials will allow the development of various ultrasmall optical circuits based on 3D photonic crystals, which may ultimately lead to higher bandwidth and faster speeds for telecommunication networks, including the Internet.

Microlens Arrays

Clear vision is crucial to many animals—they rely on eyes as their sensory organs for detection, focusing, and imaging. “Millions of years of evolution,” Yang says, “have perfected many
optical features with a wide range of tunability, which is unparalleled by today’s technology. For example, human eyes have bending lenses that dynamically change focus. In the octopus, eye muscles move the lens inward and outward to focus on close-up and distant objects. Some vertebrate animals, which spend their lives in both air and water, have developed amphibious eyes, allowing them to see clearly in both media.

But scientists hoping to replicate eyes in the laboratory, or to produce devices that have eyelike qualities, have fallen short. “Most man-made optical components have only simple functions,” Yang says, “and the range of tunability and complexity is rather limited. It is highly desirable to have complex, robust, and small photonic devices that can mimic biological designs and functions. A microlens with variable focal length over a wide range is of great interest; it could increase the efficiency of light detection, recording, imaging, and coupling.”

Hints on how to make such a lens come from the light-sensitive brittlestar, Ophiocoma wendtii, a sea creature belonging to the starfish family. Like all echinoderms, brittlestars have skeletons of calcium carbonate, which is a traditionally poor engineering material for optics. Ophiocoma wendtii has no discernable eyes, yet it can catch prey such as shrimp and can quickly flee from predators. How can it do that, and what clues to ways of seeing might it offer?

Joanna Aizenberg, with whom Yang collaborated at Lucent Technologies’ Bell Laboratories, discovered that in Ophiocoma wendtii, the calcite crystals used for skeletal construction act as a component of the animal’s photoreceptor, which may have the function of a compound eye.

“The periphery of the calcitic skeleton extends into a close-set, nearly hexagonal, array of spherical microstructures that have a characteristic double-lens,” Yang says. “The lenses guide and
concentrate light onto photosensitive tissue and offer remarkable focusing ability, angular selectivity, and signal enhancement.”

Surrounding the lens structure is a network of pores through which pigment migrates nightly. “By controlled transport of radiation-absorbing intracellular particles through the pores to cover the lens,” Yang says, “the brittlestar microlenses can be considered an adaptive optical device.”

Inspired by the unique lens design and its optical properties, Yang is finding novel ways to engineer a similar structure. “First, we mimic the structure—a lens, with pores surrounding it,” she says. “Using three-beam interference lithography, we generate the lens as well as the pores.

“Creating the biomimetic lens arrays, we can show that the microlenses have strong focusing ability and that light-absorbing liquids can be transported in and out of the pores between the lenses, which provides a wide range of tunability to the lens’s optical properties.

“Our future research is aimed at developing a fundamental understanding of how to control photochemistry, chemical composition, surface functionalization, and softness (deformability) to create robust yet highly responsive microlens arrays. By taking this knowledge and coupling it with microfluidics, we would like to develop an advanced, multifunctional photonic microdevice.”

Tunable Soft Robots

Another area of Yang’s research is robots. Whereas animals are soft and tunable, robots are rigid. “No programmed machine,” Yang says, “has been able to compete with biological muscle tissues, which utilize compliance and damping properties in tendons and skeleton to dynamically tune the mechanics of the body and limbs. Advances in robotics have been significantly hindered by the lack of exploitation of tunable soft materials, which can combine strength, resilience, compliance, and nonwettability.

“One innovative approach that my lab is taking is to assemble stacks of soft springs and hard springs from micropatterned layers, which will produce periodic ripple-like nanostructures induced by elastic instability at the stack interface. Preliminary results suggest that the formation of such ripple-like structures has dramatic impacts on the adhesion and friction between stacks—which will lead to dynamical tuning of the leg stiffness. My goal is to work with electrical and mechanical engineers to incorporate materials’ properties in the design framework and tackle various intricate robotics questions.”

Yang is collaborating with Dan Koditschek, Alfred Fitler Moore Professor and Chair of Electrical and Systems Engineering and Penn Engineering’s robotmeister. “In our robotics work,” Koditschek says, “it has become clear that as much of the ‘algorithm’ for motor skills (running, hopping, and so on) should be ‘written’ in the materials properties of the limbs (shape, compliance, damping) as in the computer code that animates motors. Shu is one of the young wizards in the design and construction of novel materials with the potential for actively tunable properties of this kind: compliance that can be selected by electrical or magnetic command; or roughness, smoothness, hardness that can be programmed by some easily programmable variable.

“We are exploring with Shu’s group the prospects for building such programmable materials into the structure of an advanced generation of robots that would be more agile and versatile than any the field has yet been able to produce.”

The missing link between robots and animals, Yang contends, is materials science and engineering. She’s intent on supplying that link.

Biomimetic lenses—Shu’s group is interested in learning from nature to create complex optical devices.
It looks like most any other business meeting on campus. Suits and ties. Bagels and spreads. Agendas passed and ideas exchanged.

But even as faculty, students and administrators share a conventional conference table, the similarities end there. Leading this meeting are the students—the students of the Engineering Deans’ Advisory Board (EDAB).

The Board advises Dean Eduardo Glandt and the School’s deans, faculty and administrators on student needs and opinions—offering a valuable insider’s view to Penn Engineering’s leadership.

“It’s my own wonderful ‘kitchen cabinet,’” says Dean Glandt. “Their proposals are well-researched, on-point, and key to the School’s continuing success. EDAB members take their work seriously, and so do I.”

And, he adds, “the students arrive not only fully prepared, but smiling and energetic at 8 a.m.!”

On a blustery February morning, EDAB members and Penn Engineering leaders gather in Levine Hall to discuss a full agenda. It includes the Engineering library renovations, access to sample curricula on the School’s website, and the possibility of an Engineering honors program.

EDAB members Rahul Bhandari ’07, Carlson Lau ’09, and Karthik Sridharan ’07 distribute an outline for an exploratory discussion on an honors program.

They talk about such a program as a tool for student recruitment and retention and an opportunity for intensive research. They point to models at Penn and elsewhere. Dean Glandt leans forward, and listens intently. “Interesting,” he says. “This is something that, in my many years here, I don’t think we have discussed and I think it’s overdue.”

He inquires more deeply about the other models and appreciates the “clear purpose of recruiting top freshmen.” An honors program, the students add, could create a unique “community of scholars” within the School. Dean Glandt agrees.

The brainstorming vibrates around the room: “It’s worth considering, and we need to consider extra staffing,” says Associate Dean and CIS Professor Sampath Kannan. Dean Glandt asks: “Do we have a sense of the faculty’s reaction?” An EDAB student wonders: “Is staffing the biggest obstacle?” An administrator suggests: “Could it be a seminar-type program?”

The students are eager to move forward on the idea. And Dean Glandt takes it to the next level: “Let’s create a taxonomy of different scenarios and see what the staffing structures and needs would be.”

Then it’s on to the next agenda item.

Well-organized and in tune with Penn Engineering undergraduates, EDAB develops ideas like the honors program to enrich the student experience.

“I wanted to make a change and give back to the School,” says the high-energy student, who is also a leader in business fraternity Delta Sigma Pi and the community service group Rebuilding Together.
In consultation with Penn Engineering faculty and administrators, EDAB members are working on a half-dozen projects at any one time. Among their current efforts:

- easing the transition for new undergraduates to Penn Engineering;
- developing a website on the best study spaces in the School;
- developing Research Opportunities at Penn Engineering, a program to enrich the undergraduate research experience;
- hosting Dinner with the Deans, where undergraduates can “tell the deans exactly how they feel about what’s going on in the Engineering School.” (Dean Glandt gladly reciprocates: EDAB members are invited guests for dinner at his home during the academic year.)

When EDAB members speak, the administration listens. “EDAB is an essential liaison between students and School leadership,” says Joe Sun, director of academic affairs at Penn Engineering. “It is important for us to listen and act on the concerns of the students, and EDAB is an excellent guide.”

LESSONS IN LEADERSHIP

Even as EDAB aims to improve the undergraduate experience at Penn Engineering, this unique organization also provides leadership opportunities for its members. Says EDAB President Trevor Lott ’06: “It is our responsibility to understand what students want and craft solutions to fit those needs.”

EDAB’s lessons in leadership appeal to its well-rounded student members who are active not only at Penn Engineering, but throughout the University. Meet three of them:

EDAB member Rahul Bhandari ’07 is working to enhance the Penn Engineering student experience, and finding his own experience deepening as well.

“I wanted to make a change and give back to the School,” says the high-energy student, who is also a leader in business fraternity Delta Sigma Pi and the community service group Rebuilding Together. When Bhandari completes his degree, he will look back on two EDAB achievements with special pride:
“We are working to ensure that students will be provided with innovative technology and effective workspace.”

The Penn Engineering web “portal” (allowing students to streamline online access to School services) became the prototype for the University-wide PennPortal, now a model in higher education; and the textbook study collection, developed under Bhandari’s leadership, offers students alternate textbooks for introductory level courses right in the Engineering Library. Students can strengthen understanding of their subjects while lightening the load in their backpacks.

Students working closely with faculty and administrators for the greater good appeals to EDAB Secretary Gabe Kopin ’08. “The strength of the relationship that the organization has built up with the administration really provides the best possible avenue to improve the School,” he says.

This committed undergraduate also chairs the Student Committee on Undergraduate Education (SCUE), a University-wide organization that holds the respect of students, faculty and administrators for its thoughtful approaches to undergraduate education. “It is difficult for the faculty and administrators to assess, on a holistic level, the issues — beyond departments and individual courses — which undergraduates need to have addressed and resolved,” says Kopin. At Penn Engineering, “EDAB provides that intermediary mechanism which, in the past, has paid huge dividends.”

In her junior year, EDAB member Lisa Markusson ’07, active and attuned to student needs, saw EDAB as “a perfect way to turn my ideas into action.” Markusson, also vice president of administration in Delta Delta Delta sorority, speaks for students on a Penn Engineering library renovation committee. “We are working to ensure that students will be provided with innovative technology and effective workspace,” she says. “I can’t wait until the construction begins and we will get a chance to see the improvements!”

As Markusson has learned, leadership also requires muscle: Fixings for a student Bagel Breakfast didn’t include a transport cart. “Instead, we had to make about 10 trips down Walnut Street with arms full of bagels, cream cheese, donuts, and coffee,” Markusson recalls. “It was definitely a morning workout. . . .” It was also a lesson in leadership from the ground up—a hallmark of the innovative EDAB.
Awards and Honors

2006 Heilmeier Faculty Research Award

Dawn A. Bonnell, Trustee Professor of Materials Science and Engineering and Director of the Nano/Bio Interface Center, is the 2006 recipient of the George H. Heilmeier Faculty Award for Excellence in Research. The award is presented annually to encourage and recognize excellence in scholarly activities among the School of Engineering faculty.

Professor Bonnell received the award for her pioneering studies of the application of scanning probes to the study of complex oxides. Over the past five years her work has led to major breakthroughs in manipulation of atomic polarization to control the local chemical reactivity of ferroelectric solids for nanolithography and nanostructure assembly. She presented a University-wide lecture to faculty and students on Wednesday, February 22, 2006, entitled “Probing, Manipulating and Exploiting Nanostructures.”

Dr. Bonnell received her PhD from the University of Michigan and was a Fulbright scholar to the Max-Planck-Institute in Stuttgart, Germany, after which she worked at IBM Thomas Watson Research Center. Her current research involves atomistic processes at oxide surfaces, nanometer scale electronic phenomena in materials, and assembly of complex nanostructures. She has authored or coauthored over 180 papers, edited several books, including Scanning Probe Microscopy and Spectroscopy: theory, techniques, and applications. Her work has been recognized by the Presidential Young Investigators Award, the Ross Coffin Purdy Award, and several distinguished lectureships. Professor Bonnell has taught short courses for scientific societies, served as a Founding Board member of the Nanoscale Science and Technology Division of AVS, and as president of AVS. She has served in leadership positions in the Basic Science Division and Exhibitions and Meetings Committee. She is a Fellow of the American Ceramic Society and a Fellow of the American Association for the Advancement of Science. She serves on the editorial boards of several journals, on national and international advisory committees, and is involved with several nanotechnology based companies.

The Award is named in honor of Dr. George H. Heilmeier (EE’58, PhD, Princeton), Chairman Emeritus of Telcordia Technologies, in recognition of his extraordinary research career, his leadership in technical innovation and public service, and his loyal and steadfast support of Penn Engineering. Dr. Heilmeier received international recognition for his discovery of several new electro-optic effects in liquid crystals leading to the first liquid crystal displays for watches, calculators, and instrumentation. In 2005, he was awarded the Kyoto Prize for Lifetime Achievement for these pioneering achievements. Dr. Heilmeier serves on the Board of Overseers for the School.

Vaclav Vitek Named to the National Academy of Engineering

Vaclav Vitek, Professor of Materials Science and Engineering, was recently named a member of the National Academy of Engineering, one of the highest professional honors accorded an engineer. Members are elected to NAE membership by their peers (current NAE members) and have distinguished themselves in business and academic management, in technical positions, as university faculty, and as leaders in government and private engineering organizations.

Vaclav Vitek joined the Penn faculty in 1978 as a full professor after serving as a postdoctoral fellow at Oxford, a Research Associate and a Research Fellow at Wolfson College (Oxford) and as the Principal Research Officer at the Central Electricity Research Laboratories, Leatherhead, England.

Dr. Vitek’s current research concentrates on structure and properties of dislocations and interfaces in metallic materials that are suitable for high temperature applications associated with the generation of energy—specifically, transition elemental metals, intermetallic compounds and transition metal silicides. The principal goal is linking atomic level structure and properties with nano-scale, mesosopic and macroscopic behavior via multi-scale modeling. In these studies he draws greatly on his background in physics and introduces into the engineering analyses approaches based on fundamental physics.

Dr. Vitek is a Fellow of the Institute of Physics (London), the ASM International, and The Minerals, Metals and Materials Society, and is a member of the American Physical Society and the Materials Research Society. He published over two hundred original papers in peer-reviewed journals, fifty invited papers and more than one hundred papers in various conference proceedings. He is a member of editorial boards of several international journals in the field of Materials Science. He has received numerous awards including the Pfeil Medal of The Metals Society (London) in 1982, Alexander von Humboldt Senior Scientist Award (Germany) in 1991, NEDO Research Award (Japan) in 1992, Acta Metallurgica Gold Medal in 1996, Honorary Doctorate of the Technical University of Brno (Czech Republic) in 1999, and Ernst Mach Medal in Physical Sciences awarded by the Czech Academy of Sciences in 1999.
**New Associate Dean**

Dr. Sampath Kannan of Computer and Information Science has been named Associate Dean of the School of Engineering and Applied Science effective January 1, 2006. Dr. Kannan began his career at Penn in 1994 after three years on the faculty of the University of Arizona. He received his undergraduate degree in Electrical Engineering from the Indian Institute of Technology, Bombay, his Masters degree from Princeton University and his PhD from Berkeley.

Dr. Kannan has served his department, his School and the University in various capacities, including as Undergraduate Chair of Computer and Information Science, as Recruiting Chair, and as a member of the Curriculum Committee. At the School level he has served on Faculty Council and the Academic Performance Committee, and at the University level on the Task Force for Global Engagement and on the Pluralism Committee.

As Associate Dean, Dr. Kannan is responsible for overseeing all undergraduate and graduate programs, all student support services, international exchanges and interdisciplinary programs with other schools in the University.

Dr. Kannan replaces Dr. Norman Badler of Computer and Information Science who served the School in the position since January 2001. Dr. Badler has now redirected his energies to his dual roles as Director of the Center for Human Modeling and Simulation and as Founding Director and Faculty Advisor of the Digital Media Design Program. Dean Eduardo Glandt praised Dr. Badler’s five years of service as Associate Dean, adding that “Norm Badler is a price-less asset to our School, one of its most innovative educators and foremost citizens.”

**New Faculty**

Gianluca Piazza, Assistant Professor of Electrical and Systems Engineering

Gianluca’s research focuses on piezoelectric micro and nano systems (MEMS/NEMS) for RF wireless communications, biological detection, wireless sensor platforms and medical ultrasounds with general interest in the areas of micro/nano fabrication techniques and integration of micro/nano devices with state-of-the-art electronics.

Prashant K. Purohit, Assistant Professor of Mechanical Engineering and Applied Mechanics

Prashant joined Penn Engineering in January from a postdoctoral appointment in Physics and Astronomy at Penn.

His research interests are in the area of rod theories for DNA and biopolymers, mechanics of sub-cellular organelles, mechanics at the bio-nano interface, martensitic phase transitions in solids.

Casim A. Sarkar, Assistant Professor of Bioengineering

Casim arrived at Penn in January from a postdoctoral appointment at the University of Zurich. His research interests are in the area of molecular and cellular bioengineering using both experimental and computational techniques to assess and engineer protein function in the context of cellular processes.

**Awards & Honors**

Dawn Bonnell, Trustee Term Professor of Materials Science and Engineering, has been named a Fellow of the American Association for the Advancement of Science.

Joseph Bordogna, Alfred Fitler Moore Professor of Engineering, Electrical and Systems Engineering, was awarded the Distinguished Service Medal of NSF for his exemplification of the highest standards, his vision, leadership and mentorship, and his wise stewardship of NSF resources.

Eduardo Glandt, Dean and Robert D. Bent Professor of Chemical and Biomolecular Engineering, will be inducted as a corresponding member into the National Academy of Exact, Physical and Natural Sciences of Argentina.

Ali Jadbabaie, Assistant Professor of Electrical and Systems Engineering, received the 2005 George Axelby Outstanding Paper Award for the best contribution to the IEEE Transactions on Automatic Control.

Vijay Kumar, Chair and UPS Professor of Mechanical Engineering and Applied Mechanics, has been named an IEEE Fellow.

Daniel Lee, Associate Professor of Electrical and Systems Engineering, received the Lindback Award for Distinguished Teaching. Many students mentioned Dan’s accessibility and willingness to be helpful. One student said, “He is one of our outstanding professors, very passionate about his work and cares about his students.”

Jennifer Lukes, William K. Gemmill Assistant Professor of Mechanical Engineering and Applied Mechanics, received an NSF CAREER Award for her work “Integrated Approach for Modeling Thermal Energy Transport in Mesoscale Arrays of Nanostructures.”

Warren Seider, Professor of Chemical and Biomolecular Engineering, has been elected Fellow of the American Institute of Chemical Engineering.

Beth Winkelstein, Assistant Professor of Bioengineering, received an NSF CAREER Award for her work “Biomechanics of Neck Pain: Does Form Dictate Function?”

Shu Yang, Skikkanich Assistant Professor of Materials Science and Engineering, received an NSF CAREER Award for her work “Selective grafting of responsive polymer brushes on topographically structured surfaces: a new route for surface and interface manipulation.”
Lecture Notes

The Harold Pender Award

Mildred Dresselhaus, Institute Professor of Physics and Electrical Engineering, Massachusetts Institute of Technology, was the 2006 recipient of the School’s most prestigious award for her pioneering contributions and leadership in the field of carbon-based nanostructures and nanotechnology. She was also recognized for her work in promoting opportunities for women in science and engineering. Her lecture entitled, “Recent Advances in the Photophysics of Carbon Nanotubes,” was presented on February 28, 2006. Dr. Dresselhaus participated in a full day of activities including lunch with students and meetings with various faculty. In the evening, the University community gathered to honor Dr. Dresselhaus with a reception and dinner at the University Museum.

Grace Hopper Lectures Series

In support of the accomplishments of women in engineering and science, each department within the School brings prominent speakers to campus for a lecture and opportunities to interact with undergraduate and graduate students and faculty.

September 14, 2005—Daphne Koller, Associate Professor of Computer Science, Stanford University—“Probabilistic Models for Complex Domains: Cells, Bodies, & Webpages”

December 6, 2005—Sangeeta Bhatia, Associate Professor, Massachusetts Institute of Technology—“Application of Micro- and Nanotechnology Tools to Tissue Dysfunction”

January 18, 2006—Molly S. Shoichet, Canada Research Chair in Tissue Engineering, Professor of Chemical Engineering and Applied Chemistry, Chemistry and Biomaterials, and Biomedical Engineering, University of Toronto—“Tissue Engineering and Drug Delivery Strategies for Spinal Cord Injury Repair”

Tedori-Callinan Lecture Series

The Department of Mechanical Engineering and Applied Mechanics presented the inaugural Tedori-Callinan Lecture on February 13, 2006, with guest speaker Fritz B. Prinz, Chair, Department of Mechanical Engineering, Stanford University. Dr. Prinz’s lecture was entitled “High-Performance Solid Oxide Fuel Cells for Low Temperature Operation.”

John A. Quinn Lecture in Chemical Engineering

Douglas A. Lauffenburger, Uncas & Helen Whitaker Professor of Bioengineering and Director of the Biological Engineering Division, Massachusetts Institute of Technology, was this year’s recipient. Dr. Lauffenburger presented a lecture on March 1, 2006, entitled “What Are Cells Thinking…And How Might We Think About This? An Engineering Approach to Understanding How Signaling Networks Govern Cell Behavior.”

Alumni Notes

Pier Francesco Guarguaglini, GRE’72, CEO of Finmeccanica, was named Person of the Year by Aviation Week & Space Technology. The award recognizes the impact individuals have on the broader aviation, aerospace and defense community. Dr. Guarguaglini took the helm of Finmeccanica in 2002 and has transformed the Italian defense and aerospace company into a global market force in a few short years.

Thomas DiMarco, MSE’94, is currently an instructor of Computer and Information Science at Temple University. Tom has previously worked for Andersen Consulting and Bellcore as well as taught at the high school and college level.

Francis M. Linguitti, EE’72 GEE’79, has been elected to partnership at Caesar, Rivise, Bernstein, Cohen & Pokotilow, Ltd., one of Philadelphia’s leading intellectual property law firms. Frank’s practice has included all aspects of intellectual property law with emphasis on patent prosecution and validity/infringement opinions in the field of complex computer, telecommunications and business systems. He is a member of the Pennsylvania and Philadelphia Bar Associations.

In Memoriam

William Oliver Baker, Overseer

William Oliver Baker, died October 31, 2005, at the age of 90. A native of Chestertown, Maryland, he graduated from Washington College and received his doctoral degree in Physical Chemistry from Princeton University in 1938.

In 1939, he joined the technical staff of Bell Labs, where he remained until his retirement in 1980. Throughout his career, he had the distinction of being called upon by U.S. Presidents Truman through Reagan for his advice on issues of science, technology and national security. He was awarded the President’s National Security Medal in 1982 and the National Medal of Science in 1988.

He headed Bell Labs as company president from 1973 to 1979, a period in which researchers under his leadership won back-to-back Nobel Prizes—the first for theoretical research involving the electronic structure of magnetic systems and the second for work underpinning the big-bang theory of the origin of the universe. It was during this time, also, in 1974, that he joined Penn Engineering as an Overseer. He brought to the table a deep commitment to higher education in America and a strong advocacy for technology research at the university level, valuable contributions to the oversight of the School. In memory of Dr. Baker, the Board of Overseers of the School of Engineering and Applied Science entered this tribute into the minutes of its meeting held March 24, 2006.

Iredell Eachus, Jr. EE’41 GRE’43

Iredell Eachus, Jr. died December 13, 2005, at Sunrise Assisted Living in Havertford, PA. He was 85. As a graduate student in Electrical Engineering, he was involved in the pioneering research and design of ENIAC at the University of Pennsylvania’s Moore School. After his graduation from Penn, he was assigned, as a Navy Ensign, to the Naval Research Labs in Washington, D.C., where he worked with technology for weapons systems during World War II. He succeeded his father in 1959 as President of the Macbeth Arc Lamp Company, a leading manufacturer of process lighting in the graphic arts and plastics industries in Philadelphia, and retired in 2002. He was predeceased by his wife, Helen, and is survived by his sons, David and Robert, daughters Alison, Meredith Eachus Armstrong and Lola Judith Chaisson, eight grandchildren, and a great grandchild.
Create your legacy: Remember Penn Engineering

Estate plan bequests and beneficiary designations, both large and small, have been crucial to Penn Engineering’s success since its founding in 1852, and remain among the largest sources of contributions each year. Through their estate plans, our alumni and friends have endowed professorships, scholarships and fellowships. They have supported other aspects of the School with unrestricted gifts, creating a legacy to ensure that future generations of Engineering students will continue to have the best training possible.

To include the School in your estate plans, simply name Penn Engineering as a beneficiary of your 401(k), IRA, or other retirement plan. Specify Penn Engineering by name to make sure the School benefits directly.

For those in the highest tax brackets this designation can save you over 70% in estate and income taxes at death. Penn Engineering also welcomes your bequest of cash, property or a percentage of your estate through your will or living trust.

Benefits of an Estate Intention

- Enables you to make a significant contribution that may otherwise not have been possible during your life time, while supporting an institution with great personal value to you.
- Removes the value of the estate intention from your taxable estate.
- Allows for changes in the value of your assets when set up as a percentage.

For more information on retirement plan designations, sample bequest language or to review the full range of ways to meet personal planning objectives while creating your legacy for Penn Engineering, contact:

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Support Penn Engineering with a Charitable Gift Annuity. Rates vary from 5% to 9.5% depending upon your age.
Cora M. Ingrum, Director of the Office of Multicultural Programs, is a stalwart of the School of Engineering, providing advice and counseling to students from diverse backgrounds and cultures. Cora’s warm and nurturing personality draws students to her office for her sage advice and often just for a caring hug.

**What is the mission of the Multicultural Programs?** We enable students to optimize their talents, capitalize on their cultural perspectives, realize their intellectual potential, and fulfill their career aspirations.

**How are students engaged in achieving their goals?** Students receive advising, counseling and mentoring. They build relationships that help them contribute to the culture of Penn Engineering and the University. They benefit from learning about the workings of the University in order to be successful.

**How are these efforts consistent with President Gutmann’s Penn Compact?** Penn Engineering’s multicultural activities are fully consistent with President Gutmann’s vision of increasing access and diversity, integrating knowledge, and engaging locally and globally. A diverse student body enhances the intellectual environment in the School, and helps people view complex problems through a multifaceted lens. The essence of an engineering career is knowledge integration. A multicultural environment enables students to learn globally as they engage locally.

This active pace of learning attracts investments from outside the campus to support activities in which multicultural students are involved with Penn’s world-class research faculty. For example, the National Science Foundation (NSF) supports the SUNFEST program through its National Research Experience for Undergraduates initiative. For the past twelve years Penn Engineering has been a member of the NSF/Greater Philadelphia Region Louis Stokes Alliance for Minority Participation Program.

**What impact does the School’s Multicultural Program have on similar programs at the University?** Since the 1970s Penn Engineering has founded, developed, and implemented novel programs of recruitment and retention and has served as a model for the University at the pre-college, pre-freshman, upper classmen, and graduate student level. We know that these students are future leaders and we want to make sure they reach their full potential.

**Anticipating the future, what is your vision for the success of the students you have engaged?** Our task is to prepare students for what may come rather than for what is. An ability to make connections among areas of knowledge, to understand relationships among seemingly different discoveries, events and trends, and to integrate them in ways that benefit the world will be the hallmark of tomorrow’s leaders. The multicultural aspect of a Penn Engineering education can ensure this outcome—this is my vision. I believe it was what our founder, Benjamin Franklin, was seeking when he said, “Genius with education is like silver in the mine.” Mining the intellectually-rich silver that lies in the minds of each and all in our multicultural student body is our educational aim.
The University of Pennsylvania values diversity and seeks talented students, faculty and staff from diverse backgrounds. The University of Pennsylvania does not discriminate on the basis of race, sex, sexual orientation, gender identity, religion, color, national or ethnic origin, age, disability, or status as a Vietnam Era Veteran or disabled veteran in the administration of educational policies, programs or activities; admissions policies; scholarship and loan awards; athletic, or other University administered programs or employment. Questions or complaints regarding this policy should be directed to: Executive Director, Office of Affirmative Action and Equal Opportunity Programs, Sansom Place East, 3600 Chestnut Street, Suite 228, Philadelphia, PA 19104-6106 or by phone at (215) 898-6993 (Voice) or (215) 898-7803 (TDD).