Message from the Dean

Innovation and Inspiration

We recently took our oldest daughter to see the popular movie, Big Hero 6. After the movie, she came home and said, “Dad, I want to build a robot!” It is great when young girls are inspired by STEM subjects, and we will certainly do everything we can to continue to foster her interest in these subjects.

One of the most wonderful features of the undergraduate Brown experience is the “Open Curriculum,” a liberal academic approach that includes no core requirements aside from those of the concentration the student pursues. Revolutionary at the time of its introduction in the late 1960’s, it inaugurated a national movement for student-directed learning at the University level that is even more relevant today across the entire landscape of higher education.

At the same time, a rigorous and deep engineering curriculum requires many courses in science and math, the ultimate goal being to build comprehensive knowledge in the student’s discipline. These disciplines (mechanical engineering, chemical engineering, computer engineering, etc.) each constitute a body of knowledge that has been constantly refined and expanded over many decades. Each student of engineering is committed to achieving excellence in one of these disciplines over the course of his or her study at Brown.

Our engineering program here at Brown is famously adept at integrating the goals of the open curriculum and liberal learning in the context of a deep and rigorous engineering education. The result is an engineering graduate fully prepared to be a leader in the modern world - adept at communication to a broad range of constituencies, well versed in social and historical trends and values, and comfortable in applying their strong analytical and scientific skills to any problem.

One way that we externally validate the strength of our engineering program is through the every-six-year accreditation process known as ABET (www.ABET.org). The national ABET accreditation process is an extremely thorough review of all aspects of our undergraduate program, and the ABET “stamp-of-approval” is a validation of the high quality of our undergraduate approach. The ABET reviewers worked with our faculty intensively for a year, culminating in a three-day campus visit in September. They met with faculty, staff and students. They reviewed our undergraduate laboratories, textbooks, exams, pedagogical approaches, feedback mechanisms and mentoring approaches. The team was experienced and dedicated to their efforts - with a goal of ensuring that each student gets the best possible education.

Though the official ABET results will not be available until much later this year, the unofficial feedback that we received on our program at the end of the three-day visit was extraordinarily positive. One of the aspects of our culture here that most impressed the reviewers was the extremely close ties that the faculty form with our student, and the care and attention each faculty member puts into student advising and mentoring. It is this personal commitment to the students and the community that has made the Brown engineering experience so extraordinary for the last 150 years, and will continue to do so for the future as well.

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Wireless Brain Sensor Could Unchain Neuroscience From Cables

Neuroscience research has been constrained by the cables required to connect brain sensors to computers for analysis. In the journal **Neuron**, scientists in a collaboration led by Brown University describe a wireless brain-sensing system to acquire high-fidelity neural data during animal behavior experiments.

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Experiments in the paper confirm that new capability. The results show that the technology transmitted rich, neuroscientifically meaningful signals from animal models as they slept and woke or exercised.

“We view this as a platform device for tapping into the richness of electrical signals from the brain among animal models where their neural circuit activity reflects entirely volitional and naturalistic behavior, not constrained to particular space,” said Arto Nurmikko, professor of engineering and physics affiliated with the Brown Institute for Brain Science and the paper’s senior and corresponding author. “This enables new types of neuroscience experiments with vast amounts of brain data wirelessly and continuously streamed from brain microcircuits.”

The custom-engineered neuroelectronic platform is composed of two elements: a 100-channel transmitter only 5 centimeters in its largest dimension and weighing only 46.1 grams, and a four-antenna receiver that looks like a home Wi-Fi router but employs sophisticated signal processing to maximize the transmitter’s signal while the subject is moving around. Via a small port embedded in a subject’s skull, the transmitter connects to a tiny implanted electrode array that detects the activity of scores of neurons in the cortex. The wireless transmitter is compatible with multiple types and classes of brain sensors, Nurmikko said, with a view toward future sensor development.

“Among the unique features of our technology is that we developed this compact lightweight neurosensor with a custom-designed, low-power high-efficiency transmitter,” said paper lead author Ming Yin, a research engineer in Nurmikko’s lab at Brown at the time of the work. “It dissipates two magnitudes less power than commercial 802.11n transceivers to broadcast a comparable rate of high-speed data – up to 100 megabits per second – within a few meters distance. The low power and small size, along with built-in electrostatic discharge protection features, make our device safer and more practical for mobile subjects.”

In the study the team demonstrated that the transmitter can run continuously for more than 48 hours on a single rechargeable AA battery as it relays a high rate of data directly from the brain.

“The brain sensor is opening unprecedented opportunities for the development of neuroprosthetic treatments in natural and unconstrained environments,” said study co-author Grégoire Courtine, a professor at EPFL (École Polytechnique Fédérale de Lausanne), who collaborated with Nurmikko’s group on the research.

Behavioral demonstrations

Courtine and co-lead author David Barton helped lead experiments testing whether the system could match the performance of the common wired systems. They, with colleagues at Brown and the Bordeaux Institute of Neuroscience, also applied it in two behavioral tasks to ensure that it relayed scientifically interesting neural patterns. The experiments employed a platform developed by the European Project NeuWalk, which is supported by a €9-million investment from European Union.

In one experiment, three rhesus macaques took walks on a treadmill while the researchers used the wireless system to measure neural signals associated with the brain’s motor commands. Meanwhile they used other sensors to measure the activity of leg muscles. The data from the brain showed clear patterns of activity related to the movements of the muscles, demonstrating that the sensor allows for studies of how the brain controls the legs.

“In this study, we were able to observe motor cortical dynamics during locomotion, yielding insight into how the brain computes output commands sent to the legs to control walking,” said Barton, now assistant professor of engineering at Brown.

In another experiment, the Brown and EPFL researchers used the technology to observe brain signals for hours on end as the animal subjects went through sleep/wake cycles, unencumbered by cables or wires. Again the data showed distinct patterns related to the different stages of consciousness and the transitions between them.

“We hope that the wireless neurosensor will change the canonical paradigm of neuroscience research, enabling scientists to explore the nervous system within its natural context and without the use of tethering cables,” Barton said. “Subjects are free to roam, forage, sleep, etc., all while the researchers are observing the brain activity. We are very excited to see how the neuroscience community leverages this platform.”

In 2013, Yin, Barton, and Nurmikko unveiled a related, implantable wireless brain sensor with a different design. Whereas the new head-mounted sensor is intended for research use by the wider brain science community, Nurmikko said, the researchers hope that wireless brain sensor technology will be useful in clinical research as well in the coming years.

Blackrock Microsystems LLC of Utah, where Yin is now an engineer, has licensed a portion of the technology described in the new **Neuron** study from Brown University for commercial development.

In addition to Yin, Barton, Nurmikko, and Courtine, the paper’s other authors are Jacob Komin, Naubahar Agha, and Yao Lu of Brown; Christopher Bull, senior lecturer and sensor research engineer at Brown, and Lawrence Larson, dean of engineering at Brown; David Rosler of Brown and the Providence Veterans Affairs Medical Center; Jean Laurens of EPFL; Hao Li of Marvell Semiconductor; Yiran Liang and Erwan Bezd of the Bordeaux Institute of Neuroscience; and Qin Li of Motac Neuroscience. Bezd and Li are also affiliated with the China Academy of Medical Sciences.

The U.S. National Institutes of Health, the National Science Foundation, the Defense Advanced Research Projects Agency, and the EU funded the research.
A ‘Clear’ Choice for Clearing 3-D Cell Cultures

Scientists have hailed recent demonstrations of chemical technologies for making animal tissues see-through, but a new study is the first to evaluate three such technologies side-by-side for use with engineered 3-D tissue cultures.

Because biomedical engineering graduate student Molly Boutin needed to study how neural tissues grow from stem cells, she wanted to grow not just a cell culture, but a sphere-shaped one. Cells grow and interact more naturally in 3-D cultures than when they are confined to thin slides or dishes. But the very advantage of a culture having thickness also poses a challenge: How to see all the cells and their connections all the way through the culture. It’s a problem that confronts many biologists, physicians, bioengineers, drug developers - and others who also see 3-D cultures as a useful stage before moving to animal models.

“As I was imaging these tissues I was only able to get the outer layer or two of cells and that wasn’t a very good representation of what was going on inside of the sphere,” Boutin said.

There are inelegant ways to slice up an engineered 3-D tissue for imaging and then to reconstruct it, but a more tantalizing solution seemed likely to come from one of the chemical treatments invented in just the last few years to make tissues see-through. But which one, if any, would work with her scaffold-free engineered neural tissues? To find out, Boutin and adviser, Diane Hoffman-Kim, associate professor of medical science in the Department of Molecular Pharmacology, Physiology, and Biotechnology, decided to test the three simplest methods: ClearT2, SeeDB and Scale.

Their results – which read like a Consumer Reports article for the lab bench set – now appear online in the journal Tissue Engineering Part C: Methods. For Boutin’s criteria, the ClearT2 method turned out to be clear winner. For her little balls of neural tissue – 100 millions of a meter in diameter – ClearT2 allowed her to see fluorescing cells at all depths of focus and, importantly, it did not change the size of the tissue. Scale made her “neural spheres” substantially larger, while SeeDB made them smaller and didn’t improve clarity as much.

Methods may vary with different samples, but they expect that for many “scaffold-free” engineered 3-D neural tissues – tissues that grow without added matrix supports – ClearT2 should work well.

Knowing that could clear the way for many research projects with 3-D tissues.

The National Science Foundation, The National Institutes of Health, and the Brown Institute for Brain Science supported the research. Imaging occurred in Brown’s Leduc Bioimaging Facility. Boutin created her 3-D cultures with technology from Microtissues Inc., a company founded by Jeffrey Morgan, professor of medical science in the Department of Molecular Pharmacology, Physiology, and Biotechnology at Brown.

- by David Orenstein
Using a microengineered device that acts as an obstacle course for cells, researchers have shed new light on a cellular metamorphosis thought to play a role in tumor cell invasion throughout the body.

The epithelial-mesenchymal transition (EMT) is a process in which epithelial cells, which tend to stick together within a tissue, change into mesenchymal cells, which can disperse and migrate individually. EMT is a beneficial process in developing embryos, allowing cells to travel throughout the embryo and establish specialized tissues. But recently it has been suggested that EMT might also play a role in cancer metastasis, allowing cancer cells to escape from tumor masses and colonize distant organs.

For this study, published in the journal Nature Materials, the researchers were able to image cancer cells that had undergone EMT as they migrated across a device that mimics the tissue surrounding a tumor.

“Our people are really interested in how EMT works and how it might be associated with tumor spread, but nobody has been able to see how it happens,” said lead author Ian Y. Wong, assistant professor in the Brown School of Engineering and the Center for Biomedical Engineering, who performed the research as a postdoctoral fellow at Massachusetts General Hospital. “We’ve been able to image these cells in a biomimetic system and carefully measure how they move.”

The experiments showed that the cells displayed two modes of motion. A majority plod along together in a collectively advancing group, while a few cells break off from the front, covering larger distances more quickly.

“In the context of cell migration, EMT upgrades cancer cells from an economy model to a fast sports car,” Wong said. “Our technology enabled us to track the motion of thousands of ‘cars’ simultaneously, revealing that many sports cars get stuck in traffic jams with the economy cars, but that some sports cars break out of traffic and make their way aggressively to distant locations.”

Armed with an understanding of how EMT cancer cells migrate, the researchers hope they can use this same device for preliminary testing of drugs aimed at inhibiting that migration. The work is part of a larger effort to understand the underpinnings of cancer metastasis, which is responsible for nine out of 10 cancer-related deaths.

‘Obstacle course for cells’

To get this new view of how cancer cells move, the researchers borrowed microelectronics processing techniques to pattern miniaturized features on silicon wafers, which were then replicated in a rubber-like plastic called PDMS. The device consists of a small plate, about a half-millimeter square, covered in an array of microscopic pillars. The pillars, each about 10 micrometers in diameter and spaced about 10 micrometers apart, leave just enough space for the cells to weave their way through. Using microscopes and time-lapse photography, the researchers can watch cells as they travel across the plate.

“It’s basically an obstacle course for cells,” Wong said. “We can track individual cells, and because the size and spacing of these pillars is highly controlled, we can start to do statistical analysis and categorize these cells based on how they move.”

For their experiments, the researchers started with a line of benign cancer cells that were epithelial, as identified by specific proteins they express. They then applied a chemical that induced the cells to become malignant and mesenchymal. The transition was confirmed by looking for proteins associated with the mesenchymal cell type. Once all the cells had converted, they were set free on the obstacle course.

The study showed that about 84 percent of the cells stayed together and slowly advanced across the plate. The other 16 percent sped off the front and quickly made it all the way across the device. To the researchers’ surprise, they found that the cells that stayed with the group started to once again express the epithelial proteins, indicating that they had reverted back to the epithelial cell type.

“That was a remarkable result,” Wong said. “Based on these results, an interesting therapeutic strategy might be to develop drugs that downregulate mesenchymal sports cars back to epithelial economy models in order to keep them stuck in traffic, rather than aggressively invading surrounding tissues.”

As for the technology that made these findings possible, the researchers are hopeful that it can be used for further research and drug testing.

“We envision that this technology will be widely applicable for preclinical testing of anti-migration drugs against many different cancer cell lines or patient samples,” Wong said.

Other authors on the paper are Elisabeth A. Wong (no relation), now a medical student at the Albert Medical School of Brown University, as well as Sarah Javidi, Gnom Park, Daniel A. Haber, Mehmet Toner, and Daniel Irimia of Massachusetts General Hospital. The work was supported by the Damon Runyon Cancer Research Foundation (DRG-2065-10), the Howard Hughes Medical Institute and the National Institute of Health under (CA129933, EB002503, CA133501, GM092806).

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Microchip Reveals How Tumor Cells Transition to Invasion

A microscopic obstacle course of carefully spaced pillars enables researchers to observe cancer cells directly as they break away from a tumor mass and move more rapidly across the microchip. The device could be useful for testing cancer drugs and further research on the mechanics of metastasis.
Copper Foam Turns CO₂ into Useful Chemicals

Scientists at Brown University’s Center for Capture and Conversion of CO₂ have discovered that copper foam could provide a new way of converting excess CO₂ into useful industrial chemicals, including formic acid.

A catalyst made from a foamy form of copper has vastly different electrochemical properties from catalysts made with smooth copper in reactions involving carbon dioxide, a new study shows. The research, by scientists in Brown University’s Center for the Capture and Conversion of CO₂, suggests that copper foams could provide a new way of converting excess CO₂ into useful industrial chemicals.

The research is published in the journal ACS Catalysis. As levels of carbon dioxide in the atmosphere continue to rise, researchers are looking for ways to make use of it. One approach is to capture CO₂ emitted from power plants and other facilities and use it as a carbon source to make industrial chemicals, most of which are currently made from fossil fuels. The problem is that CO₂ is extremely stable, and reducing it to a reactive and useful form isn’t easy.

“Copper has been studied for a long time as an electrocatalyst for CO₂ reduction, and it’s the only metal shown to be able to reduce CO₂ to useful hydrocarbons,” said Tayhas Palmore, professor of engineering and senior author of the new research. “There was some indication that if you roughen the surface of planar copper, it would create more active sites for reactions with CO₂.”

Copper foam, which has been developed only in the last few years, provided the surface roughness that Palmore and her colleagues were looking for. The foams are made by depositing copper on a surface in the presence of hydrogen and a strong electric current. Hydrogen bubbles cause the copper to be deposited in an arrangement of sponge-like pores and channels of varying sizes.

After depositing copper foams on an electrode, the researchers set up experiments to see what kinds of products would be produced in an electrochemical reaction with CO₂ in water. The experiments were performed by Sujat Sen and Dan Liu, graduate students in chemistry working in Palmore’s lab at Brown’s School of Engineering.

The experiments showed that the copper foam converted CO₂ into formic acid—a compound often used as a feedstock for microbes that produce biofuels—at a much greater efficiency than planar copper.

The reaction also produced small amounts of propylene, a useful hydrocarbon that’s never been reported before in reactions involving copper.

“The product distribution was unique and very different from what had been reported with planar electrodes, which was a surprise,” Palmore said. “We’ve identified another parameter to consider in the electroreduction of CO₂. It’s not just the kind of metal that’s responsible for the direction this chemistry goes, but also the architecture of the catalyst.”

Now that it is clear that architecture matters, Palmore and her colleagues are working to see what happens when that architecture is tweaked. It is likely, she says, that pores of different depths or diameters will produce different compounds from a CO₂ feedstock. Ultimately, it might be possible to tune the copper foam toward a specific desired compound.

Palmore said she is amazed by the fact that there’s still more to be learned about copper.

“People have studied electrocatalysis with copper for a couple decades now,” she said. “It’s remarkable that we can still make alterations to it that affect what’s produced.”

The work in the study is part of a larger effort by Brown’s Center for the Capture and Conversion of CO₂. The Center, funded by the National Science Foundation, is exploring a variety of catalysts that can convert CO₂ into usable forms of carbon.

“The goal is to find ways to produce some of the world’s largest-volume chemicals from a sustainable carbon source that the Earth not only has in excess but urgently needs to reduce,” said Palmore, who leads the center. “This is a way for us as scientists to begin thinking of how we produce industrial chemicals in more sustainable ways and control costs at the same time. The cost of commodity chemicals is going nowhere but up as long as production is dependent on fossil fuels.”

The Center for Capture and Conversion of CO₂ is a Center for Chemical Innovation funded by the National Science Foundation (CHE-1240020).

- by Kevin Stacey

SEM images of electrodeposited copper foams on a copper substrate. Inset of (a) is a photo of a copper electrode immediately after electrodeposition of the copper foam.
Encapsulating Brown In a Day

As part of Brown University’s 250th Celebration, the School of Engineering hosted an all-day design workshop in the Brown Design Workshop in Prince Lab.

As part of Brown University’s 250th Celebration, students came together on Saturday, September 27, in the Brown Design Workshop in Prince Lab for an all-day Design Workshop. The theme of the design challenge was ‘Brown Encapsulated’, and students were tasked with re-imagining a ‘time capsule’. What could be created to capture small representations of Brown culture and society now to revisit in the future? This workshop focused on design concepts and hands-on design, showcasing team-based, experiential learning. After receiving an overview of the challenge, students began discussing the design process. They formed teams, but members continued to shift between groups as they generated ideas, shared feedback, and began sketching models.

Throughout the workshop, students continued to iterate, design new prototypes, and share feedback with each other to refine their ideas. Later in the day, each group presented its work to a group of alumni and President Christina Paxson.

After designing further iterations, more feedback, and critique sessions, each group gave a final presentation and discussed their work. One of the three groups worked on a “pixelated” wall concept and consisted of Rebecca Barron ’15 (Engineering and architectural studies), Coleen Chan (RISD ’17 Apparel Design), Victoria Chavez ’18 (Applied Math/Computer Science), Stewart Lynch ’16 (Computer Engineering), Maggie Mathieu ’17 (Mechanical Engineering), Eric Shine ’15 (Computer Engineering), and Hayley McClintock ’16 (Biomedical Engineering). They designed a series of trap- ezoidal blocks (50cm X 20 cm each) that fit together in various configurations. Some of the blocks are made of wood and have images that represent important events in Brown’s 250 years, such as the founding of the Open Curriculum and the merger with Pembroke. The other blocks are made from a whiteboard material, so that students can add their own events that are either pertinent to the whole University or maybe just a group of friends. The idea is to make a growing and moving timeline.

The final design of this would include many more blocks of both types, the wood blocks would be colorful and more cohesive visually, and all of the boards would be fitted with velcro backings and attached to an indoor velcro wall so that students can move them around and create new shapes as well as writing and drawing on the boards, creating new connections between events by their placement, as well as new shapes on the wall.

A third group consisted of Tommy Jung ’15 (Computer Engineering) and Zainab Soetan ’18 (Engineering), who worked on an 8x8 LED matrix controlled by Arduino. It uses a 3-to-8 decoder to select rows and 8 pull-down pins to control columns of LED matrix. Only one of the rows can be controlled at a time, but the fast switching in row selection gives an illusion that all the LEDs could be controlled simultaneously. A number of possible ideas were suggested on uses for this. In addition, consideration was given to integrating this concept with the first group’s concept of LED cubes.

Two of the prototypes will be chosen for further development and later ‘buried’ to mark Brown’s 250th Anniversary celebration.

STUDENTS IN THE NEWS
Re-engineering ENGN0030

With help from an AAU grant, Brown faculty members Clyde Briant and Chris Bull have been working to incorporate more experiential learning into the engineering curriculum.

With help from a prestigious grant from the Association of American Universities (AAU), Brown faculty members Clyde Briant and Chris Bull have been working to incorporate more experiential learning into the engineering curriculum, starting with the first-year ENGN0030: Introduction to Engineering.

The Association of American Universities (AAU) has chosen Brown University as a project site for an initiative to improve undergraduate education in science, technology, engineering, and mathematics (STEM) fields. Brown is one of eight AAU member institutions chosen to implement the initiative, which is designed to encourage STEM departments to adopt proven, evidence-based teaching practices and to provide faculty with the encouragement, training, and support to do so.

Brown’s three-year plan began with a rethinking of STEM classes for first- and second-year students, starting with seven classes in physics, engineering and neuroscience, including ENGN0030. These classes represent crucial gateways to further study in the STEM disciplines for more than 800 Brown students who take them each year, including approximately 300 students in ENGN0030. Ensuring student engagement in these classes and an effective learning environment is a key to recruiting and retaining students in STEM fields. In the plan’s second and third years, practices developed in these classes will be expanded to other classes and disciplines.

Faculty and graduate students have been working with Brown’s Sheridan Center for Teaching and Learning and the Brown Design Workshop to expand access and hours. Prior to the semester, these engineering students received a week of training across many areas including designing with various materials, electronics design, 3D printing, CAD, and MATLAB. Their role as mentors to the first-year students has been vital to the success of the course.

Master Week
Student mentors received a week of training prior to the semester.

Mentor Week
Student mentors received a week of training prior to the semester.

Credit: Christopher Bull

Brown Forms Partnership with Lincoln School

Lincoln School is partnering with Brown’s School of Engineering and the Sheridan Center for Teaching and Learning to offer the course, Introduction to Engineering, to Lincoln students.

Lincoln School is partnering with Brown’s School of Engineering and the Sheridan Center for Teaching and Learning to offer the course, Introduction to Engineering, to Lincoln students. The course will be taught in the School of Engineering at Brown and will take advantage of the newly established Brown Design Workshop. The Sheridan Center for Teaching and Learning will work with both Lincoln School and the School of Engineering to aid in the course design and student-centered pedagogy.

“Lincoln School is very excited to be partnering with Brown’s School of Engineering and the Sheridan Center for Teaching and Learning,” said Suzanne Fogarty, Lincoln School’s Head of School. “Lincoln is a school devoted to promoting STEM initiatives for girls and young women and this collaboration allows our students to take advantage of Brown’s excellent facilities and teaching resources while exploring engineering as an option for future study. Our shared mission is closing the gender gap in engineering.”

It’s especially exciting for the School of Engineering to partner with Lincoln, an independent school that is dedicated to the education of young women. Nationwide, there have been efforts to increase the number of women who choose to enter the engineering profession. By engaging young women at Lincoln there is an opportunity to introduce them to the excitement of engineering earlier than is often possible for most high school students. Professors Iris Bahar and Clyde Briant will lead the effort for the School of Engineering, and Dr. Kathy Takayama, Executive Director of the Sheridan Center, will lead the effort for the Sheridan Center.

“We are very excited to work with Lincoln School on this program. It offers an opportunity to engage young women in engineering while they are at the high school level and to pioneer pedagogical methods of teaching engineering to students in high school,” said Briant.

The course will include both laboratory and analytical components and introduce students to the engineering profession, engineering design, CAD analysis of static structures, 3D printing, engineering materials, and electronics. The students will also gain practice in applying math concepts to engineering problems. The course will meet once a week for three hours and students will receive credit at Lincoln School for the course.

The Lincoln students’ projects and experiences will be showcased through e-portfolios. A major goal will be to help the students explore their own interests in this field and also appreciate the contributions that engineering makes to society.
David Borton

Understanding the neurological basis of movement could lead to implantable sensors that can relay the brain's instructions to nerves and muscles across damaged spinal cords. David Borton is working toward such implantable "bridge" devices.

The capacity of the human body to make incredibly precise and powerful movements was on full display last summer during the World Cup soccer tournament. David Borton, assistant professor of engineering, knows all about the moves needed to be a successful soccer player. For two years in his late teens, he played professionally for Santos FC in Brazil—a squad whose all-time leading scorer is the great Pelé. But after coming to the realization that there was more to his life than soccer, Borton decided to go back to school to become an engineer.

Now, in his neuroengineering lab at Brown, Borton is developing technologies to better understand the neurological underpinnings of human movement. Ultimately, he hopes to help develop neural prosthetic systems to restore movement for those who have lost it to injury or disease.

In part, Borton says, it is his experience playing soccer that motivates his work to help people with motor difficulties. "It touches a little bit closer to home when you see people who are paralyzed and they can't do the things that you can do," he said. "That's why I'm doing this work."

"I want to help students from both EPFL and Brown to have the experience that I had in seeing a whole different set of labs," Borton said. "You get to learn about things you never thought were possible.

The key advance of this device is that it's wirelessly enabled. It can then be combined with data from brain sensors to shed new light on the neural basis of movement.

"During my postdoc, I worked on systems—not just devices, but systems of devices—that can talk to each other and find ways to read from one part of the nervous system and write into another part," Borton said. "That means understanding the information coming from the brain and building a useful signal to bring it back into the nervous system."

"The spirit of our lab," he said, "is building technologies that can answer old questions in neuroscience and help ask new ones."

Borton already has lined up collaborations toward those ends.

He plans to work with Gabriel Taubin, associate professor of computer science and engineering, who is an expert in computer vision. With Taubin, Borton would like to develop new ways of using computer imaging to monitor and quantify the movements of animals in the lab. Borton will also work with assistant professor Jacob Rosenstein to develop kinematic sensors that can be implanted directly into joints as another means of capturing fine detail in movement. Those detailed movement data can then be combined with data from brain sensors to shed new light on the neural basis of movement.

But the ultimate goal of restoring movement for people who have had a neural insult will require more than collecting neural data on movement. Borton would like to find new ways of reinstalling that information back into the nervous system. During a postdoctoral appointment at Ecole Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, Borton worked on new techniques to do just that.

"During my postdoc, I worked on systems—not just devices, but systems of devices—that can talk to each other and find ways to read from one part of the nervous system and write into another part," Borton said. "That means understanding the information coming from the brain and building a useful signal to bring it back into the nervous system."

"The effect is a corico-spiral bridge that reconnects regions of the nervous system that have been separated by injury or disease. And while he is building those technological bridges, Borton would also like to build a research bridge across the Atlantic to EPFL."

John Donoghue, director of the Brown Institute for Brain Science, is on leave this year to help set up a new neuroengineering center at EPFL. As Borton settles in here at Brown, he envisions a steady stream of researchers and students moving back and forth between the two institutions.

"I want to help students from both EPFL and Brown to have the experience that I had in seeing a whole different set of labs," Borton said. "EPFL is one of the top universities in Europe, so it's great to have that connection."

"The good thing about Brown is even when you are a grad student most professors treat you as a colleague anyway," he said. "That's one of the more powerful attributes of the Brown community."

"It's great to have that connection."

"EPFL is one of the top universities in Europe, so it's great to have that connection."

"The good thing about Brown is even when you are a grad student most professors treat you as a colleague anyway," he said. "That's one of the more powerful attributes of the Brown community."

"That's one of the more powerful attributes of the Brown community."

by Kevin Stacey

Natural Inspirations - Shreyas Mandre

When asked about his teaching philosophy, Assistant Professor of Engineering Shreyas Mandre leans back in his office chair and thinks for a moment. He then pops up and procures an envelope. Inside are several paper models of maple seeds, designed by undergraduates in his fluid dynamics course. The idea was to understand the design of the seeds, and how it might be useful in other applications. He excitedly tosses a few into the air. They flitter toward the floor in neat spirals.

"I like to be inspired by nature," he says. "That's my philosophy, roughly—to use phenomena in nature to build a fascination for the subject."

That spirit is also what fuels Professor Mandre's research. Whether it's studying the way cereal moves in a bowl of milk or how the gentle, synchronous waving of seagrass helps sustain marine life, his work begins with a certain wide-eyed wonder. But, it's more than just that: "It's driven on one hand by curiosity and on the other by application. There is no one answer to the question whose answer might be useful.

One project that fulfills that dual aim is his collaborative study on the mechanics of the human foot. Backed by a grant from the Human Frontier Science Program, Professor Mandre and two colleagues in Japan and India are in the midst of a three-year endeavor examining the form, function, and evolution of the human foot. The hope is that the study's discoveries can be applied to fields like evolutionary biology and robotics.

"There are robots that do some kind of running but none actually run like humans do," says Professor Mandre. "We think one of the critical pieces is that none have the right kind of foot." And what could a running robot do? For one, it could aid search-and-rescue missions in dangerous situations where the terrain is too unwieldy for humans or motorized vehicles.

Professor Mandre is also working with engineering faculty members Kenneth Breuer and Jen Franck on an energy-harvesting study backed by ARPA-E, an agency under the purview of the United States Department of Energy. Dubbed the "water wing," the project aims to harness the power and reliability of oceanic tides and convert them into a highly efficient renewable energy source.

Support for the path-breaking work of projects like these—and the forthcoming new engineering building—will allow the School of Engineering to continue its rise as a world leader in research and training.

Professor Mandre can hardly wait. "Getting a new building will allow us to hire new faculty and bring in interesting and new ideas. It's going to help us grow."

In the meantime, he'll continue to let the natural world inspire him, finding ways to turn seemingly small observations into something much bigger.

by Jacob Goldman

How tidal energy could take flight: Mounted on the sea floor, the device's wings move up and down the stationary pole, generating power. More wings can be added, and the device can fold flat to allow large ships or loaded barges to pass safely.
Professor Huajian Gao to Receive Prager Medal

Brown University Professor of Engineering Huajian Gao has been selected to receive the William Prager Medal from the Society of Engineering Science (SES) made in recognition of his outstanding research contributions in theoretical solid mechanics. The award will be presented at the 52nd Annual Technical Meeting of the Society of Engineering Science to be held at Texas A&M University, October 26-28, 2015.

The medal is named for former Brown professor William Prager, who helped to establish the Division of Applied Mathematics at Brown in the 1940s. Of the 22 times the Prager Medal has been awarded, a current or former Brown solid mechanics faculty member or alumnus, has won it ten times. Previous Brown recipients include: Daniel C. Drucker (1983), Rodney J. Clifton (1986), James R. Rice (1988), George J. Dvorak Ph.D. ’69 (1994), L. Ben Freund (2000), Alan Needleman (2006), Richard James ’74 (2008), Alan Wimberly Ph.D. ’64 (2009), Robert M. McMeeking Sc.M. ’74 Ph.D. ’77 (2014) and Huajian Gao (2015). Eight of the ten winners, including Huajian Gao, are also members of the National Academy of Engineering (NAE).

Sara Kadkhodaei Wins Materials Research Society Graduate Student Award

Sara Kadkhodaei, a fifth year doctoral student in the mechanics of solids group at the Brown University School of Engineering, has won the Materials Research Society (MRS) Graduate Student Award for a presentation on Mathematical and Computational Aspects of Materials Science at the MRS 2014 Fall Meeting in Boston. The MRS Graduate Student Awards are intended to honor and encourage graduate students whose academic achievements and current materials research display a high order of excellence and distinction. MRS seeks to recognize students of exceptional ability who show promise for future substantial achievement in materials research. Emphasis is placed on the quality of the student and his/her research ability. At Brown, Kadkhodaei is advised by associate professor Axel van de Walle of the materials group.

Her research involves devising and developing computational tools toward automated calculation of thermodynamic properties of alloys.

20 Students Inducted into Tau Beta Pi, the engineering honor society

Tau Beta Pi, the engineering honor society, inducted 20 new members into the Rhode Island Alpha chapter at Brown University on Friday, December 5. Thirteen juniors were inducted along with seven seniors. Among the thirteen juniors elected were: Paolo Emil Burkley ’16, Kyle Erf ’16, Ian Knapp ’16, Thamin Kovitchandachai ’16, Stewart Lynch ’16, Jad Nasrallah ’16, Carlos Reyes ’16, Rohan Sanspeur ’16, Min Yee Teh ’16, Jacques Van Arnh ’16, James Violet ’16, Jack Wilson ’16, and Haeri Yoon ’16. The seven seniors elected included: Jennifer Cardona ’15, Theresa Cloutier ’15, Pawel Golykski ’15, Ethan Madigan ’15, Guarav Nakhare ’15, Jenna Norton ’15, and Emily Toomey ’15.

Tau Beta Pi, founded in 1885, is the second oldest Greek-letter honor society in America; the oldest is Tau Alpha Epsilon. Tau Beta Pi is designed to “offer appropriate recognition for superior scholarship and exemplary character to students in engineering.” In order to be inducted into the prestigious honor society, juniors must rank in the top eighth of their class and seniors must rank in the top fifth of their class. Graduate students who have completed at least 50% of their degree requirements and who rank in the top fifth of their class are also eligible to become candidates for membership.

2014 AICHE National Meeting

Several Brown University engineering students attended the 2014 American Institute of Chemical Engineers (AICHE) Annual Meeting in November in Atlanta. During the meeting, the Nanoscale Science and Engineering forum hosted an award session to honor graduate students whose research achievements, in the broad area of carbon nanomaterials, demonstrate a high level of excellence. Finalists were selected based on their abstract submissions and then presented their work in the award session to a panel of judges. Brown chemical and biochemical engineering fifth year doctoral student Megan Creighton was awarded the first place prize for her research on “Molecular Barrier Functions of Graphene Oxide in Liquid-Liquid Systems.” She is advised by Professor Robert Hurt.

Nine undergraduates attended the national meeting and competed in the national poster competition, including Helen Bergstrom ’15, Anna Brown ’16, Theresa Cloutier ’15, Jenna Ditto ’15, Collin Felton ’15, Naser Mahfouz ’15, Donna Nozik ’16, Rebecca Pinals ’16, and Finn van Kreeken ’15.

More than 200 posters were presented, and the competition was divided into ten topic areas, and the topic areas were broken down further into subgroups. Nozik presented in the materials engineering and sciences VII subgroup and won first place. She presented a poster entitled, “Body-fitted Fiber-parous Vascular Scaffolds: Effect of Crosslinking on Properties.” Bergstrom presented in the sustainability category, and won second place. She presented a poster entitled, “Rethinking the Traditional Wall: Textile Wall Assembly Systems for Healthier, Energy-Efficient Structures.” Brown presented her poster entitled, “Multiple Wavelength Interferometry for the Characterization of Material Properties,” and won second place in the materials engineering and sciences VI subgroup. Mahfouz presented his poster entitled, “Graphene Oxide-based Materials for Environmental and Selective Barriers,” and won third place in the separations category. Cloutier competed in the Food, Pharmaceutical and Biotechnology category and won third place for her poster entitled, “Towards Inducing MSC Chondrogenesis in Hydrogels through Treatment with Kartogenin.” Pinals won third place in the Materials Engineering and Sciences V subgroup. She presented a poster entitled, “Band-Gap Tuning of Colloidal Silicon-Based Quantum Dots by Surface Functionalization Using Conjugated Organic Ligands.”
Mehrdad Kiani ’15, a materials engineering concentrator, considers his academic interests “a little unorthodox.” That is one way of putting it. One might also call them “fascinating” and “exciting.”

Specifically, Mehrdad is applying his engineering know-how to two seemingly disparate areas: archaeology and cancer research. In some ways, the two categories could not be further apart, but to Mehrdad, it just makes sense: “Materials engineering,” he says, “the study of finding, designing and implementing new materials—‘really is all-encompassing.’ When you look at many other scientific fields, there is a lot of materials-based work going on.”

There is an interesting arc, too, in working across these fields: investigating and creating 3D models of ancient artifacts helps tell stories of the past, while enhancing the components of cancer research is a nod toward the future.

As a first-year, Mehrdad aided Associate Professor Gabriel Taubin and Kevin Smith, chief curator of the Haffenreffer Museum, in implementing a new kind of archaeological archiving software called REVEAL, across three active dig-sites. This meant a whirlwind summer of travel: Mehrdad headed to central Turkey, the Peruvian Andes, and a cave in Iceland. The trip, he says, was unforgettable: “These were really secluded, unique areas. In Iceland, we worked inside a massive lava cave with artifacts and animal bones from the Viking age. In Peru, there were these tiny crawlspaces that connected old buildings. I’ve never experienced anything like it.”

Last year, Mehrdad began working out of the lab of Ian Wong, assistant professor of engineering. Through the competitive DiMase Internship, Mehrdad spent the past summer tracking how different cells move—both physically and through computerized simulations. He will continue this work throughout his final year on College Hill, collaborating with his fellow undergraduates and a few doctoral students.

In case all of that was not enough to satisfy Mehrdad’s intellectual curiosities, he also took on the presidency of Brown’s Tau Beta Pi chapter, the national engineering honor society. Yet, he shrugs off the suggestion that his academic efforts are prodigious: “I’m still a regular college student. I go out with my friends and try to keep that part of my life intact.”

In fact, Mehrdad says, one of his favorite things about the University is how its open curriculum and focus on interdisciplinary encourages a wide array of both academic and social interactions: “I didn’t want to go to a big school where all of my friends would have been engineering students. Here I have good friends in economics, neuroscience, computer science and public health. If you’re looking for a school that gives you extra perspective, I don’t think it gets any better than Brown.”

“We have a lot of energy,” Davis said. “Why not take on this challenge?”

The conference schedule included workshops on advanced study skills, careers in engineering and resume writing. Workshop topics for high school students included choosing and paying for college. Several members of the Brown engineering and computer science faculty took part, and the keynote address was delivered by Oscar Groomes, a graduate of Brown and Tougaloo College and former president and CEO of GE Rail Services.
You could say to be an engineer you need something in your soul. In my case, it was in my blood. My great-grandfather, grandfa- ther, three uncles, my mother, and my father were, or are engineers. Growing up, I was always dragged out to the garage by my par- ents to watch them solder, fix an engine, or use a drill press, all while learning the theory and rationale behind what they were doing. At the dinner table my parents would ask my sister and I for ideas when they were having trouble solving something at work. Most times we could barely understand the prob- lem, much less figure out how to help them, but on the occasions that we could help it was magical. We had helped our parents, which for me was like aiding Superman to spin the world in the other direction. Fast for- ward to college. My freshman year I decided to go into engineering because I was inter- ested in math and science. Day one Prof. Janet Blume opened up the ENGN 3 class, and I knew I was a goner. From day one at Brown I was an engineer.

Unlike my experience with engineering, it took some time for me to find my sport. When I was 10 years old, we moved to Rhode Island. Being a transplant, I couldn’t join the summer soccer team - we had missed the sign up period. So my parents put me in sail- ing summer camp. A few weeks later, I was hooked. Years later, looking at colleges, I wouldn’t even consider a school without a sailing team. I sailed for Brown for three years, while studying engineering and maintaining my international racing status. Unfortunately, this was a bit ambitious so

**Sailing is all about fluid dynamics. How much heel should you allow the boat given the waves’ depth and spacing? Traditionally, a flat boat is a fast boat, but in choppy waves you need heel to slice through the waves, in rolling waves you need to cant and steer the boat up the front of a wave and down the back. All of this to maximize the lift that the boat’s boards experience from the water. At what point of sail should you be at? How tight should the sailboat’s control lines be to maximize the power of the sail generated by the wind? In light air, you typically ease the boat’s controls a bit, or you will choke off the flow, killing your speed. In medium air, you must balance between speed and sailing with the closest angle to the wind. In heavy air, you strap on all the controls to flatten the sail, making the boat more manageable.**

**Sailing is all about solid mechanics. How do you position your body in each maneuver? Your body behaves as a weighted lever to the boat, how you position it directly affects the lift on the boards and sails changing the boat’s speed and direction. How do you set up the boat? The Nacra 17, the boat I am currently racing, has both stays and diamonds. Stays keep the mast in a “vertical” position on the boat.**

**However, you can choose to tilt the mast slightly off vertical. In heavy air you would rake it back, this helps to depower the sail and keep the boat controllable. In light air you would have a perfectly vertical mast or rake the mast forward a bit to open up the slots between the sails to keep the turbulence developed on the trailing edge of one sail to affect the next sail, you let the sails breathe. Diamonds compress the carbon fiber mast, making it more or less rigid. In heavy air, you want more compression to keep the mast straight. This: depth of the sails, taking power out of the sail and allowing a closer angle of travel to the wind. In light air you want less compression, permitting the mast to bellow out in the middle giving the sails more volume hence more power.**

**Look at the Nacra 17. It is a two person, dou- ble trapeze (wires that hook into and hang out of the boat), foiling (the boat’s hulls come out of the water completely, resulting in just the boards touching the water), catamaran (two hulls, double the water line, double the speed - 20mph aver- age speed). Think of the engineering it took to design that thing.**

**But not everyone that sails goes to the Olympics. With two Brown engineering degrees, I am frequently asked why I am giv- ing that up to train.**

I am still pursuing engineering, not just by way of sailing, but also in the academic sense. I am collaborating with Prof. Joseph Liu from Brown University on several papers while I am training. After the Olympics I plan on designing medical devices, ranging anywhere from IV drips to artificial hearts. I want my engineer- ing expertise to make a direct difference in people’s lives. I am also thinking of going to medical school to aid in my circunavas. The Olympics is the most competitive ath- letic event. As such, you would expect the training, the qualification, and the com- petition to be the greatest challenge. For many countries, the hard part is getting on the team. After all, only one team from each country gets to go. Once on the team, the country supports the athletes’ financial needs. However, for an American sailor this is not the case. The greatest challenge is raising enough money to train, qualify, and compete in the Olympics. To run an Olympic campaign costs several hundred thousand dollars a year due to the travel, coaching, equipment, and regatta fees, not to men- tion basic living expenses. In the U.S., the sailing team’s costs are subsidized and the athletes get a jacket and a handshake. All additional funding must come from out of pocket or from private sponsorship and/or donations. That’s a huge strain on the athlete. Not only is fundraising difficult and stressful, but it also takes valuable train- ing time away. However, you cannot train if you cannot afford to train. It is the Olympic catch-22.

To try to encourage donations, I have cre- ated a non-profit called Salstrong. Its purpose is not to simply raise tax-free money for my Olympic dreams. I wanted to create a foundation that would encour- age the next generation to become true student-athletes, to show that you really can

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Jessica Claflin ’13 Sc.M. ’14 graduated from Brown with a Sc.B. in mechanical engineering as well as an Sc.M. in fluid & thermal science. She is training to represent the USA at the 2016 Olympics in the Nacra 17, a two-person catamaran. To try to encourage donations, I have cre- ated a non-profit called Salstrong. Its purpose is not to simply raise tax-free money for my Olympic dreams. I wanted to create a foundation that would encour- age the next generation to become true student-athletes, to show that you really can

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Jessica Claflin
Community Planning

As an important element of the new Engineering building planning effort, a Community and Program Committee has been formed with members of the Brown Engineering faculty and administration, with important input planned for students. This committee, chaired by Professor Iris Bahar, has been meeting for over a month now, and has gathered and discussed topics of community importance which will be shared with the Brown community.

Specifically, this committee has been established to work closely with the architects, KieranTimberlake on the overall design of the building, its relationship to the engineering community, and the Brown community as a whole. An important topic which has emerged early on is the importance of physical connectivity to Barus and Holley, which is the current nerve center of the School of Engineering and Department of Physics. A seamless connectivity will be important to merge together an integrated faculty and student population working in one building or the other, but also to facilitate flow of students, staff, and visitors, and ensure that there is no isolation or segmentation of communities.

The importance of promoting interactions across the Engineering community as well as connecting with other departments such as Physics, Applied Math and Computer Science, have been discussed throughout these first planning weeks as well.

The Barus and Holley lobby is currently home to a wide variety of events, including study groups, career networking sessions, art shows, and student presentations and competitions. It is also a popular gathering place for undergraduate and graduate students. Therefore, the committee has been putting careful thought into how to maintain and enhance the lobby since it has served as such an important component over the years. In particular, the committee is considering how to improve connectivity between the Barus and Holley, Prince Lab, and the Ganciario building by extending the existing lobby space into the new building. This extended lobby may also include a new café, as well as multi-functional seating and gathering spaces.

The committee will continue to discuss other topics including the creation of good collaborative spaces, and how this new building can be a part of our goal to foster a sense of community and commitment, with the idea that this new building can be a part of something that excites and inspires engineering and the whole campus for the next 50 years.

Lab Strategy and Design

As a central part of the new Engineering building planning effort, Dean Larson has called for a Laboratory Strategy and Design Committee to develop concepts for the adaptable and configurable research space that is the major part of the programming for the new building. This committee of faculty and administrators is being chaired by Prof. Nitin Padture and has been meeting during the semester to review both the current labs and facilities needs of the Engineering faculty and projections about future research capabilities that will be critical for the School of Engineering in the coming years.

The committee is engaging in regular workshop sessions with the design team, led by architects from KieranTimberlake, on lab typologies needed in different areas of research as well as the organization of the supporting spaces, shared equipment rooms, and student write-up and conferencing areas that together contribute to the kind of highly collaborative and productive research communities that will help the School attract the best young and established faculty in its coming growth phases.

Access to adequate research space currently is a part of the School’s “Lab and Campus Planning Committee’s desire to fund the School’s new research labs are now arrayed across multiple campus locations,” notes Prof. Rod Beresford, Senior Associate Dean for Academic Programs, “in some cases occupying spaces that were not intended for the intensity of uses we demand.”

The new building is expected to provide research space for up to 18–20 groups, including both existing and new investigators. We are seeing a convergence of infrastructure needs in the different disciplines,” points out Prof. Rashid Zia, who also serves as Director of Microelectronics, a major shared-use facility that is expected to relocate from Barus and Holley to the new building. Whereas Barus and Holley was completed just before the surge in materials-driven innovation that ushered in the growth of the world semiconductor industry, this new building will be arriving at a time when engineers in all disciplines are manipulating matter at the micro and nano scales, requiring access to synthesis tools and instruments that often were not even known a few decades ago.

“Planning for a future research landscape of more convergence, more and bigger data sets, and more diverse collaborations is where we think this project should head,” says Beresford.

With the prospect of close connections to all of Barus and Holley, Ganciario, and Prince, the new building is likely to become a hub of activity integrating many different aspects of the School’s programs, with cutting-edge research being the major focus. To ensure that all of the faculty research needs are represented in the planning process, the committee members worked closely with the architects to design a survey probing issues of technical needs, space configurations and sharing, and usage patterns. Over 85 percent of the faculty has completed the survey, providing a trove of data that the team is digging into as needed to evolve a strategy for the new lab modules and their context in the existing campus.

“This will be a world-class research facility,” says Dean Larson, “and our process for getting there is very ‘Brown’ – very inclusive, creative, and full of the excitement of discovery.”

Engineering Building to Utilize Integrated Project Delivery

For the new School of Engineering building, Brown decided to engage with a new and innovative design, planning, and building process known as “Integrated Project Delivery.”

Integrated Project Delivery is a relatively new contracting method where the owner (Brown University), architect, contractor, and subcontractors sign a multi-party agreement that fundamentally shifts both the risk and reward away from the individual parties onto the project as a whole. The project profits and contingencies are pooled together, so the entire team is motivated to truly collaborate throughout the delivery process.

For complex projects like the School of Engineering new research building, incentivizing strong collaboration is the key to driving the best value solutions. In our first experience, with a smaller renovation project at Brown, we were able to save over 15% on the cost of the original project estimate and add value that would have otherwise been lost back into the project to increase scope, ultimately getting more with the same planned funds.

We have built a team together with KieranTimberlake as our architect, and Shawmut as our construction firm, aligned around creating the best possible building for the smartest use of our funding. Working with all parties committed to working seamlessly and end to end throughout this project to share information, decision making and execution. We look forward to seeing the output of this process and hope to utilize it in future Brown University projects as well.
The CAB also received an overview and discussed applications for an innovative new research area of bio-informed smart lighting by Jimmy Xu, the Charles C. Tillinghast Jr., future industries, and strategies for their own career searches. A career panel discussion was led by CAB members who described in detail their own personalty of ideas. They also discussed increasing industrial collaborations with Brown Engineering, and the value of having multiple levels and avenues of engagement available to interact with industry. These included engaging with students in courses, hiring students, sponsoring student competitions and groups, finding research, sponsoring specific research projects around R&D interests, donating equipment for testing, licensing patents, and others. A career panel discussion was led by CAB members who described in detail their own personal career paths, choices they made, and how they arrived at the leadership positions they hold today. Students in attendance were highly engaged and asked advice on career aspects of future industries, and strategies for their own career searches.

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The Honor Roll is in appreciation and recognition of those individuals, corporations, foundations, and organizations whose support makes the continued commitment to excellence in teaching and research at the Brown School of Engineering possible.
Scott Friend ’87 reflects on…

...beliefs of entrepreneurs

“I started my post-Brown career at a big company - IBM - where I learned about sales and account management and how to make your customer successful. But I always wanted to be an entrepreneur. Fortunately, I had the chance to join a start-up company after business school and then co-founded my own business. I'm now a venture investor supporting young, talented entrepreneurs with great new ideas that have a chance to really make an impact. Being a venture capitalist is a fantastic opportunity because, while it sounds clichéd, I get to see the future every day in the entrepreneurs I work with and meet every week. Since I do very early-stage investing, I hear about ideas that have no business existing and products that no one has thought of before and for which there is no market. These young engineers, designers, and business people have a belief—often an irrational belief—that what they are passionate about can come true. But it's exactly this type of irrational enthusiasm and passion that leads to the greatest successes!

“Having built a company from the ground up as an entrepreneur and helped others do the same as an investor, it’s obvious to me that teaching students about entrepreneurship and giving them opportunities to think through and perhaps start their own businesses is great training for whatever they do in life. Entrepreneurship is an aggregation of all sorts of important skills from innovation to salesmanship to general management: it all comes together when you think about building a product and building a business.

...different but complementary skills

“The nature of Brown's curriculum is such that students who are excited about entrepreneurship can capitalize on that passion and build those skills. Every one of my courses taught me to peel back the onion and see what was going on underneath: how to think about the world in ways that were different than I had in the past. I remember taking an entry-level engineering course on mechanics and walking around for days looking at bridges and buildings through an entirely new lens. Similarly, I had an amazing professor, Skillman, who taught what could have been a pretty dry course on labor economics. Yet his approach brought the material to life in a way that influenced how I thought at the time about markets and businesses and human resources—and those perspectives and learnings are with me still.

...a unique environment

“I have unbelievably positive feelings about the University. The most important relationships in my life were established there—relationships with individuals who have become lifelong contributors to my success and happiness. It is, for the right kind of student, just an incredibly unique environment. I love that Brown continues to innovate and find new ways to be even better.”

Scott Friend ’87 - former head of ProfitLogic and present managing director of Bain Capital - has given to several University priorities, including the Brown Annual Fund and current-use and endowed scholarships. Currently, Friend has also pledged to support the forthcoming Center for Entrepreneurial Innovation.

-Alumni Perspective

CAMPAIGN FOR ENGINEERING

“This plan is ambitious, but Brown has implemented equally ambitious plans in the last several years. Aiming for excellence invigorates and inspires us all.”

— Larry Larson, Dean, School of Engineering

For more than 160 years, Brown University’s engineering program has sustained an exciting and unique environment for learning, teaching, and research. What began in 1847 has grown into a distinguished School of Engineering characterized by global impact, innovation, multi-disciplinary pursuits, and outstanding faculty and students.

These characteristics provide a unique opportunity to help transform the School of Engineering into a force for global technological and entrepreneurial innovation by:
- Hiring and supporting transformational faculty in key areas of explosive technological growth and profound societal impact
- Transforming undergraduate engineering education
- The time to begin these initiatives is now. Philanthropic, visionary individuals are encouraged to seize this unique opportunity to make a difference in our community and in the world.

Giving Opportunities

New Engineering Facility

- School of Engineering Building Fund starting at $100,000 new and renovated space on College Hill for education, collaboration and research including classrooms, research labs, classrooms, etc.

Brown Design Workshop in Prince Lab $10-15 million

The focus of collaborative "making" and experiential learning for the campus

Faculty Support

- Endowed Professorships $5 million Providing faculty support plus start-up funds for research and infrastructure needs
- Endowed Visiting Professorships $2 million Brining new perspectives and real-world experience

Endowed Post-Doctoral Scholars $1.5 million Training the next generation of leading faculty

Graduate Student Support

- Endowed Graduate Fellowships in Engineering $750,000 Support for transformative research

Transforming Undergraduate Education

- Endowed First-Year Seminar Fund $500,000 Provides funding for one first-year seminar each year
- First-Year Seminar Fund $50,000 Provides funding for one first-year seminar

Endowed Department/Program Fund

$250,000 Used broadly to help build the profile of School of Engineering programs

Endowed Technology Investment Fund

$250,000 Support for enhanced classroom technology and new and upgraded state-of-the-art instructional equipment for labs

Dean’s Fund for Engineering Excellence All amounts Support investment in novel research and curriculum innovations, and the creation of new educational ventures
ENGIN 0030 DESIGN PROJECTS 2014