

Associate professor Andre Levchenko, here with PhD candidate Hojung Cho, has developed a way to mimic neuron growth on a microchip.

WILL MARK

New Cues to Neuron Growth

A new “lab on a chip” developed by Whiting School engineers will make it easier to study how and why neurons grow the way they do.

For nerve cells to function properly they have to make the right connections. To do this, they follow their noses, making their ways to their final destinations guided by complex chemical cues. But it has been difficult to study how these chemical cues work in the lab.

If you grow the neuron in a liquid medium, shearing forces from tiny currents tend to affect growth or damage the cell. And it can be hard to control the amount and the gradient of the chemical signals you want to study.

Now Andre Levchenko, associate professor of biomedical engineering, has created a “lab on a chip”—a micro-scale tool designed to mimic the chemical complexities of the brain—that allows nerve cell growth to be precisely controlled and studied.

“The current state of the art is rather crude. People use micropipettes, which they bring very close to a growth cone, and try to dump out a little bit of soluble cue. It’s not a very precise technique, and it doesn’t allow multiple cues. It’s also not high throughput,” Levchenko says. “We wanted to design a device that would allow us to put living neurons into it. We wanted to subject neurons to different cues and multiple cues at the same time.”

To create the chip, Levchenko and his colleagues used a photolithographic technique

similar to that used to make silicon computer chips. They etched the pattern they wanted into a silicon wafer, and used the wafer as a mold to cast the plastic. When they were done, they had a plastic chip full of tiny channels and wells. Using computer-controlled valves, they could precisely control the flow of nutrients and chemical signals throughout the chip.

For the experiment, the researchers implanted embryonic spinal nerve cells from the African frog *Xenopus* in the wells in the chip. Some of the channels were coated with chemical cues. Other chemical cues were introduced in solution.

The entire device was mounted under a powerful microscope. As the cell grew, the researchers were able to watch how it responded to the chemical cues on the channel walls, and also see how other cues they introduced affected the growth.

They were especially interested in how two different chemical cues might interact. They found that one chemical on a surface could attract the neuron to grow toward it, and another in solution could do the same. But when exposed to both cues at the same time, the cell grew in a random fashion.

Levchenko says that the chip will allow researchers to continue to examine how chemical cues affect neuron growth. It could be especially helpful in studying how neurons regenerate after an injury, and could also have applications for drug discovery.

“It’s a wonderful tool,” he says.

—Kurt Kleiner

By the Numbers

At Hopkins, continuing education for engineers is embodied in the Engineering and Applied Science Programs for Professionals (EPP). Now in its 25th year*, the program has grown by leaps and bounds and the numbers prove it...

Year that classes at the Applied Physics Laboratory (APL) became part of the Whiting School of Engineering and EPP was born: **1983**

Master’s programs offered by EPP in 1983: **6**

Master’s programs offered by EPP in 2008: **16**

Number of students enrolled in master’s programs at EPP in 2008: **1,840**

Graduate Certificate programs offered by EPP in 2008: **6**

Advanced Certificates in post-master’s study offered by EPP in 2008: **16**

Students enrolled in certificate programs at EPP in 2008: **52**

Percent of students whose tuition at EPP is paid for by their employers: **80–85**

Number of online classes offered by EPP in 2008: **568**

Program with highest enrollment in 2008: **Computer Science (2,424)**

*Through the years, the part-time program within the School of Engineering has changed names several times. What began, in 1983, as The Johns Hopkins University Part-Time Engineering Programs, saw three name changes before being renamed, a fourth time, to the Johns Hopkins Engineering and Applied Science Programs for Professionals in 2005.



A. James Clark Endows Benjamin T. Rome Deanship

A. James Clark, longtime friend of the Whiting School and a university trustee emeritus, has committed \$10 million to the Johns Hopkins University to endow the deanship of the university's Whiting School of Engineering in honor of his mentor and business colleague, Benjamin T. Rome. Nicholas Jones, a former chair of the school's Department of Civil Engineering and dean of the Whiting School since August 2004, was appointed the inaugural recipient of the Benjamin T. Rome Deanship in 2008.

Rome, who died in 1994, was a 1925 civil engineering graduate of Johns Hopkins Engineering and throughout his lifetime



A. James Clark and Nicholas Jones, the inaugural Benjamin T. Rome Dean of the Whiting School of Engineering.

JAY VAN RENNSLAER

generously supported the university's School of Advanced International Studies (SAIS), especially its China Studies Program. In fact, one of the two SAIS buildings in Washington, D.C., bears his name.

While Rome was president and CEO of the Washington D.C.-based George Hyman Construction Company, which was founded by his uncle, he hired a freshly minted college graduate named A. James Clark in 1950. Rome soon became not only Clark's employer but also his mentor. In the late 1960s, Clark succeeded Rome as president of Hyman Company, which was later named the Clark Construction Group. Today, Clark is chairman and chief executive officer of Bethesda-based Clark Enterprises, a holding company for a variety of businesses, including Clark Construction Group. — Kimberly Willis

Guaranteed to Have a Ball

Bicycles, springs, billiards, ball throwers, wind tunnels, music, and lacrosse balls. Those may sound like unlikely components to an undergraduate engineering course, but that's exactly what they are.

In the Department of Mechanical Engineering, a newly launched curriculum integrates hands-on lessons in physics and mechanical engineering to bring to life the underlying principles of mechanical engineering. The curriculum is divided into three year-long components: Freshman Experiences in Mechanical Engineering I and II, Introduction to Mechanics I and II, and Mechanical Engineering Freshman Laboratory I and II.

In the Freshman Lab, toys are used to teach one-dimensional motion, bicycles in the study of forces, springs to illustrate the conservation of energy, and billiards to show the physics of collisions and momentum. Students must design ball throwers as a mid-semester design project, the wind tunnel is used to teach concepts of fluids, and music brings alive the complexity of wave theory.

"Every week there's a brand new lab that's never been thought of before," says associate professor Allison Okamura, who teaches the

course. The goal? To get engineering students engaged as quickly as possible, to retain a diverse group of students, and—fundamentally—to generate student interest in the field.

Planning and work for the new curriculum began in 2007, involving a committee of four professors: now-retired professor Bill Sharpe, professor Joseph Katz, former professor and former dean Ilene Busch-Vishniac, and assistant professor Lester Su, all in the Department of Mechanical Engineering. Okamura was asked to develop the actual courses and, eventually, teach them.



"Every week there's a brand new lab that's never been thought of before." — Allison Okamura

"We asked, what turns people off?" Okamura says. The professors learned that, to better capture the imagination of young engineering students, they would have to teach physics with an engineer's perspective. "Science is the study of what is," she explains. "Engineering is the study of what can be."

So, instead of sending their newbie students off to the School of Arts and Sciences to enroll in introductory physics, the department now incorporates a more engineering influenced physics education into its own curriculum.

Hence the lacrosse balls. By first building one and then measuring the density of it, freshmen discover how uncertainty plays a role in engineering. "Students must question how measurement uncertainties increase when applied to the things we build," says Okamura. "Because they must make the ball and then measure it, they evaluate how the building of it may have introduced design or production flaws that result in measurement challenges."

The new curriculum, which is funded in part by the department chair's budget and the WSE Kenan Teachers Fund, aims to "instill in students, early on, a love of design and engineering," Okamura says. "There's no question that we'll continue to refine the curriculum. As we get feedback from students," she says, "we'll keep improving the courses." — Angela Roberts



Bridge Buddies

Few visitors to Homewood's Gilman Hall realize that the second floor passage leading into the Hutzler Reading Room is built on a steel girder truss bridge spanning what was once an open courtyard. Decades ago, that breezy courtyard was enclosed to provide a home for the university bookstore, with the store's ceiling suspended from the trusses above. Plans for the renovation of Gilman Hall now under way call for the removal of the bridge, to be replaced with a soaring glass-roofed atrium.

But 15 Civil Engineering seniors in their capstone Design and Synthesis II class were asked to imagine a different future: How could the goals of the three-year, multi-million dollar Gilman Hall renovation be achieved while at the same time preserving and incorporating the second floor truss bridge?

"Our theme has been preservation engineering," says Michael Palantoni '08, explaining that the first step in preserving any structure is first finding out how it's put together. "Part one is an existing condition survey, which means doing a detailed structural analysis of the building in its current state." In several hard-hat visits to the construction site, students went at the passageway with hammers and saws to see past finished walls, floors, and ceilings for a good look at the bones of the bridge.

"We probed into the bridge by taking out sheet walls to see the old steel connectors," Palantoni says. "It was an interesting challenge. The roof is very complex and involved." Site visits gave the students an opportunity to do field drawings and take careful measurements, which they subsequently employed to calculate the strength and capacity of the existing structure. On another visit, the site construction supervisor took them from the basement to the attic level of Gilman Hall for an up-close look at building practices from nearly a century earlier. "You can see how columns change in size as they descend through the building," reports Palantoni. He adds, "You don't see structural brick nowadays, and you know when you see a three-foot-thick brick wall you've got some pretty serious structural elements."

After probing, measuring, and calculating, the students were ready to begin designing. They

broke into groups of three and began imagining new uses for an old bridge. "The biggest thing in trying to use an existing structure is figuring out how to do it economically," says Zach Rosswog '08. "Our group opted to keep existing steel columns in place, but proposed welding steel plates to their sides in order to increase load capacity."

In final presentations each of the five student groups had to solve a complex set of design criteria, which called for allocating space for a 1,500-square-foot lecture hall, creating mechanical space at or below the second floor level, preserving the existing bridge while adding north/south traffic flow to its east/west axis, and covering the final structure with a glass roof above the



Civil engineering students created theoretical plans for the renovation of Gilman Hall, including this plan created by undergraduates Jesse Richter, Zach Rosswog, and Josh Hoagland.

fourth floor level. Most of the groups opted to strip the bridge of its original brick cladding to expose and highlight its steel truss structure. Proposals also included adding new stairways or separate bridge walkways to accommodate north/south pedestrian traffic. Each team made a detailed presentation before their classmates and a group of engineering faculty and construction experts, who critiqued the work.

The students found that when moving from theory to practice, experience counts. "The biggest challenge in any project, but especially something like this, is generating an actual way of accomplishing your concept," says Palantoni. "It's connecting what you want to do with what actually exists, and resolving all the structural issues." —Mike Field

More Masters in the Whiting School Universe

Financial Mathematics

To be officially launched this fall, the new Master of Science in Financial Mathematics program aims to produce the next generation of financial markets leaders, by sending its graduates to brokerages, trading floors, hedge fund companies, and banks around the world. Housed within the Department of Applied Mathematics and Statistics, the Financial Mathematics master's program is based in probability, statistics, optimization, partial differential equations, and scientific computing.

"Financial Mathematics quantifies and enables much of the modern interplay among companies, investors, and financial agents in global markets," explains David Audley, PhD '72, who spent 35 years in the financial markets industry before returning to Hopkins to teach a new generation of financial mathematicians.

Dan Naiman, who heads the Department of Applied Mathematics and Statistics, believes the new program will enhance students' quantitative abilities, and strengthen their ability to communicate with specialists and non-specialists alike. "Fundamentally," he says, "we are giving our graduates the ability to translate real-world problems into mathematical ones and determine solutions that can be applied in the global markets industry."

Master of Science in Engineering Management

Based within the school's Center for Leadership Education, the Master of Science in Engineering Management (MSEM) program offers an equal blend of graduate-level engineering knowledge with professional development training including communications, management, law, leadership, entrepreneurship, and technology commercialization.

Beginning this fall, students can enter the MSEM program directly after graduation from a bachelor's program or after a few years of professional experience, but must have a bachelor's degree in engineering, mathematical sciences, or natural science and are expected to have completed courses in accounting and marketing. And undergraduates can choose to combine the program with their undergraduate work, creating a five-year bachelor's/master's program. —AR

A Riveting Solution to What Sank the *Titanic*

The mystery has remained unsolved for nearly a century. The RMS *Titanic* was a 46,000-ton, double-hulled marvel of modern engineering. Unsinkable, people called it. Why then on April 14, 1912, did a glancing blow off an iceberg cause the *Titanic* to sink into the depths of the North Atlantic in less than three hours? For decades after the sinking, scientists offered up different theories. Perhaps, many speculated, it was the brittleness of the ship's hull, an attack by a German U-boat, or a patch of low-lying pack ice that was to blame.

Enter Jennifer Hooper McCarty (MSE '99, PhD '03). She has spent the last decade studying remnants of the *Titanic* recovered from

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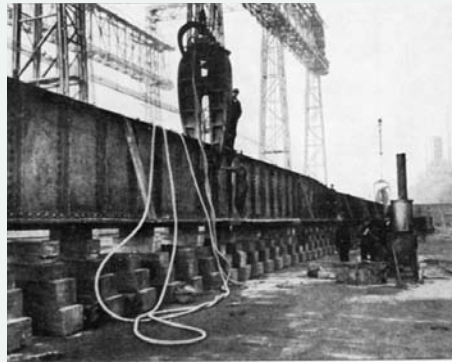
J. H. McCarty

the ocean floor, examining their makeup, testing their strength, and researching how and where they were made.

Along with her co-investigator, Tim Foecke, a materials scientist with the National Institute of Standards and Technology and a Whiting School adjunct professor, what she found in the first-ever hands-on forensic investigation was surprising.

"It was sort of like the unzipping of a seam," explains McCarty, who details her findings in the book she co-wrote with Foecke, *What Really Sank the Titanic: New Forensic Discoveries* (Citadel Press, 2008). "This enormous ship that was supposed to be unsinkable sank in less than three hours because of 12 square feet of damage."

They determined that the 6-inch-long rivets used in the *Titanic's* bow and stern were hand-forged from wrought iron—not steel—in order to save money and meet deadlines. Some of the iron rivets, which had been made and installed by apprenticed and sometimes less-experienced workers, contained a high concentration of slag. While the glasslike substance adds strength at smaller concentrations (2 to 3 percent), the duo concluded that the higher concentration of slag weakened the wrought-iron rivets. Thus, the rivets popped under the stress caused by the ship's contact with the iceberg, resulting in the flooding of five or six



Alumna Jennifer Hooper McCarty studied rivets from the sunken *Titanic* to solve one of the world's most famous mysteries.

watertight compartments. Had the rivets been stronger, fewer compartments would have been compromised and the mighty ship would have remained afloat for several more hours—enough time for the nearby *Carpathia* to rescue all those on board, McCarty hypothesizes.

McCarty began her research on the *Titanic* while she was still at Hopkins, where she won a Carl E. Heath Jr. Fellowship for women in engineering. In 1999 when her advisor, Professor Tim Weihs, asked her if she would be interested in studying some 45 rivets from the *Titanic* for her dissertation in materials science, she jumped at the chance. "I've always liked the historical aspect of materials science," says McCarty, who currently works as a clinical assistant professor at Oregon Health & Science University in Portland, Oregon. At Hopkins, her research started in the lab, where she looked at the rivets under the microscope, tested them mechanically, and created computer models to see how the rivets responded under conditions similar to the iceberg collision. Following completion of her PhD she spent two years in England delving through records and correspondence detailing how the *Titanic* was built. "At times I really did feel like a detective," she recalls.

For her next project, McCarty is interested in researching and writing about the building of the Eiffel Tower. "I'm just fascinated by this whole iron and steel age," she says. "I love the idea of bringing people into the story of Gustave Eiffel and why he was so incredible as a designer and a builder; [I want to] talk about how the Eiffel Tower was built and why it has stood all of these years." — Maria Blackburn

Partnership Offers Promise for New Surgical Tools

Researchers at the Whiting School and the School of Medicine have forged a partnership with Europe's largest research organization. Germany's Fraunhofer-Gesellschaft has a staff of 13,000 scientists and engineers, an annual research budget of € 1.3 billion, and is committed to undertaking various applied research projects for both the private and public sectors.

The partnership with the organization, which has more than 80 research units at locations across Europe, the U.S., and the Middle East, has resulted in the Johns Hopkins-Fraunhofer Initiative for Innovations in Interventional Medicine. The goal: to develop new, minimally invasive surgical tools.

"This agreement provides a wonderful opportunity for researchers from the two institutions to work together to develop important new medical tools and move them out of the lab and into applications where they can help patients," says Kristina M. Johnson, provost and senior vice president for academic affairs at Hopkins.

In the initial phase of the collaboration, projected to last a total of 15 months, scientific researchers and biomedical engineers will focus their efforts on three distinct but related projects. The development of a computer-aided endoscopy tool will enable physicians to better diagnose gastrointestinal disease. A laparoscopic surgery tool will help align pre-operative CT scans during surgery. And a new system will be developed to track endoscopes and surgical tools during medical procedures.

"Although this collaboration will initially focus on these three specific projects, we expect that the underlying technology developed can be applied to a broad spectrum of interventional and diagnostic medicine," says Elliot McVeigh, Johns Hopkins' director of Biomedical Engineering and the university's Massey Professor.

Perhaps most importantly, McVeigh says, the partnership will prompt the development of long-term, working relationships that will bring new technologies into practice more rapidly.

—AR



From the Archives

More Than a Century of “Restrained Elegance”

Luanne Green, a principal architect with the Baltimore based firm Ayers/Saint/Gross, refers to the period from the turn of the century to the 1920s as the “golden age” of campus planning. Several prestigious universities during this time grew up, and out, and had to shed their original skins, says Green.

At Johns Hopkins, that skin-shedding began in November 1894, when university president Daniel Coit Gilman asked local businessman William Keyser for his assistance in securing another site for the school, which was outgrowing its location in downtown Baltimore on Howard and Eutaw streets.

The effort took some time, and creative deal making, but eventually yielded the acquisition of the Homewood site. In early 1901, Keyser and his cousin William Wyman offered 179 acres to the university with the condition that at least 30 acres of the property be given to the city for use as a public park—what would become Wyman Park. The trustees accepted the offer on Feb. 22, 1902.

Later that year, university trustee R. Brent Keyser (William’s son) laid out his vision for the newly acquired campus. Keyser, who agreed to pay the cost of the architectural plan, wanted the future buildings, dormitories, athletic grounds,

and other structures “to form a symmetrical whole.” The university invited five firms to enter a competition to create an overall campus plan that would lead Hopkins into the future.

University leaders ultimately chose the plan presented by the firm of Parker and Thomas.

“The vision was that you would enter this academic retreat by passing through a blanket of trees to its very ordered core.”

— LUANNE GREEN, ARCHITECT, AYERS/SAINT/GROSS

The plan featured a circular driveway leading from Charles Street to a roughly square quadrangle and a second, longer quad to the south to be bordered by the university’s scientific laboratories.

Parker and Thomas chose to orient the Upper Quad’s buildings on a line parallel with Charles Street, rather than at an angle, realizing the street would become a major thoroughfare. Green says that the architects also wanted to create a sense of order and work with the topography of the land. I call it pre-bulldozer planning,” she said. “They were interested in the least amount of grading.”

A later revised Parker/Thomas Plan also took into account the addition of two new buildings, the Mechanical and Engineering Building (Maryland Hall) and the Power House for the

newly created School of Engineering.

Green said that the architects essentially intended to create a tree-lined enclave within an urban setting. The plan called for the buildings to define the campus’s open space and to serve as linked outdoor rooms. “The vision was that you

would enter this academic retreat by passing through a blanket of trees to its very ordered core,” says Green.

Construction began on both Maryland Hall and Gilman Hall in 1913 and they were completed in 1914 and 1915, respectively. Gilman Hall capped the Upper Quad (later renamed the Keyser Quadrangle), and Maryland Hall became the first piece for what would later be known as Wyman Quadrangle, the engineering quad.

The original plan also anticipated the university’s future growth.

“They planned well for the things they knew about and what they thought was over the horizon that could not be defined,” says Green.

However, for all its strengths, the Parker/Thomas Plan could not anticipate the impact of

New Chairs and Professorships



Edward Bouwer, professor and chair of the Department of Geography and Environmental Engineering, has been named the Abel Wolman Professor of Environmental Engineering, succeeding

Charlie O’Melia. Bouwer has been the chair of DOGEE since July 2007. He is a co-author of *The Illusion of Certainty: Health Benefits and Risks* (Springer Science+Business Media, LLC, 2007), which explains the principles of calculating basic epidemiologic risk estimates.

Bouwer’s named chair honors Professor Abel Wolman, one of the most highly respected leaders in the field of sanitary engineering, and a member of the faculty for more than 50 years, from 1937 until his death in 1989.



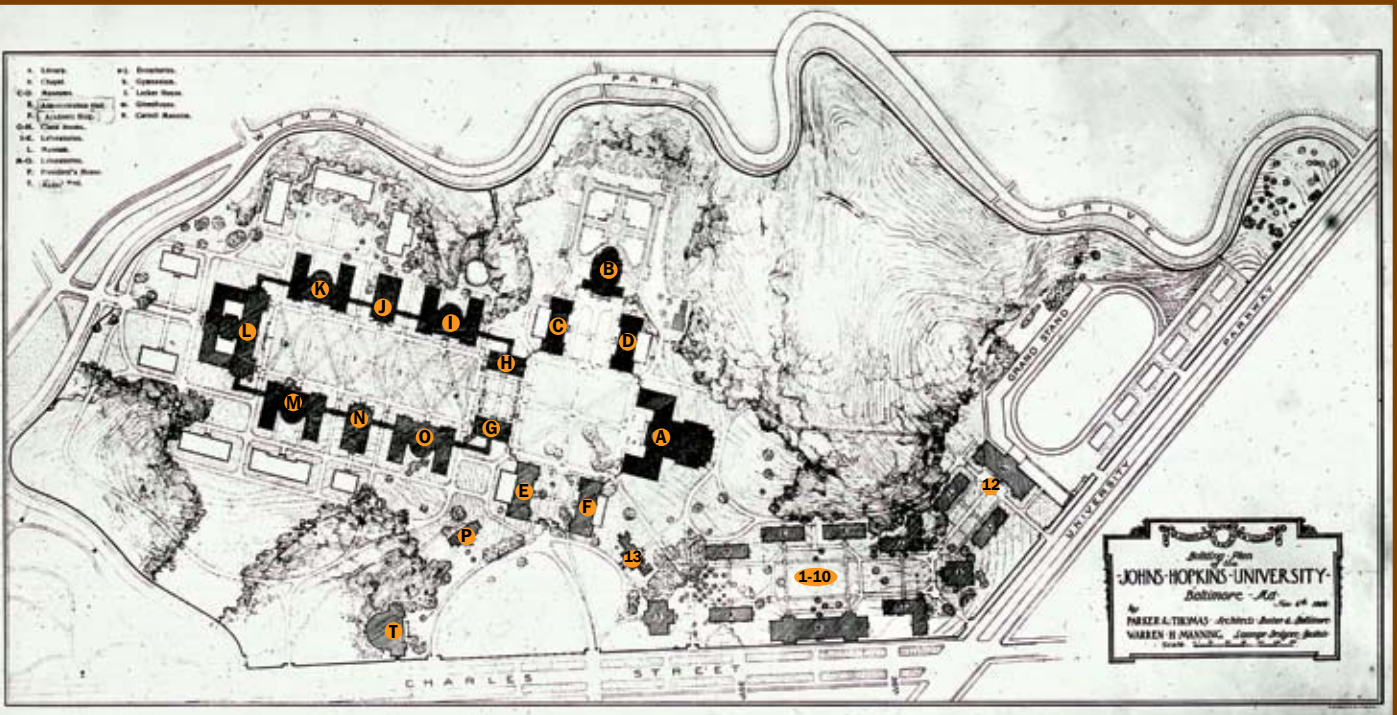
Professor Jin Kang has been named chair of the Department of Electrical and Computer Engineering, succeeding Gerard Meyer, who served as the department’s chair since 1999.



Professor Howard Katz has been named chair of the Department of Materials Science and Engineering, succeeding Robert Cammarata, who served as the department’s chair since 2003.



Peter Searson, professor of materials science and Engineering and the director of the Johns Hopkins Institute for NanoBioTechnology, has been named the inaugural Joseph R. and Lynn C. Reynolds Professor in the Whiting School.



The "Parker/Thomas Plan," initiated in 1902, laid the groundwork for the current day Homewood campus.

the automobile, Green says, which in subsequent decades led to the creation of a spaghetti-like mish-mosh of roads and parking slots throughout campus.

By 1999, university leaders were ready for a new plan to guide future growth and fix the mounting car congestion problem. They turned to Ayers/Saint/Gross.

Green says her firm essentially returned to the campus's planning roots. Ayers/Saint/Gross opted to restore the full circle that historically ran entirely around "The Beach" and back to Charles Street, bring back the park-like setting, and create

new symmetric quads that could be filled out. In less than eight years, all has come to pass.

What made implementation of the new plan possible, Green says, was the university's strict adherence to the original plan and unwillingness to fall prey to the trappings of modernism.

"No high-rises popped up here in the 1970s like at other campuses. Happily, Johns Hopkins was unharmed by all of that," she says. "Nothing is over the top or excessive. I like to say that the Homewood campus is a picture of restrained elegance." —GR

- A. Library
- B. Chapel
- C-D. Museums
- E. Administration Hall
- F. Academic Building
- G-H. Class Rooms
- I-K. Laboratories
- L. Museum
- M-O. Laboratories
- P. President's House
- T. Auditorium Hall
- 1-10. Dormitories
- 12. Gymnasium
- 13. Carroll Mansion

Searson joined the Department of Materials Science and Engineering in 1990, having received his PhD in 1982 from the University of Manchester Institute of Science and Technology.

Joseph Reynolds, who earned his bachelor's degree in electrical engineering from Johns Hopkins in 1969, is the founder and CEO of RTI Consulting LLP. He founded FTI Consulting Inc., is a university trustee, and is the current chair of the National Advisory Council.



Ben Hobbs, professor in the Department of Geography and Environmental Engineering, has been appointed the inaugural Theodore M. & Kay W. Schad Professor in Environmental Management. Hobbs is also chairing the university-wide Task Force on Climate Change, a group formed by President William R. Brody that will help guide the development of the university's new climate change policy.

The late Ted Schad, who graduated from Johns Hopkins in 1939 with a degree in civil

engineering, is considered one of the 20th century's leaders in federal water resources planning.

Schad, who died in 2005, established this chair in memory of his first wife, Kathleen White Schad. The professorship also honors his long friendship with Abel Wolman, a world pioneer in water treatment and waste disposal and one of Schad's teachers.

Corporate Connections



A “Boot Camp” for Young Engineers

Terry Neimeyer warns that waning national interest in the engineering profession has reached crisis proportions. With the Baby Boomer generation set to retire, and their replacements in exceedingly short supply, a level of anxiety has crept in for employers like Neimeyer, who is the CEO of KCI Technologies, a multidisciplinary engineering firm that has offices in 13 states.

“There’s a feeling of helplessness in some respects,” he says. “It’s become clear that we in the engineering profession have to do more to get students interested in engineering and the sciences.”

Neimeyer and others in his position see hope in Engineering Innovation, a unique pre-college program aimed at demystifying engineering and showing off its creative character.

The program, founded in 2006 and run by the Whiting School’s Center for Educational Outreach, allows rising high school juniors and seniors to enroll in What is Engineering?—a course originally designed for Hopkins undergraduates by Michael Karweit, a research professor of chemical and biomolecular engineering.

The program’s participants spend four to five weeks at Johns Hopkins or a partner institution (a college, high school, or learning academy) in the summer learning the basics of engineering as they conduct hands-on laboratory experiments and complete assignments that range from assembling a digital circuit that operates a robot to constructing a bridge made out of spaghetti and epoxy. The course, taught by college-level instructors trained by Johns Hopkins, is designed to illustrate how engineers think and problem solve.

Students who complete the program with a “B” or better are eligible to receive three transferable (elective college) credits from Johns Hopkins.

This summer, the Whiting School offered the program at 14 locations: four in Maryland, one in New Mexico, one in Pennsylvania, and eight sites in California (four within the University of California system).

The program has attracted an impressive list of private and public donors, including corporations such as Bechtel, Black & Decker,

Pool and Kent, TIME Center, and Whiting-Turner Contracting. The sponsors have allowed Johns Hopkins to expand the program, originally offered just in Maryland, and offer need-based financial aid for partial and full scholarships. Last year, nearly 80 percent of those enrolled received some tuition assistance.

This past year, due to increased sponsor support, Engineering Innovation was able to enhance its offerings by launching the New Mexico site and creating a monthlong Homewood residential program that offers a more immersive experience.

Neimeyer is buoyed by the program’s potential, especially in reaching students from disadvantaged backgrounds, which was until now a largely untapped demographic.

“The hope is that [the high school students] who go through the program, get and stay interested in the field,” he says, “and one day, maybe four to six years down the line, we’ll be able to recruit them as interns or employees.”

Marc Donohue, vice dean for research for the School of Engineering, says that most students enter the program with little to no knowledge of engineering. They are thrown into the deep end.

“This is a very challenging course in thinking. It’s more like boot camp than a summer camp,” says Donohue, adding that only half of participants earn a “B” or better.

Donohue concurs that the engineering pipeline is shrinking at an alarming rate. According to national statistics, engineering school enrollments have declined nearly in half over the past 10 years. Part of the problem, Donohue says, is that students lose interest in math and science during their middle school years and it’s tough to win them back.

Engineering Innovation may offer one avenue for re-igniting student interest: A survey of the program’s alumni showed overwhelmingly positive responses.

And an optimistic Neimeyer is quick to note that “it’s a long shot, but one well worth trying.”

—GR



WILL KIRK

“The hope is that [the high school students] go through the program, get and stay interested in the field, and one day, maybe four to six years down the line, we’ll be able to recruit them as interns or employees.”

— Terry Neimeyer

Pooling Expertise to Combat Pollution

Two Johns Hopkins chemists—one environmental and the other bioinorganic—have joined forces to create a new approach for studying pollutant reactions in the environment. By drawing on their different areas of expertise, researchers Alan T. Stone and Justine P. Roth hope to develop a better way to predict the behavior of previously unexplored pollutants, including some hazardous metals.

The Krieger School of Arts and Sciences' Roth, an assistant professor in the Department of Chemistry, develops methods to examine how enzyme-bound metals gain or lose electrons, most notably in response to reactions with oxygen. A number of elements, including oxygen, exist as two or more natural isotopes, meaning their atoms possess the same number of protons but different numbers of neutrons. Molecules made up of different isotopes react at slightly different rates when the electrons move from one position to another. By comparing these rates, Roth is able to collect important information about the reactions and interpret the results using computational chemistry.

Stone, an environmental chemist in the Whiting School of Engineering, realized that Roth's approach could uncover critical new data about how pollutant molecules react with chemicals that are naturally present in water, soils, and sediments.

Their decision to pool resources recently received a key endorsement from the Camille and Henry Dreyfus Foundation, which allocated a \$120,000 fellowship grant that will support two years of research by a postdoctoral scientist who will be supervised by both faculty members. The researcher will seek to develop fundamental models that describe the transfer of electrons to and from dissolved chemicals and mineral surfaces.

Roth and Stone are especially interested in gains or losses of electrons that occur when pollutants react with naturally occurring minerals. For example, manganese oxide minerals, which appear black, and iron oxide minerals, with red, yellow, orange and brown hues, are believed to play a particularly important role when they make contact with some hazardous metals. When these minerals take electrons away from the toxic metal chromium, the metal is less



WILL KIRK

Researchers Alan T. Stone and Justine P. Roth bridge the School of Engineering and the School of Arts & Sciences to jointly explore pollutant reactions.

likely to stick to soils and is often carried away by water. In contrast, taking electrons away from the toxic metal lead causes the metal to precipitate, forming solid particles that separate from the water instead of dissolving in it.

The Johns Hopkins scientists say the Dreyfus Foundation funding should bolster their efforts to use advanced chemistry lab techniques to help remedy real-world concerns.

"We need a better understanding of what kind of chemical reactions occur when hazardous metals and other waste materials come in contact with minerals that are already there in the environment," says Stone.

Adds Roth: "In the past, these types of questions haven't been addressed because the tools weren't available. This is a chance to apply some of our new lab techniques to practical problems encountered in the Chesapeake Bay and other ecosystems. We're really forging a new field in environmental science by focusing on the fundamental reactions that are taking place when contaminants are present in soil and water."

—Phil Sneiderman

New Faculty Faces

Michael Bevan joined the Department of Chemistry and Biomolecular Engineering as an associate professor. He received his PhD in Chemical Engineering from Carnegie Mellon University. Before joining Hopkins, he was an associate professor of chemical engineering and mechanical engineering at Texas A&M University.

Kai Loon Chen will join the Department of Geography and Environmental Engineering as an assistant professor. Chen earned his PhD from the Environmental Engineering Program at Yale. His doctoral research focused on the aggregation and deposition behavior of both naturally occurring and engineered nanomaterials and earned him the Henry Prentiss Becton Graduate

Prize for exceptional research in Engineering and Applied Science.

Michael Falk will be joining the Department of Materials Science as an associate professor. Falk, who earned his PhD in physics from the University of California, Santa Barbara, completed a postdoctoral fellowship at Harvard University and served as a visiting scholar at the National Institute of Standards and Technology.

Hynek Hermansky will join the Department of Electrical and Computer Engineering as an assistant professor. Hermansky earned his PhD in electrical engineering from the University of Tokyo and served as professor and director of the Center for Information Technology in the Department of Electrical and Computer Engineering at Oregon Graduate Institute of Science and Technology.

Youngmi Hur will join the Department of Applied Mathematics and Statistics as an assistant professor. Hur received her PhD in mathematics from University of Wisconsin-Madison. Before joining Hopkins, she was the C.L.E. Moore Instructor in the Department of Mathematics at the Massachusetts Institute of Technology.

Nam Lee will join the Department of Applied Mathematics and Statistics as an assistant research professor. Lee recently received his PhD in mathematics from the University of California San Diego.

Tim Sui-Tang Leung will join the Department of Applied Mathematics and Statistics as an assistant professor. Leung recently received his PhD in operations research and financial engineering from Princeton University.

Danielle Tarraf will join the Department of Electrical and Computer Engineering as a professor. She received her PhD in mechanical engineering from MIT and has been a postdoctoral associate at MIT and a postdoctoral scholar at the California Institute of Technology, Pasadena.

How Green?

We asked Professor Ben Hobbs, chair of Hopkins' President's Task Force on Climate Change and the recently appointed Theodore M. & Kay W. Schad Professor in Environmental Management in the Whiting School's Department of Geography and Environmental Engineering, to imagine visiting the Homewood campus in the year 2018. What "green" changes—both visible and behind-the-scenes—will be in place?

Many more people will be riding bikes in Baltimore. The city has already established bike lanes on streets near campus and I like to think there's finally going to be a safe and pleasant way to bike down Charles Street and University Parkway with barriers between car and bicycle traffic. You'll see bike racks everywhere on campus. I think commuting by bike is an idea people will adapt to fairly quickly—the more cyclists people see, the more it occurs to them that they can do it, too.

The number of hybrid cars available for short-term rental will have grown from the few we have today. They'll be located across the campus and their ready availability and popularity will make it much less necessary for students

Enter the buildings—even the older ones—and you'll notice changes. Window replacement and rooms equipped with sensors that automatically douse lights when the spaces are unoccupied will reduce our energy load.

to have their own cars. Our parking lots will be half empty and most of the cars you do see will be conventional hybrids, plug-in hybrids, or fueled by natural gas or biofuel.

When you walk around campus, disposable water bottles will be a rarity. People will still carry water bottles, but the refillable kind. That change should happen at Hopkins if for no other reason than out of respect for the legacy of Abel

Wolman—our department's founder who championed the provision of clean, safe water supplies for everyone.

New ecological landscaping means areas will be planted with low-maintenance grass, leafy plants, and shrubs that require less fertilizing and watering—resulting in decreased water runoff and pollutants entering the Bay.

Enter the buildings—even the older ones—and you'll notice changes. Window replacement and rooms equipped with sensors that automatically douse lights when the spaces are unoccupied will reduce our energy load. Paperless offices will be common, so file cabinets will be a rarity. That will reduce the need to store files and books, resulting in more available space and less construction.

Labs will be equipped with "intelligent" fume hoods that effectively protect users, don't interfere with laboratory work, and minimize the loss of heated or cooled air. We already have hoods that can be closed, but students and faculty just don't close them. By 2018, people's behavior and sensitivity to the environment will have changed enough that they won't see switching a hood off as an inconvenience.

Some of these changes are relatively inexpensive and easy to implement, but many that will have the greatest impact won't necessarily be visible and will require large, long-term investments in infrastructure. New HVAC systems will include smarter building and individual room controls, allowing us to keep from overheating and overcooling some rooms while inadequately servicing others. Plans are already under way for a combined heat and power plant that will wring more energy out of the natural gas we burn at Homewood, generate electricity by burning natural gas, and use waste heat to provide space heating and cooling and hot water.

Perhaps most significant, though, is the research we're generating at Johns Hopkins that will not only lead to changes on the Homewood campus but provide global solutions to climate change. We're finding ways to derive more energy services from the fossil fuels we have and expand renewable energy production while reducing costs and pollution.

—Interview by Abby Lattes

When Nanotechnology Hands You a Lemon...

Technology now allows researchers to manipulate matter on the scale of a nanometer—one 5,000th the width of a human hair. From tiny electronic circuits to little gears and pumps, scientists are developing all sorts of nano-scale devices that could be useful in everything from computers to medical devices.

But the physical world at that scale often exhibits unexpected properties that can be troublesome to the device designer. Among these



“When any device gets small enough, interfacial and surface forces become important. My view is not to look at this as a problem but as forces that can be harnessed.” —Joelle Frechette

effects are the often counterintuitive interactions of surfaces, which can stick together when you would expect them to slide past each other, or vice versa.

Joelle Frechette, an assistant professor of chemical and biomolecular engineering, is exploring these interfacial interactions, with an eye toward helping designers not just to work around them but actually to take advantage of them.

“In many cases, surfaces or interfaces are considered a problem. When any device gets small enough, interfacial and surface forces



become important. My view is not to look at this as a problem but as forces that can be harnessed,” Frechette says.

Earlier this year, Frechette received a National Science Foundation Faculty Early Career Development (CAREER) award of \$400,000 for a proposal to develop ways to achieve external, reversible, and local control of wetting and adhesion properties.

At the nanoscale, for instance, tiny “capillary bridges” of water or other liquids can form between surfaces, and they can interfere with the electronic or mechanical functioning of the devices. Frechette wants to figure out how these bridges can be controlled and even made useful. So she is studying exactly how they can be modified through changes to the wettability of the surfaces they form on and through the application of electric fields. What happens when the wettability of surfaces—how much they attract or repel liquids—is changed? She also wants to examine electrowetting, a technique in which an electric charge can be used to influence the shape and movement of nanodroplets.

The work can have implication for the fairly new field of optofluidics, which combines optics and microfluidics. Breakthroughs in optofluidics could lead to better low-power display technology for computers or cell phones. They might also produce better designs for “labs-on-a-chip,” a micro-scale tool, which could manipulate liquids in tiny, discrete quantities.

To study the interactions she’s interested in, Frechette uses a piece of equipment called a surface force apparatus (SFA). The SFA uses two moving plates to measure separation to a resolution of 0.1 nanometer, and surface forces to 10 nanonewtons.

Frechette has been studying surface forces ever since earning her PhD in chemical engineering and materials science at Princeton University in 2005. From there she went on to a postdoctoral fellowship at University of California, Berkeley, before joining Hopkins Engineering in 2006.

“Our group is tackling important issues in surface or interfacial science, keeping in mind that the results one day could be used in new generations of devices,” Frechette says.

—KK

Cool Thinking Saves the Day



Spine specialist Andrew Cappuccino performed the surgery that allowed tight-end Kevin Everett to walk again.

It was the opening day of the NFL season at Ralph Wilson Stadium in Buffalo, N.Y., last September. Buffalo Bills tight-end Kevin Everett made a tackle that injured his spine and left him lying on the field, paralyzed.

Andrew Cappuccino ’84 was there. Cappuccino, a spine specialist who has been an assistant team orthopedic surgeon for the Buffalo Bills since 1995, was one of the first medical professionals to reach Everett in the moments after the accident. His immediate assessment? The 24-year-old football player would most likely be a quadriplegic for life. But, at that point, Cappuccino’s focus was on keeping Everett breathing.

“Don’t leave me like this,” Cappuccino remembers a frightened Everett saying to him that day. And so, with Everett and his family’s agreement, the physician began a course of treatment that included spine surgery and induced hypothermia, an extreme cooling of Everett’s body temperature to reduce swelling of the tissue surrounding his spine. Hypothermia had never been used in a human spine patient before, but Cappuccino felt that it was the best course of action—both during the surgery and in the hours afterward. “If I did nothing, chances were he would remain a quadriplegic and on a respirator for the rest of his life,” he says. “Or I could try something risky [risks include cardiac arrhythmia] and it might help to preserve some spinal cord function. He was just a kid—the same age as one of my boys. I wanted what was best for him.”

His strategy paid off. Several days after the injury, Everett could move his legs. Today he can walk.

It’s the kind of recovery that makes headlines, lands one on *Oprah*, and causes people to bat around words like “miracle.” Cappuccino, 46, credits his studies at Johns Hopkins for teaching him how to make critical decisions. “One thing my professors always pushed us to do was to think outside the box,” says Cappuccino, who earned undergraduate degrees in biomedical engineering and materials science before returning to Johns Hopkins after medical school to undertake specialty training with nationally recognized spine surgeon Paul McAfee. “They encouraged us to think critically and not to be afraid to make decisions we could support in our work and support in the literature.”

In addition to running his private practice, Cappuccino does research and product development on the biomechanics of spine implants. He lives in Lockport, N.Y., with his wife, breast surgeon Helen Cappuccino. They have six children, aged 14 to 27.

For Cappuccino, treating Everett last fall was a life-changing experience. “Over 15 years, things can become pretty straightforward,” he says. “You can be at the top of your practice but things can become routine. This whole experience reminded me that what we do is significant. We can make a difference.” —MB

Kudos



Gregory S. Chirikjian (left), professor in the Department of Mechanical Engineering, and **Kevin Hemker** (below), professor and chair of the Department of Mechanical Engineering, have been elected fellows of the American Society of Mechanical Engineers (ASME). A fellow is the highest grade of membership within ASME; it recognizes exceptional engineering achievements and contributions to the engineering profession.



Joelle Frechette, assistant professor in the Department of Chemical and Biomolecular Engineering, has received a National Science Foundation Faculty Early Career Development (CAREER) award, given in recognition of young scientists' commitment to research and education. (For more on her work, see p. 10.)



In a ceremony on June 15, **Sharon Gerecht**, assistant professor in the Department of Chemical and Biomolecular Engineering, received the Outstanding Young Engineer Award. The award,

sponsored by the Maryland Academy of Sciences and conferred by the Maryland Science Center, aims to encourage the important work of young scientists and engineers in the state of Maryland, and to increase public awareness of their accomplishments.



David Gracias, assistant professor in the Department of Chemical and Biomolecular Engineering, has been selected as one of 12 recipients of the 2008 DuPont Young Professor Award.

This award is designed to provide start-up assistance to promising young and untenured research faculty.

Ben Hobbs, the Theodore M. & Kay W. Schad Professor in Environmental Management, has been elected a fellow to the Class of 2008 by the Institute of Electrical and Electronics Engineers (IEEE) for "integration

of economic and environmental concerns into power systems design and operation."



Susan Hohenberger, assistant professor in the Department of Computer Science and a member of the Johns Hopkins Information Security Institute, received a 2008 Microsoft Research New Faculty Fellowship. The fellowship will support Hohenberger's research in cryptographic challenges in verifying authenticity of incoming messages and encrypting outgoing ones in energy-, data-, and time-constrained applications, computer security, algorithms, and complexity theory.

Kristina M. Johnson, provost and senior vice president for academic affairs and professor of electrical and computer engineering, received the 2007 American Association of Engineering Society's John Fritz Medal. Established in 1902, the medal is widely considered the highest award in the engineering profession and is presented each year for scientific or industrial achievement in any field of pure or applied science. Past honorees have included Thomas Edison, Alexander Graham Bell, George Westinghouse, and Orville Wright.

Nicholas Jones, dean of the Whiting School and professor of civil engineering, received the 2008 Robert H. Scanlan Medal from the Engineering Mechanics Institute of the American Society of Civil Engineers. The medal is awarded annually to recognize distinguished achievement in engineering mechanics based upon scholarly contributions to both theory and practice in the areas of structural mechanics, wind engineering, and aerodynamics. Jones was recognized in particular for his many contributions in the fields of aerodynamics of bridges and full-scale monitoring of structures.



Rachel Karchin, assistant professor in the Department of Biomedical Engineering and a member of the Institute for Computational Medicine, was awarded a Susan B. Komen

Investigator Initiated Research Grant. It provides three years of support for the exploration

of new ideas and novel approaches to breast cancer research and clinical practice.

Howard E. Katz, professor of materials science and engineering, was named one of 34 inaugural fellows of the Materials Research Society. This honor was given "for introducing multifunctional organic materials into electronic and optical devices including transistors and electro-optic modulators; for innovation in materials synthesis; and for serving the materials community through society leadership, editorship, and government outreach." Katz will assume the presidency of the International Union of Materials Research Societies in 2009.



Hai-Quan Mao, assistant professor in the Department of Materials Science and Engineering, has received a National Science Foundation Faculty Early Career Development (CAREER) award, given in recognition of young scientists' commitment to research and education.



Carey Priebe, professor in the Department of Applied Mathematics and Statistics, is one of six to be named a 2008 National Security Science and Engineering Faculty Fellow by the

Department of Defense. This new program provides grants to top-tier researchers from U.S. universities to conduct long-term, unclassified, basic research, in an effort to engage the next generation of outstanding scientists and engineers in the most challenging technical issues facing the government.



Russ Taylor, professor in the Department of Computer Science and the director of the Center for Computer-Integrated Surgical Systems and Technology, has been selected as a co-recipient of the 2008 Pioneer in

Robotics and Automation Award from the IEEE Robotics and Automation Society. The award recognizes individuals who have made a significant impact on the robotics and/or automation fields by initiating new areas of

research, development, or engineering.



Natalia Trayanova, professor in the Department of Biomedical Engineering and a member of the Institute for Computational Medicine, was selected as a fellow of the Heart Rhythm Society.

The most distinguished level of the society, fellow status recognizes members who have realized significant professional achievement, provided exceptional service, and are prominent in the field of cardiac arrhythmia research and treatment.



Peter Wilcock, professor in the Department of Geography and Environmental Engineering with a joint appointment in the Department of Civil Engineering, received the 2008 Hans Albert Einstein award from the American Society of Civil Engineers for his contributions to research in sediment transport in gravel-bed rivers.

Partnerships in China

One of the four focus points of the Whiting School's Strategic Plan is a commitment to local and global strategic partnerships throughout academia and industry. Illustrating that commitment are two recent partnerships between the Whiting School and universities in China.

This past January, a delegation from the Whiting School traveled to China to participate in a successful joint bioengineering symposium. Attending the event along with Dean Nick Jones were Andrew Douglas, vice dean of faculty; Elliot McVeigh, director of Biomedical Engineering; Hedy Alavi, assistant dean for international programs; and professors Nitish Thakor, Jin Kang, Xiaoqin Wang, Joel Bader, Gislín Dagnelie, and Hai-Quan Mao.

The symposium was co-hosted by the Whiting School and the Shanghai Jiao Tong University College of Life Science and Technology, after a partnership was formed between the two schools last May. Founded in 1896, Jiao Tong is one of the oldest universities in China, with over 200 of its alumni belonging



Provost Kristina Johnson and Professor Jining Chen formalize a partnership between Johns Hopkins and Beijing's Tsinghua University.

to China's Academy of Sciences and Academy of Engineering. By forming this partnership, the universities aim to promote academic interaction and joint research between faculty and students in the area of bioengineering.

At its core, the agreement supports a Collaborative Ph.D. Student Agreement, enabling PhD students from the two universities to participate in one to two semester-long exchange programs and supports symposiums, such as the one held recently in China.

In May of last year, Ronald Gue '62, PhD '64, chairman of Phoenix Health Systems Inc. and a member of the National Advisory Council for the Whiting School of Engineering, visited Shanghai Jiao Tong University while he was on a trip to China. Gue, who earned his PhD from the Whiting School in Operations Research and Industrial Engineering, met with Professor Jin Wei, director of International Cooperation & Exchange, as well as the faculty of the Biomedical Engineering Department, on behalf of the National Advisory Council to reinforce Johns Hopkins' commitment to international outreach and the partnership with Shanghai Jiao Tong University.

Also this past January, the Department of Biomedical Engineering and Tsinghua University, one of China's premier research universities, established the Tsinghua–Johns Hopkins Joint Center for Biomedical Engineering Research. That month, Provost Kristina Johnson joined Jones, Douglas, McVeigh, and Wang in a ceremony in Beijing to sign a memorandum of agreement between the two universities.

To be housed on Tsinghua University's campus in Beijing, the center will provide joint research projects, exchange of visiting scholars and students, joint educational initiatives, and conferences. Its research focus includes neuro-

engineering and neuroscience, medical imaging, tissue engineering, and biology in medicine.

At the heart of the program is an undergraduate exchange program that will enable students from Johns Hopkins and Tsinghua to spend summers at each other's campuses, working on collaborative research projects.

Additionally, many of Tsinghua's doctoral students and faculty will travel to Baltimore to study in the labs of Johns Hopkins or work as visiting scholars, while Johns Hopkins faculty will spend semesters in Beijing teaching at Tsinghua or studying during sabbatical leave. A final component of the center is the joint research symposia, which will be held regularly and be open to participating faculty and students from both universities.

The two schools have shared a history since the 1920s, when William Henry Welch, the first dean of the Johns Hopkins School of Medicine, traveled to China and was instrumental in founding the Peking Union Medical College, the medical school of Tsinghua University. For the past decade, Johns Hopkins and Tsinghua have had an informal but strong working relationship, and the center, three years in the making, has formalized that commitment.

"The commitment in China to the development of a world-class research enterprise is extraordinarily impressive. The opportunities this presents to our students and faculty are very broad and dynamic," says McVeigh.

"The opportunities for collaboration," adds Jones, "particularly in the field of bioengineering, have been increasing in the past decade. As we partner with our colleagues across the globe in countries such as China, we vastly increase our ability to share ideas, conduct groundbreaking research, and contribute toward the betterment of all society." —AR