Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY fall 2009

Go Bear Area!

Concrete canoe team takes national title

THE BIG DEAL ABOUT SMALL | BIOENGINEERING LOOKS AHEAD | FROM BACON TO BIOFUEL

Broadening participation

PEG SKORPINSKI

One of Berkeley Engineering's great pleasures is getting to eavesdrop on random snippets of excited conversation. Walking past Bechtel Center, you might overhear someone say, "Protein engineering is cool, but cells are even cooler!" Or, "It's a great feeling to come up with an idea and then make it happen." The place is brimming with enthusiasm and the joy of young people discovering and accomplishing new things.

Our primary mission is to feed that enthusiasm and inspire our students to find a place in the world where their curiosity and ingenuity can make a difference. In addition to a superb classroom curriculum, we continue to incorporate experiential learning: activities like field and research projects, corporate internships, study abroad, student clubs and design teams. Such hands-on experiences foster leadership skills by allowing students to comingle their technical abilities with knowledge of social, legal, financial and usability issues, to integrate technology pull with societal needs and thereby achieve satisfying, results-oriented outcomes.

But we need to do more. To strengthen their leadership skills, we must provide our undergraduates with access to even more paid research, capstone projects and group activities. To this end, in July we announced the formation of Engineering Student Services (ESS), which will be a focal point for these efforts by engaging with students more proactively and empowering our student groups. ESS staff will focus on developmental services that promote academic success including recruitment, finding paid internships and other real-world experiences, steering undergraduates toward research activities, and new support mechanisms like peer advising and mentoring.

We are renovating space in the Bechtel Engineering Center to serve as a hub for undergraduate life in the college. At the same time, we have launched our Broadening Participation Initiative, whose goal is to offer a rich, multicultural environment for learning and leadership that reflects the global reach of engineering. To achieve the optimal ecosystem, we must do a better job of attracting, recruiting and retaining women and multicultural students. A new faculty-led Task Force on Diversity and Inclusion is working with student groups to rejuvenate existing programs and develop new programs and strategies to broaden participation on every level of student life.

We believe that the new ESS structure will enable each member of our student body—those from well-represented as well as traditionally underrepresented populations—to discover, accomplish and lead.

I welcome your thoughts and ideas at **dean.forefront@coe.berkeley.edu.**

—S. SHANKAR SASTRY
Dean, College of Engineering
Roy W. Carlson Professor of EECS, BioE & ME
Director, Blum Center for Developing Economies

Forefront is published twice yearly to showcase the excellence of Berkeley Engineering faculty, alumni and students and bring their work to life for a broad engineering audience through news and research, profiles and current issues and events.

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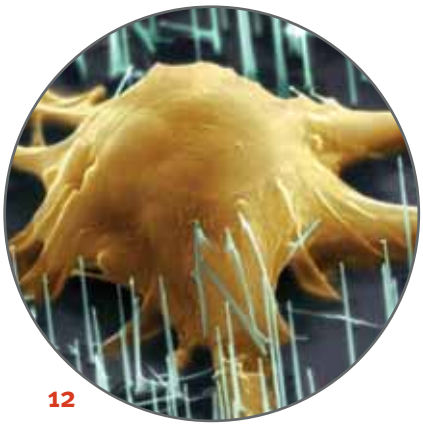

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On the cover
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Concrete canoe team members (front to back) Johnny Mendoza (B.S.'09 CEE) and CEE seniors Charlene Sadiarin and Danielle Des Champs paddled UC Berkeley to first place in last June's U.S. National Concrete Canoe Competition at the University of Alabama in Tuscaloosa.

COVER PHOTO BY GARY TRAMONTINA
BACK COVER PHOTO BY NICK LAMMERS

Letters
TO THE EDITOR

Engineers, the best inventors

In his letter in your last issue of *Forefront* [spring 2009, p. 2], Mr. Anders Lundberg dismisses the current dialog on climate change as "chatter." He believes that engineers "have a duty to bring out the facts." Overwhelming data have been accumulated over the last 20 years showing that the atmospheric carbon dioxide concentration is currently rising at a faster rate than at any time in the last 400,000 years, accelerated by several powerful positive feedback mechanisms.

Rather than duplicating the last 20 years of climate data, engineers should be doing what they do best: inventing the revolutionary clean energy and transportation technologies needed to slow human-caused planetary warming.

—**AL GRAF** (B.S.'68 EE)
Saratoga, California

Solar water heater redux

Not to belittle the excellent intentions of the Design for Sustainable Communities class that developed a $100 solar water heater [spring 2009, p. 9], but thousands of variations of such water heaters have been built all over the world. This is in no small part thanks to Stewart Brand's *Whole Earth Catalog*. . . . From the first issue in 1968, articles on thermosiphon solar water heaters inspired many in the "back-to-the-earth" movement to duplicate, simplify and improve on the basic design.

I've been delighted to read all the recent articles in *Forefront* about Berkeley's innovations in green tech and other less commercial applications. But your story about Elizabeth Hausler ["Home safe home," p. 12] better reflects the challenges entailed in promoting beneficial technologies. Developing a potential product or technology is only a small part of the process; it's really all about marketing and dissemination, and this is as true for solar showers and earthquake-safe houses as anything else that ever came out of Berkeley or Silicon Valley.

—**STEVEN J. FABRICANT** (B.S.'64 EE)
Naha, Okinawa, Japan

Impressive accomplishments

The communications I receive [from you] keep me thinking of the significant work that Cal Engineering is involved in and inform me on other institutional issues. As an ABET evaluator and commissioner of the Engineering Accreditation Commission, I see a number of engineering programs at quite a few campuses. I am consistently impressed by Cal, both in terms of research projects and accomplishments and the direction and content of programs. I am consistently proud to be a Cal graduate.

—**JOHN KOON** (Ph.D.'71 CEE)
Malcolm Pirnie, Inc., Atlanta, Georgia

Lost in translation

Your "Engineering evolved" story [spring 2009, p. 17] is plenty pertinent on how American engineering graduates can work effectively on a global basis. But in my field of sanitary/environmental engineering, an engineering education program must also take into account the critical need to modify American design criteria and matching environmental standards so that these will be appropriate for use in developing countries. Since the start in the 1950s of the international program for assisting developing countries, most projects in this field for which American engineers were designing or advising have not made this adjustment, hence are wasteful investments.

—**HARVEY F. LUDWIG** (B.S.'38, M.S. '42 CE)
Samutpkrakarn, Thailand

Where GM has the edge

When explaining the feasibility of Project PUMA and rendering auto insurance obsolete ["GM's green guru hangs tough," spring 2009, p. 27], people may relate to the Honeywell Aerospace system for landing commercial passenger jets, which uses ground-based augmentation of GPS to precisely control airplanes, even in inclement weather. This saves time, fuel and money while avoiding the need to extend runways. Has GM considered helping solve California's budget crisis—while at the same time expanding demand for their vehicles—by applying the "non-tax" income-generating concept to transportation and auto insurance? Because of OnStar, this is one area where GM has an edge over other manufacturers. There are many policies and technologies such as these the legislature could adopt to reduce the $50 billion Californians currently pay each year for vehicle insurance. If such policies could reduce insurance expenditures to $20 billion, the "non-tax" could reward California's general fund with half the savings, $15 billion.

—**MARK E. CAPRON** (B.S.'76, M.S. '81 CE)
Oxnard, California
www.PODenergy.net

WE LOVE YOUR LETTERS!

Write to us at **forefront@coe.berkeley.edu** or send letters to *Forefront* letters, 312 McLaughlin Hall #1704, University of California, Berkeley, CA 94720-1704. Please write a maximum of 250 words and include your name. We cannot include all letters and may edit for length and clarity.

What's new
AT BERKELEY ENGINEERING

SMART PHONE, SMART USER

California is one of about 20 states restricting cell phone use behind the wheel. But efforts to limit texting and other cell phone activities while driving have escalated recently, following new research, increased public awareness and a national summit on the dangers of driving while distracted. Below, doctoral student Aude Hofleitner demonstrates safe use of her cell phone in the car—using a wireless earpiece and dash mount—to get live traffic conditions through an application developed by civil and environmental engineering professor Alexandre Bayen and his research group. "For safety reasons, we want to give drivers the option of using a voice interface," says Bayen, whose Mobile Millennium technology was designed, in collaboration with Nokia, to comply with California's hands-free law. Like systems used in Europe, the program gathers traffic data through GPS-enabled cell phones and distributes reports via graphical maps or, to minimize driver distraction, MP3 audio files played through a headset or speaker.

RACHEL SHAFER

AARON WALBURG

Mondale calls on students to aid needy nations

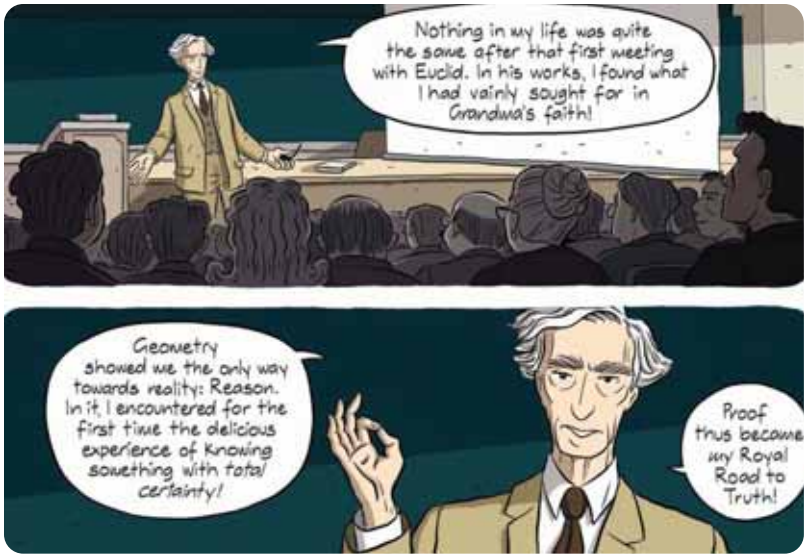
Walter Mondale, vice president under Jimmy Carter, visited UC Berkeley in September to discuss the growing crisis in U.S. aid and development policy.

Addressing an audience of about 200 in Sibley Auditorium, Mondale urged students to get involved and take advantage of hundreds of new USAID and State Department jobs to give "people around the world a better chance." While foreign development aid was once perceived as poverty "gift-giving," he said, Americans increasingly realize the importance of development policies as a national security issue.

"In the long run, these policies will help not only developing countries, but also the U.S. and the world," Mondale said. "They'll become the lens from which other people will view Western values and our commitment to social justice."

Mondale cited evidence that overwhelming poverty contributes to violence, spread of infectious disease, decreased income growth and environmental degradation. Implementing intelligent policies, like supporting agricultural techniques for poverty relief, could lead to greater security domestically and abroad, he said.

The talk was sponsored by the Blum Center for Developing Economies.



Graphic content:

He's not quite faster than a speeding bullet, but Bertrand Russell achieves superhero status in the new graphic novel *Logicomix*, coauthored by Professor Christos Papadimitriou of electrical engineering & computer sciences and Greek writer Apostolos Doxiadis. Released in the U.S. and U.K. in September, the book follows Russell, world-famous British mathematician, logician and philosopher known for his *Principia Mathematica*, as he battles failed romance, incarceration and brushes with madness of all sorts in his lifelong pursuit of rationality and the foundations of mathematics. For Web extras, visit *Forefront* online at **www.coe.berkeley.edu/news-center/publications/forefront/**.

New research center to focus on sustainable nuclear energy

The future of sustainable nuclear energy just got a boost with a $3.8 million award from UC's Office of the President Lab Fees Research Program. The award will fund the new Berkeley Nuclear Research Center (BNRC), which will investigate next-generation nuclear technologies and national nuclear fuel cycle policy.

The BNRC will combine the expertise of UC Berkeley with Lawrence Livermore (LLNL) and Los Alamos (LANL) National Laboratories to provide R&D and strategic leadership on sustainable, safe, secure and affordable nuclear energy. The focus will be on advanced fuel cycle technologies, waste repositories, environmental impact, regulation, nuclear security and nonproliferation, with particular emphasis on Asia-Pacific countries, where nuclear technologies are already undergoing major growth.

"Nuclear energy in the United States has been neglected for more than 25 years," said Jasmina Vujic, nuclear engineering professor and BNRC co-director. "The BNRC will infuse new young talent into our aging workforce and encourage open and timely discussion of the challenges and opportunities of expanding nuclear energy on a global scale."

David McCallen, LLNL deputy principal associate director for national security, Global Security Principal Directorate, will serve as BNRC director. For more, go to **http://bnrc.berkeley.edu.**

newsmakers

MORE NEWSMAKERS **www.coe.berkeley.edu/news-center**

MANEESH AGRAWALA

(EECS) receives a MacArthur "genius" award for his work on algorithms and other tools to help users distill computerized information.

RUZENA BAJCSY (EECS) receives the Anita Borg Technical Leadership Award for contributions to the women's technology community.

In MSE, the TMS names **JAMES W. EVANS** a 2010 fellow and honors **EUGENE E. HALLER** with the 2010 John Bardeen Award.

ASHOK GADGIL (CEE) is

among 10 recognized by the Heinz Family Foundation for his efforts to improve energy efficiency in buildings and life in developing countries.

ALLEN GOLDSTEIN (CEE) lands on *Scientific American*'s list of "10 Important Atmospheric Science Experiments" for his research on plant-released volatile organic compounds.

In EECS, the IEEE honors **SUSAN GRAHAM** with the 2009 John Von Neumann Medal, **CHENMING HU** with the 2009 Jun-Ichi Nishizawa Medal, **IVAN KAMINOW** with the 2010 Photonic Award, **ERNEST S. KUH** with the 2009 Gustav Robert Kirchoff Award and **TSU-JAE KING LIU** with the 2010 Kiyo

Tomiyasu Award.

The NSF grants CAREER awards to **TOM GRIFFITHS, ALI JAVEY, MICHEL MAHARBIZ** and **YUN SONG** (all EECS), along with **FRANCESCO BORRELLI** (ME).

HELP US GREEN UP OUR ACT!

Although slimmer than previous issues, this fall's *Forefront* is full of great content about our talented faculty, students, alumni, events and other activities at UC Berkeley College of Engineering. But did you know that *Forefront* lives online too? In case you prefer pixels to pages, find our current issue at **www.coe.berkeley.edu/news-center/publications/forefront.** (If you wish, click on "contact us" to opt out of receiving the publication by mail.)

As we work to conserve resources and live within our means, we encourage you to subscribe to our online monthly, *Innovations*, the easiest way to get regularly scheduled news blasts from Berkeley Engineering (go to **http://innovations.coe.berkeley.edu**). To be added to the e-mail distribution, please send your e-mail address to **innovations@coe.berkeley.edu.**

Whether your preference is for print or electronic, please stay in touch! And thanks for your continued interest in Berkeley Engineering.

High on engineering

About 800 seniors who graduated from Berkeley Engineering last May faced one of the bleakest job markets in years. But on the bright side, *U.S. News & World Report* ranked engineering high on its list of "Best Careers 2009." Among the highest-paid bachelor's level professionals, engineers are being hired in industries starving for innovation and new ideas, the report says, with the most secure jobs in the government sector. In particularly high demand are biomedical and computer engineers, as well as mechanical and nuclear engineers as the nation pushes toward greater energy efficiency, energy independence and alternative energy sources. An August report by the Bureau of Labor Statistics said the number of high-tech payrolls offered in Silicon Valley shrank by about 17 percent between 2001 and 2008, a trend that is projected to continue. But the average tech wage increased nearly 36 percent, the report said; and, although employers are cutting mid-level jobs that can be done more cheaply through automation or offshoring, opportunities for advancement remain for those with specialized college or graduate degrees.

PEG SKORPINSKI

ALI JAVEY and **DAWN SONG** (both of EECS) are among 35 scientists named to *Technology Review's* "Top 10 Innovators Under 35."

Rolling Stone names **JAY KEASLING** (BioE, ChemE)

one of "100 Agents of Change," along with Al Gore, Bill Gates and President Barack Obama.

SANJAY KUMAR (BioE) is among 100 young researchers to receive a PECASE, the Presidential Early Career Award for Scientists and Engineers.

LUKE LEE (BioE) wins the 2009 IEEE Engineering in Medicine and Biology Society William J. Morlock Award.

GEORGE LEITMANN (ME) receives the AACC Richard E. Bellman Control Heritage Award.

ARUN MAJUMDAR (ME/MSE) is appointed to direct the Advanced Research Projects Agency-

Energy, a new federal agency supporting technologies to improve energy efficiency and reduce emissions and foreign oil dependence.

KRISTOFER PISTER (EECS) receives the 2009 ISA Albert F. Sperry Founder Award, recognizing his outstanding contributions to the automation industry.

ROBERT RITCHIE (MSE) wins the 2010 TMS Institute of Metals Lecture and Robert Franklin Mehl Award.

TING XU (MSE) is honored

with the ONR Young Investigator Award for her work on nanocomposites for energy storage and is featured in *Popular Science's* 2009 "Brilliant 10" top young scientists.

AACC American Automatic Control Council
IEEE Institute of Electrical and Electronics Engineers
ISA International Society of Automation
NSF National Science Foundation
ONR Office of Naval Research
TMS Minerals, Metals and Materials Society

Breakthroughs

BERKELEY RESEARCH AT THE ENGINEERING FOREFRONT

MORE BREAKTHROUGHS **www.coe.berkeley.edu/news-center**

DON'T STAY HOME WITHOUT IT

First-generation smart thermostats were introduced during the 1970s oil crisis to save money and energy, but they were so complicated that only 20 percent of Californians actually programmed them. Working with fellow engineers, policy wonks and utilities, mechanical engineer David Auslander is evolving such devices to higher levels of sophistication. The new thermostat now being developed could be programmed to regulate air conditioning and heating as well as communicate with other appliances to conserve on power consumption. It has a built-in module that could receive periodic updates on electricity prices and download cost-saving preset heating and cooling schedules from the Internet.
http://innovations.coe.berkeley.edu/vol3-issue6-aug09/thermostat

COURTESY THE RESEARCHERS

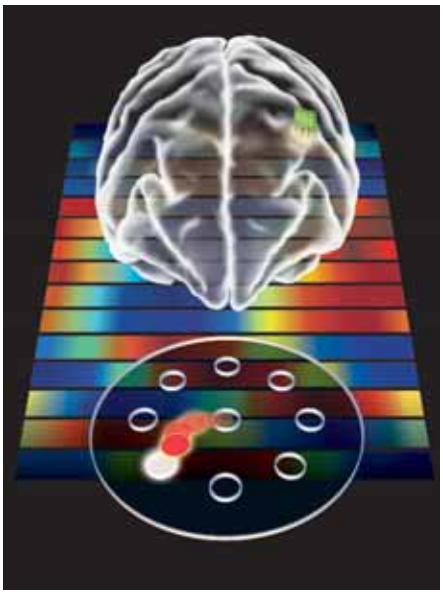
FAST BRAKE

Francesco Borrelli of mechanical engineering and team are working with Ford Motor Company to test an auto control system that does the driving for you when things get hairy. At speeds of 40 miles per hour, even on slick ice, the car can swerve suddenly to avoid obstacles by correcting the steering and operating each tire's brake independently. Companion studies are looking into car-mounted cameras, smart tires and body sensors to detect drunken drivers. The various devices feed the vehicle data about its environment, which its control system then integrates with speed and position by scanning surroundings every 50 milliseconds. Human reaction time is about 1.5 seconds. Which would you trust?

http://ieeexplore.ieee.org/ielx5/4433643/4433644/04433694.pdf?arnumber=4433694

Practice makes perfect

That's the maxim drummed into students struggling to learn any new motor skill, from riding a bike to developing a killer backhand in tennis. New research by Jose Carmena and postdoc Karunesh Ganguly of electrical engineering and computer sciences reveals for the first time that the brain can also achieve this motor memory with a disembodied device. In their study, published in *PLoS Biology*, macaque monkeys using brain signals learned how to move a computer cursor to various targets. They developed a stable, mental representation of a solution to achieve the task with high proficiency that could be rapidly recalled and was resistant to unlearning. These results, the researchers say, provide hope that physically disabled people could one day master control of disembodied devices like artificial limbs almost as effortlessly as they control their own body parts.
www.plosbiology.org/article/info:doi/10.1371/journal.pbio.0000042



©JOHN BLANCHARD ILLUSTRATION

Beetle mania


COURTESY THE RESEARCHERS

In January, Professor Michel Maharbiz and postdoctoral researcher Hirotaka Sato, both of electrical engineering and computer sciences, demonstrated the first wireless control of a rhinoceros beetle at the Institute of Electrical and Electronics Engineers' MEMS conference in Italy. Implanted on the live insect: six electrodes, a microprocessor, a radio receiver and a microbattery. Using a laptop to deliver commands to a base station, the researchers sent radio signals to the beetle's gear, stimulating the brain and flight muscles to fly, turn and hover. Maharbiz, director of the Berkeley Sensor & Actuator Center, says the DARPA-funded research could elucidate the neurobiology and biomechanics of insect flight, and the cyborg beetles could be used in the future for delicate search-and-rescue or surveillance missions.

www.eecs.berkeley.edu/~maharbiz/Cyborg.html
http://frontiersin.org/integrativeneuroscience/paper/10.3389/neuro.07/024.2009/html/

SENSITIVE CELLS

COURTESY THE RESEARCHERS


Brain-like microenvironment


Tumor-like microenvironment

The growth and spread of glioblastoma multiforme (GBM)—the most common and deadly of all primary brain tumors—are driven by the ability of individual tumor cells to remodel and invade brain tissue. A recent study led by Sanjay Kumar of bioengineering and published in *Cancer Research* demonstrates for the first time that the motility and proliferation rate of GBM tumor cells are highly sensitive to the mechanical properties of the surrounding environment. The findings offer new insight into how brain tumors spread and suggest that cancer-fighting drugs could target the cellular systems that sense and process mechanical signals.
http://cancerres.aacrjournals.org/cgi/content/full/69/10/4167

Forecast: HEAVY CLOUDS

Clouds on the horizon don't necessarily mean rain on your parade. In fact, they could signal easy access to high-performance computing. Clouds refer to large clusters of computers or data centers—mega-machines operated by Yahoo!, Google, Amazon, Microsoft and the like—that don't run at 100 percent capacity 24/7. This downtime represents computational capacity that can be accessed through the Internet on a pay-as-you-go basis. To explore potential applications, Yahoo! has expanded its cloud computing partnerships to include UC Berkeley. Masoud Nikravesh, CITRIS director of computational science and engineering, is leading the effort, with more than 100 faculty and students from bioengineering to astronomy now using Yahoo's M45 cluster to run simulations and tests. Berkeley's RAD Lab began a cloud initiative of its own this year with a white paper, blog and presentation called *Above the Clouds*, outlining why cloud computing is *the* platform of the next decade.

http://cloud.citris-uc.org/
http://berkeleyclouds.blogspot.com/

COURTESY CONCRETE CANOE TEAM

Heavyweight Champs

Concrete canoe team takes national title

At the 2009 National Concrete Canoe Competition, a team of Berkeley civil engineers took home the championship trophy and a $5,000 scholarship after defeating 21 rivals at the University of Alabama in Tuscaloosa last June.

Cal credits its first national championship since 1992 to smart technical decisions, organized leadership and 25 highly committed members who spent hours of their spare time designing and building this year's canoe.

"We put to work what we learn in the classroom," says team member Justin Beutel, a civil and environmental engineering junior. "We have to solve real problems, and they're not just engineering problems. It's dealing with people and working on a team."

At the Cal vs. Oregon State football game on November 7, the team was honored at Memorial Stadium for its achievement, but it won't be resting on its laurels. The 2010 Cal concrete canoe awaits.

BY RACHEL SHAFER

We're no. 1: ***Members of the 2009 Concrete Canoe team clocked a total of 6,400 work hours to complete their grand opus, Bear Area, a 230-pound beauty with decorative graphics made of colored concrete slip that depict familiar sights like the San Francisco skyline.***

COURTESY CONCRETE CANOE TEAM

Roll on, you bears: ***Team members press thin layers of concrete mixture into Bear Area's mold, reinforcing each layer with carbon fiber scrim. Cal's special concrete recipe included K1 glass microspheres and recycled glass beads, a specialty aggregate composed of microscopic bubbles that gave the canoe its signature floatability.***

GARY TRAMONTINA

Sprint to the finish: ***Team members and CEE students (from left) Danielle Des Champs, Melissa Chin and Kimberly Leung race Bear Area across Alabama's Lake Nicol in the women's sprint event, one of five timed races. The competition, as much brains as brawn, also requires a technical design paper, formal oral presentation and answering questions at a tradeshow-style display.***

Biology + Engineering = Greater than the sum of its parts

BERKELEY BIOENGINEERING REFLECTS ON THE ROAD AHEAD

BY RACHEL SHAFER

To find the newest department in the College of Engineering, just head uphill. A short stroll from Hearst Memorial Mining Building—its grand elegance representing 141 years of Berkeley Engineering excellence—is Stanley Hall, a beautiful and thoroughly modern science building that opened two years ago. Inside, you'll find the gleaming, light-filled offices of the Department of Bioengineering.

Here, professors are helping to pioneer a discipline so new that none of them majored in it, and they inevitably get the question: What is bioengineering, exactly? The answer is deceptively simple: bioengineers convert their knowledge of biology into useful technologies. Some of it is what you might expect: low-cost MRIs and cell phones-cum-microscopes. It's also the unexpected: innovative new nano tools for tissue regeneration and manipulating the natural processes of bacteria and yeast to produce better biofuels. It might also include creating systems for customizing therapies or managing medical records.

Such broad possibility owes its existence to the revolutionary changes in biology itself. In particular, scientists have made extraordinary advances over the last two decades in molecular and cell biology that have illuminated the function and structure of proteins and the full genetic content of organisms, enabling development of such techniques as genome sequencing and the polymerase chain reaction. Parallel advancements in bioinformatics—like more sophisticated instrumentation, faster computers and enormous databases—have enabled bioengineers to make speedy progress in such areas as stem cell engineering, synthetic biology and biomechanics.

COURTESY ZGF ARCHITECTS LLP

PEG SKORPINSKI PHOTOS

Joining Karen Rhodes, Berkeley Engineering director of marketing and communications (at head of table), for a roundtable discussion are bioengineering professors (from left) Chris Anderson, Dorian Liepmann (former chair), Matthew Tirrell, Steve Conolly, Amy Herr and Sanjay Kumar.

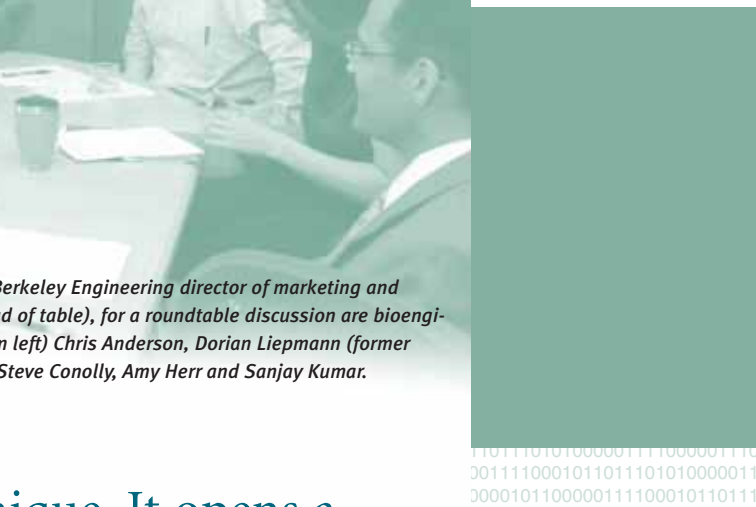
> "Bioengineering is huge and it's unique. It opens a window for engineering into biology and medicine."
>
> —MATTHEW TIRRELL

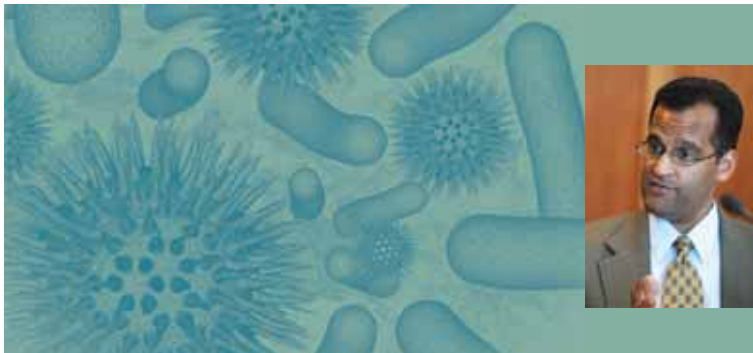
New knowledge yielded new problems, and bioengineering departments cropped up to find applied solutions and prepare young people for careers in this burgeoning new field. Burgeoning indeed. The U.S. Department of Labor predicts the number of bioengineering jobs will increase by 21 percent from 2006 to 2016. (For comparison, the number of electrical engineering jobs will grow 3.7 percent.)

Berkeley launched its own department in 1998. The first undergraduate class attracted 387 applicants; last year 1,212 applied, and the average incoming GPA of admitted freshmen is consistently higher than the college average. Enrollment in the graduate program, administered jointly with UC San Francisco, has tripled. At the same time, the department expanded its teaching capacity from two core faculty members to 19 and from one class to more than 30. Research specialties gained focus: bioinstrumentation, biomaterials and nanotechnology, cell and tissue engineering, computational biology and systems and synthetic biology.

"Bioengineering is huge and it's unique. It opens a window for engineering into biology and medicine," says Matthew Tirrell, who in July was appointed department chair and Arnold and Barbara Silverman Professor of Bioengineering, Materials Science & Engineering and Chemical Engineering. As dean of UC Santa Barbara's College of Engineering for the past 10 years, Tirrell increased research funding and established new programs. He also helped improve the college's rankings, something he hopes to accomplish here. (Berkeley's undergraduate bioengineering program is ranked 14th by *U.S. News & World Report*, lower than it expects of itself.) Tirrell's charge is to help the Department of Bioengineering secure a position of international prominence and become the next illustrious chapter in Berkeley Engineering's history.

Forefront invited Tirrell and five other professors to sit down for a roundtable discussion to explore bioengineering's future and Berkeley's unique place in it. See the next page for highlights.





BIOENGINEERING: THE NEXT GENERATION

Roundtable excerpts from some of Berkeley's newest bioengineering professors

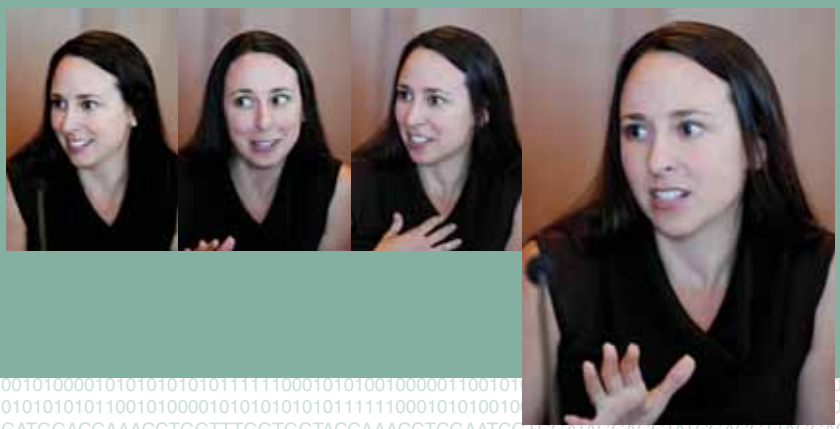
To see the video, go to **www.coe.berkeley.edu/forefront/bioengineering.**

"Tissue and biomolecular engineering—traditionally those have been part of the biology department. But what we're doing in those areas is so different: it's making a product and a process versus understanding the natural systems. Suddenly, you're in applied mode. It belongs in engineering and requires the development of courses geared toward teaching people how to make such objects."

ASSISTANT PROFESSOR CHRIS ANDERSON, whose work focuses on synthetic biology, completed his Ph.D. in chemistry.

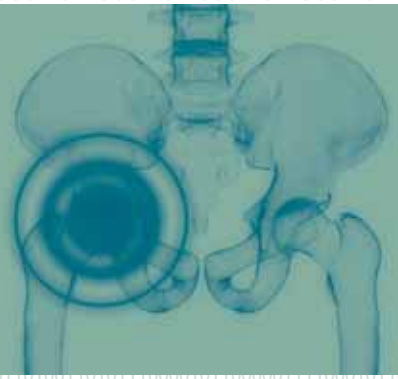
"We have to expose our students to ambiguity. As engineers, we confront big, messy, technical problems every day. To give our undergraduates a taste of engineering in the real world, we've developed a course that challenges them to apply their know-how to ill-defined problems in clinical medicine and basic science. The desire to make a positive societal impact radiates from Berkeley students . . . They hunger for such experiences."

ASSISTANT PROFESSOR AMY HERR is a mechanical engineer specializing in microfluidics.



"People [are surviving with] cancer and Type 2 diabetes for 20 years now, which means doctors will be treating those diseases for 20 years. We honestly haven't figured out how we'll afford that. It's a natural role for engineers to use information technology to do monitoring with point-of-care at the home and try to create something that's affordable."

ASSOCIATE PROFESSOR STEVE CONOLLY is an electrical engineer whose work focuses on cost-efficient and innovative biomedical imaging.



"We shouldn't limit our definition of bioenergy to the exploitation of biological systems to generate fuels, which is certainly a very worthy thing to do. We should also try to understand how biological systems handle their own energy problems and ask if we can mimic those principles to create new technological solutions."

ASSISTANT PROFESSOR SANJAY KUMAR is a biophysicist and medical doctor whose research focuses on cell structure and mechanics and their role in disease processes.

The Big Deal about

What is nano and how will it change your life?

BY PAUL SPINRAD

In first-year physics, students learn that atoms change their level of excitation as their orbiting electrons jump between higher and lower level orbits. They also learn that each element emits a characteristic mix of colors based on its set of possible electron jumps. This is the element's emission spectrum, and it's roughly the same for a bulk sample of that element as it is for an individual atom.

But, at a small enough scale—below a certain quantum limit—a collection of atoms no longer exhibits this bulk behavior. Its emission spectrum depends on the number and arrangement of atoms it contains, and adding or subtracting a single atom changes the colors it emits. By fine-tuning the composition of these quantum dots, engineers can make them give off any colors they want. It's the same for other properties of matter: strength, sonic properties, chemical behavior, electrical conductivity. Working at these scales, the old rules no longer apply. Here, it's possible to get behind the curtain of reality and work with a more fundamental and flexible palette of possibilities.

This is the power of nano. In literal terms, nano simply refers to things on the scale of a nanometer, one billionth of one meter. But what excites the nearly 100 UC Berkeley faculty now working in nano research isn't just going smaller. It's using unique nanoscale properties to create materials and devices that have the capacity to do the previously impossible.

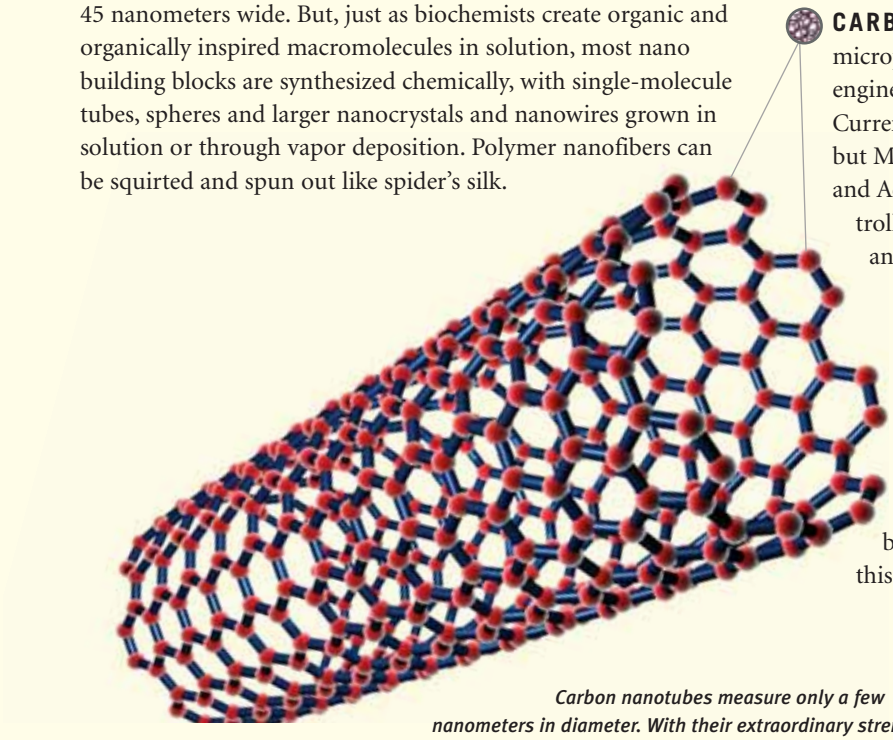
Nanotechnology emerged in the late 1980s, when physicists first visualized molecules with scanning microscopes and chemists discovered carbon molecules with new shapes like buckyballs and nanotubes that had unique properties. The concept of nano was first articulated in 1959 by American physicist Richard Feynman, the term first used in 1974 by Japanese electrical engineer Norio Taniguchi, and the idea exposed to the popular consciousness in 1986 by American molecular scientist and engineer Kim Eric Drexler.

These origins bear witness to the interdisciplinary roots of nano research, which at Berkeley involves several specialized groups uniting faculty from chemistry and physics, bioengineering, materials science and other departments. Coordinating these efforts is BNNI, Berkeley Nanosciences and Nanoengineering Institute (**http://nano.berkeley.edu**), the umbrella organization for campus nano research, especially on the non-biomedical side. (Life sciences–based nano research is covered by QB3, the California Institute for Quantitative Biosciences.)

"At their core, nanoscience and nanotech are interdisciplinary," explains BNNI director Ramamoorthy Ramesh, also professor of materials science & engineering and physics. "You need chemists who can synthesize the materials at this scale, physicists who can probe their properties, theorists who can build predictive models for their behavior and engineers from multiple disciplines who can put them into platforms." Enthusiasm for nano at Berkeley Engineering is high and, not surprisingly, the campus has been ranked consistently at or near the top among research universities by the micro and nanotech trade magazine *Small Times.*

"Given the bandwidth at Berkeley, it's one of the largest nano research efforts," Ramesh says. Berkeley's program benefits from its proximity to, and overlaps significantly with, Lawrence Berkeley National Lab (LBNL). Much of the funding for nano research comes from federal sources, including the National Science Foundation, the Departments of Energy and Defense and the National Institutes of Health, as well as the semiconductor and biomedical industries.

How do you make such small objects in the first place? Top-down techniques such as photolithography can create structures like Intel's newest microprocessors, with printed wires measuring 45 nanometers wide. But, just as biochemists create organic and organically inspired macromolecules in solution, most nano building blocks are synthesized chemically, with single-molecule tubes, spheres and larger nanocrystals and nanowires grown in solution or through vapor deposition. Polymer nanofibers can be squirted and spun out like spider's silk.



Carbon nanotubes measure only a few nanometers in diameter. With their extraordinary strength, efficient thermal conductivity and high surface-area-to-volume ratio, they have multiple potential applications in electronics, optics and materials science.

Components at the nanoscale are made in clean, controlled environments like the new Marvell Nanofabrication Lab in Sutardja Dai Hall and LBNL's Molecular Foundry. The clean rooms prevent dust from interfering with production and keep nanoparticles out of the environment for safety reasons. Although nanoscale carbon forms occur naturally in soot, and carbon nanotubes can damage lung tissue if inhaled, little is known about the possible hazards of nanoengineered materials and how they behave in the environment. Nano research at Berkeley and other major research centers is heavily regulated and complies with state and federal occupational health and safety regulations.

Nanotechnology has already hit the marketplace in the form of such products as stain-resistant fabrics, protective coatings in paints, and cosmetics with colloidal nanoparticles that help bind the product to skin. In biomedicine, nano-enabled anticancer therapies are already in clinical trials, and some types of tissue regeneration could become reality in the next few years. Microprocessor chips based on nanostructures are still several years off, but traditional top-down semiconductor fabrication techniques have already reached the nanometer scale.

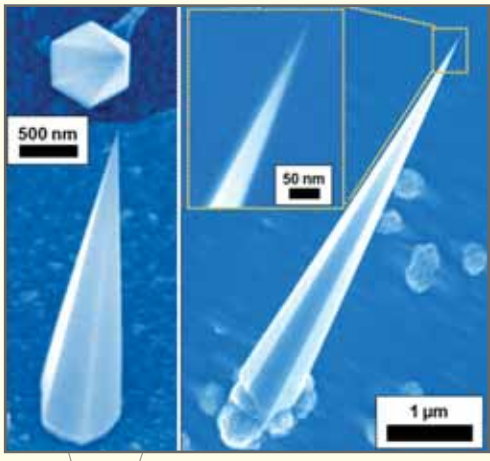
A full account of nano research on the Berkeley campus would require volumes, but here's a nanoscale summary of three strong areas.

INFORMATION TECHNOLOGY

In the semiconductor industry, it's nano or bust. Chips have been getting smaller and more powerful for decades, but the manufacturing process is approaching its physical limits. The only way to break those barriers will be some form of nanotechnology.

CARBON NANOTUBES One leading concept is to build microprocessors out of carbon nanotubes, nanostructures engineered to store data and perform logic operations. Current methods of producing them are difficult to control, but Ming Wu (EECS) and colleagues at the Berkeley Sensor and Actuator Center are working on electrostatically controlled and laser-powered "nanotweezers" that could sort and assemble components into circuits at high speed.

DNA SCAFFOLDS Jeffrey Bokor (EECS) and others use custom DNA strands that attach only to matching strands to create "smart-tape" scaffolds for nano self-assembly. By designing a sequence of liquid washes, DNA strands and chemicals that link the two together, it's possible to mass assemble arbitrary numbers of nanostructures in parallel. Refinements are still needed, but as the library of linker chemicals grows and improves, this method will support more complex assemblies.



COURTESY CONNIE CHANG-HASNAIN

This gallium arsenide nanoneedle is the sharpest point she's seen, says Connie Chang-Hasnain (EECS), who discovered it on silicon while exploring methods to monolithically integrate dissimilar single crystals. The nanoneedle has the capacity to convert single photons into more than 100 cascades of electrical charge, giving them potential as both optical detectors and solar cells.

BEYOND ELECTRICITY Farther out, nanocomputers might not even be based on electricity; any other characteristic of matter and energy that has two states can represent logic. Researchers Connie Chang-Hasnain and Eli Yablonovitch (both EECS) are working on nanocomputing and networking using light rather than electrons. Alex Zettl (Physics) has demonstrated a rewritable memory element based on the physical position of an iron nanoparticle inside a multi-walled carbon nanotube that, packed densely, would store more information and last longer than current flash memory. Jeffrey Bokor (EECS) and others are investigating spintronics—computing based on particle spin direction—and other phenomena like mechanical deformation and magnetism that might consume less energy and generate less waste heat than electronics.

COURTESY TING XU

This atomic force microscope image shows a highly ordered arrangement of nanoscale dots, each just 3 nanometers in size. The ultra-dense material, the work of Ting Xu (MSE) and colleagues, could make it possible to store the contents of 250 DVDs in an area the size of a U.S. quarter.

BEYOND TRADITIONAL COMPUTING At the nanoscale, quantum effects can influence electron behavior, opening the possibility for a fundamentally different form of information processing. Quantum computing is based on qubits, which, unlike binary bits, can exist in three states: 0, 1, or a third, uncertain state that influences other uncertain qubits and remains unknown until read. Using logic tailored to these qubits, quantum computers can run some calculations, especially those involving factoring large numbers, far faster than conventional computers. In the area of storage, Ting Xu (MSE) is fabricating copolymer thin films that can self assemble into a precise pattern when spread out on a surface, like soldiers lining up in perfect formation, providing super-dense storage capacity that could transform the storage industry.

ENERGY AND THE ENVIRONMENT

Engineering matter and energy at the nanoscale offers potential macroscale applications that could provide opportunities to generate energy more efficiently and conserve precious resources.

THERMOELECTRICS One promising area is thermoelectric generators, aka Peltier devices, which, with no moving parts, convert temperature differences into electricity. Originally invented in the 19th century, these devices are inefficient because they conduct heat as well as electricity. But Arun Majumdar (ME, MSE) and colleagues are developing specialized materials with embedded nanostructures, pores or rough surfaces that block heat but not electrons—an unnatural combination of properties that could turn these generators into sources of electricity for use almost anywhere.

SOLAR POWER Nano has already made traditional photovoltaics cheaper, and Berkeley researchers are onto even more revolutionary approaches. Paul Alivisatos (Chemistry, MSE) is developing solar cells from quantum dots of semiconductors, which can capture a wider spectrum of light than current models and convert more photon energy into electricity rather than heat. Ali Javey (EECS) and colleagues are growing highly ordered, single-crystalline nanopillar arrays of optically active

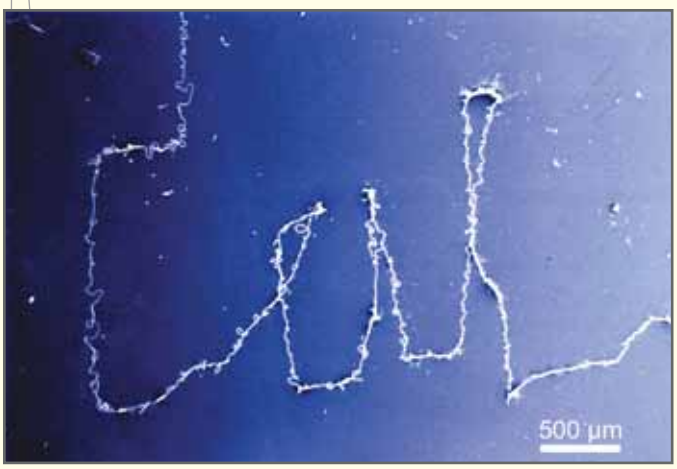
COURTESY ALI JAVEY

This scanning electron microscopic image of single-crystalline nanopillar cells of optically active semiconductor on aluminum substrate, grown by Ali Javey (EECS) and his team, could facilitate production of highly efficient and cost-effective photovoltaic solar cells.

semiconductors that could produce highly efficient and cost-effective photovoltaic solar cells. Connie Chang-Hasnain (EECS) has discovered nanoneedle crystals that convert single photons into cascades of electrical charge, giving them potential as both optical detectors and solar cells.

BATTERIES AND FUEL Berkeley-based startup Seeo, founded by Mohit Singh (LBNL), is developing rechargeable lithium batteries, safer and more powerful than conventional batteries because they're filled with a nanostructured polymer electrolyte instead of a liquid. Peidong Yang (Chemistry, MSE) has found that silicon nanowires sheathed in titanium dioxide can catalyze atoms in water to split apart, using just the energy captured from sunlight, which could lead to a low-energy method for extracting hydrogen from water for use as fuel.

ENVIRONMENTAL MONITORING Polymer nanofibers produced using the electrospinning technique developed by Liwei Lin (ME) can be used as sensitive chemical detectors to pick up the presence of a single target molecule by how it affects the fiber's conductance. David Sedlak (CEE) has found that iron nanoparticle powder, in combination with certain catalysts, breaks down contaminants in groundwater.



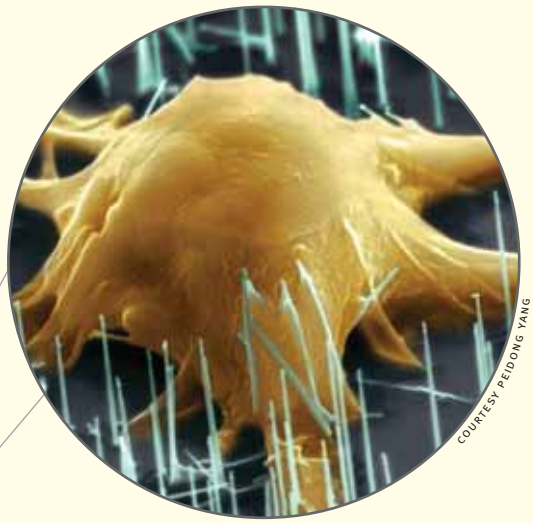
COURTESY LIWEI LIN

Liwei Lin and colleagues used near-field electrospinning to spell "Cal," demonstrating that nanofibers could be deposited in a controlled manner rather than the tangled mass resulting from earlier methods. The technique has potential for producing specialized wound dressings and chemical detectors.

BIOMEDICAL APPLICATIONS

Basic life processes work at the nanometer scale. Researchers are now learning to control many of these processes.

IMAGING LIVING CELLS Nanoscale imaging of living processes is a major challenge. The most powerful microscopes scan with a moving probe, so specimens must be flat and inanimate (or dead) and electrically conductive or sputtered with a conductor, like gold; this works for nanotubes and microchips, but not for living cells and tissues. Xiang Zhang (ME) is working on a "superlens" made from a sheet of nanostructured material that captures photons and directs them back to a focal point. Such a lens could capture near-field scattered light, which conventional optics lose, as well as images more detailed than the half-wavelength limit of conventional optics. Luke Lee (BioE) is imaging the composition of cells by introducing a gold nanoparticle "probe" that can analyze how light scatters between it and neighboring molecules.



COURTESY PEIDONG YANG

This scanning electron microscopic image shows a mouse embryonic stem cell cultured on an array of silicon nanowires, the work of Peidong Yang (Chemistry, MSE). The wires measure from 1 to several hundred nanometers across, the cell about 10 micrometers.

STEM CELLS Using the ability of stem cells to differentiate based on physical cues from the surfaces they contact, Sanjay Kumar (BioE) is using nanoengineered scaffolding to grow and study specific tissue types. Stem cells respond to physical, chemical and mechanical stimuli; Peidong Yang (Chemistry, MSE) and colleagues have demonstrated that they might also respond to electrical potentiality by using tiny nanowires to stimulate stem cells to differentiate. Seung-Wuk Lee (also BioE) pioneered a possible therapy for spinal cord repair using the M13 bacteriophage, a long, thin virus whose outer coat can be engineered to grow nanostructures. In contact with existing mature nerve cells, the modified viruses align together, forming a scaffold that stimulates progenitor nerve cells to mature into long neurons and repair the damage.

NANOFLUIDICS The flow of liquids and gases through nanotubes and nanopores can be finely controlled, increasing the sophistication of tiny "lab-on-a-chip" devices that can speed and reduce the cost of fluid analysis. Lydia Sohn (ME) is developing the nanocytometer, an artificial pore that measures cells one by one for conductance and attraction to antibodies, facilitating identification of cancer cells in a given sample. By applying electricity to the fluid, dissolved ions can be shuttled around, which is how Arun Majumdar (ME, MSE), Peidong Yang (Chemistry, MSE) and colleagues created the first nanofluidic transistor.

Class notes

Keep in touch by mailing your news and photos to *Forefront* Class Notes, UC Berkeley College of Engineering, 312 McLaughlin Hall #1704, Berkeley, CA 94720-1704. Or go to **www.coe.berkeley.edu/alumni/class-notes** and click on "*Submit a new Class Note*."

MORE ALUMNI NEWS **www.coe.berkeley.edu/alumni**

2000s

CECILIA R. ARAGON (M.S.'87, Ph.D.'04 EECS) of Berkeley received the Presidential Early Career for Scientists and Engineers (PECASE) Award for her research in scientific workflow management, including development of visualization, analysis and organization methods for large data sets. She is staff scientist at Lawrence Berkeley National Lab's Computational Research Division.

GEORGE A. BAN-WEISS (B.S.'03, M.S.'05, Ph.D.'08 ME) of Palo Alto is a postdoctoral researcher at Stanford's Carnegie Institution for Science, investigating the impact of

aerosols and land-use change on global climate. Also a successful jazz bassist, he plays with the San Francisco–based Mads Tolling Quartet, which released a new CD in October, and previously recorded two CDs with the Mitch Marcus Quintet. **www.myspace.com/georgebanweiss**

WAKOVA A. CARTER (B.S.'00 EECS) writes, "I am living in Houston, Texas, and working for oilfield services company Schlumberger as a project manager. When I'm not working, I enjoy the Southern sun at the pool."

DINO DI CARLO (B.S.'02, Ph.D.'06 BioE) is an assis-

tant professor of bioengineering at UCLA, with six graduate students and a postdoctoral fellow working in his lab on new methods in microfluidics for early cancer diagnostics and personalized cancer therapy. He writes, "One of the motivations is an inexpensive blood test for early detection of cancer, which can lead to very effective life-saving treatments before cancer spreads."

JONATHAN D. ELKIN

(B.S.'03 ME, M.Eng.'06 Ocean Engineering) of Tiburon, California, is a captain for the Blue and Gold Fleet ferry between San Francisco and Vallejo, Oakland/Alameda, Sausalito, Tiburon and Angel Island. Under his command are the Gemini green ferry and a high-speed, water jet–propelled boat out of Pier 39. He's also a naval architect at Jeppesen Marine, a division of Boeing, where he works on software for large ships to plan transoceanic routes that avoid foul weather, conserve fuel and arrive on time. He received the 2008 Graduate Paper Honor Prize from the Society of Naval Architects and Marine Engineers for his paper, *Hydrodynamic peculiarities of catamaran-like hull sections*.

MUSTAFA ERGEN (B.S.'02, Ph.D.'04 EECS) of Oakland, California, wrote his second book five years after he graduated. Entitled *Mobile Broadband—Including WiMAX and LTE*, the book covers mobile broadband communication and upcoming 4G systems, the topics Ergen has been involved in heavily through his startup.

VINCENT RUBINO (B.S.'01 BioE) worked at Bayer Healthcare Pharmaceuticals in Berkeley for seven years in equipment validation, facility engineering and quality assurance. His last project was QA support for construction and qualification of a $50M biopharmaceutical manufacturing facility. Since 2007 he has lived in South Korea, where he is the first and only foreigner to work at his Korean research institute, specializing in nanotoxicity studies. He is also a South Korean delegate to the

International Organization for Standardization (ISO) Technical Committee 229: Nanotechnologies and is ISO project leader for developing a regulatory guide for nanomaterials.

PRIYA SREEDHARAN (M.S.'01, Ph.D.'07 ME) of Plymouth, Michigan, is a Science and Technology Policy Fellow of the American Association for the Advancement of Science, working with the Office of Atmospheric Programs of the U.S. Environmental Protection Agency.

QIAN WANG (M.S.'00 CEE) writes, "I just bought a house in the beautiful city of Chino Hills in Southern California. I'm working toward obtaining my structural engineering title and license."

ALISEYA WRIGHT (M.S.'05 CS) of Oakland, California, took a brief pause from creating innovative web video applications at Yahoo! to create . . . a baby! Mya Yasmine Mokeddem was born on March 28, 2009.

1990s

ROBERT L. BERTINI (Ph.D.'99 CEE) of Portland, Oregon, was named deputy administrator of the Research and Innovative Technology Administration, which coordinates the U.S. Department of Transportation's research programs and advances cross-cutting technologies in the nation's transportation system. A professor at Portland State since 2000, Bertini headed the Oregon Transportation Research and Education Consortium and developed the university's graduate program in intelligent transportation systems.

Juels

Aragon

COURTESY DOMÈNEC JOLIS AND JON LOIACONO

MEEI-LIH AHMAD

Berkeley alumni and PUC engineers (from left) Domènec Jolis (Ph.D.'92 CEE) and Jon Loiacono (B.S.'72 CEE) are driving San Francisco's brown grease project to recycle cooking grease. "The utilities need to look at these issues more holistically," Jolis says.

From bacon to biofuel

Brown grease—a nasty mélange of leftover animal fat, pan scrapings and other gunk—is a sewer pipe's worst enemy. In San Francisco, a demonstration project led by two Berkeley Engineering alumni is in the works to explore for the first time how the state's wastewater treatment plants might turn the unappealing stuff into biodiesel fuel.

Installation of the test facility is now under way at the city's Oceanside Water Pollution Control Plant near San Francisco Zoo. Built on skids for easy transport, each day it will churn out 300 gallons of biodiesel, converted from brown grease that typically winds up in restaurant grease traps or causes trouble when improperly flushed down the drain. The $4 million project is supported by the California Energy Commission and the City of San Francisco as well as federal sources.

"For the city, it's going to be a win-win situation," says Domènec Jolis (Ph.D.'92 CEE), senior engineer at the San Francisco Public Utilities Commission (SFPUC) and the project's co-principal investigator. The effort could prevent messy and costly sewer backups and generate fuel for city vehicles and equipment as well as energy to run the sewage plant itself. Serving as project manager is SFPUC principal engineer Jon Loiacono (B.S.'72 CEE). Jolis and Loiacono hope to be up and running by January 2010 and operate for one year, with a primary goal of providing a model for public agencies statewide to set up similar programs.

"We're showing that the technology works, that it can be made commercially viable and that it has a synergy with wastewater treatment plants," Jolis says. The SFPUC will contract with outside vendors to provide and process the gunk, which must be screened several times to remove solid material ("bones, forks, napkins, you name it," Jolis adds) and heated so it won't congeal. Then it undergoes transesterification, a chemical process that involves adding methanol and a catalyst, usually an acid. The resulting products are glycerin, which is removed, and methyl ester, or biodiesel.

Brown grease recovery differs from the process for converting used cooking oil, "yellow grease," into biodiesel. Through the SFGreasecycle program, San Francisco is already turning 20,000 gallons of yellow grease each month into biodiesel for city vehicles, says Karri Ving, biofuel coordinator for the SFPUC.

But brown grease is more complicated and particularly troublesome when untreated, the engineers say. An SFPUC report estimates that nearly 70 million gallons of brown or trap grease are generated annually in California, and San Francisco alone spends an estimated $3.5 million clearing the sewer backups that result.

BY ABBY COHN

ARI JUELS (Ph.D.'96 EECS) of Brookline, Massachusetts, is chief scientist and director of RSA Laboratories in Cambridge. His new novel, *Tetraktys* (Emerald Bay Books), is a thriller hinging on concepts in cryptography that takes place partly within UC Berkeley's Department of Electrical Engineering and Computer Sciences. **www.ari-juels.com**

EDWARD L. KOSYDAR (M.S.'91 CEE) is a project management supervisor in Boise, Idaho.

YOUNG HOON KWAK (M.S.'92, Ph.D.'97 CE) of Potomac, Maryland, received the International Project Management Association's 2008 Outstanding Research Contribution Award.

WOJCIECH MATUSIK (B.S.'97 EECS) of Lexington, Massachusetts, is senior research scientist at Adobe Systems, Inc. He received the 2009 Significant New Researcher Award from ACM SIGGRAPH, the Association for Computing Machinery's Special Interest Group on Computer Graphics and Interactive Techniques. His computer graphics work includes virtual humans that interact with the environment, a wearable system for capturing human movement and a 3-D television system for acquiring and displaying data in real time.

1980s

YEW K. CHUAH (B.S.'82, Ph.D.'85 Eng Sci) of Taipei, Taiwan, is a professor at the National Taipei University of Technology.

ANDERSON E. "ANDY" HOWARD (B.S.'83, M.S.'85 EECS) of Santa Rosa, California, had worked since 1985 at Hewlett-Packard and recently took a position with Agilent Technologies. He works on applications of Agilent's RFIC, EDA and GoldenGate software.

KIM N. KING (Ph.D.'80 CS) of Atlanta has published the second edition of his best-selling book, *C Programming: A Modern Approach*. The new edition features complete coverage of both the C89 and C99 standards and has been updated to reflect today's CPUs and operating systems. King is an associate professor of computer science at Georgia State University. **www.knking.com.**

DENA R. TRAINA (B.S.'79, M.S.'80 CEE) writes, "After 17 years in Ohio, my husband and I are back in California." She is office manager for Kennedy/Jenks Consultants in their Reno office, and her husband, Samuel J. Traina (B.S.'78, Ph.D.'83 Soil Science), is vice chancellor for research at UC Merced.

DAVID NAM-PING WONG (M.S.'80 NE) of Commerce, California, writes, "It was a rather emotional feeling to accompany our son to the same college 30 years after!"

MICHAEL M. YANG (B.S.'83 EECS) is cofounder and chairman of Become, Inc., in Sunnyvale, a fully integrated Web-wide product search and comparison shopping site. **www.become.com**

1970s

PHILIPPE R. APRA (M.S.'76 CE) of Paris, France, is cofounder of Kappa Group International Consulting Engineers, consultants in energy engineering and project management.

PARTHASARATHI "PARTHA" CHAKRABARTI (M.S.'70, Ph.D.'73 CEE) directs structural engineering at Zentech, Inc., in Houston as partner and vice president of engineering. He visits India every year with his wife, Tapashi, and enjoys photography and astronomy.

REINHARD LUDKE (M.Eng.'76 CEE), of San Anselmo is senior vice president of Creegan + D'Angelo Engineers and was elected president of the Structural Engineers Association of Northern California. Born in Germany and raised on a rural farm in Seneca County, New York, he writes, "I am a country boy from New York State, now one of the national leaders for structural and earthquake engineering."

ARUN SARIN (M.S.'78 MSE) received the Global Indian of the Year Award last January, part of the 2009 Economic Times Awards for Corporate Excellence, presented by India's prime minister in Mumbai. Since graduating from UC Berkeley, Sarin has served as president and CEO of AirTouch Communications and CEO of Infospace and Vodafone Group Plc; he was appointed to a three-year term at the Bank of England's Court of Directors in 2005.

BOND M. YEE (B.S.'72, M.S.'73 CEE) is director of Parking and Transportation for San Francisco Municipal Transportation Agency. He's worked for the City and County of San Francisco since 1982 in areas including residential permit parking, red light camera enforcement, the Third Street Light Rail Transit Priority Project and SFgo, a real time, intelligent transportation management system. Under his watch, the city demolished and removed the Embarcadero Freeway, the Terminal Separation Structure and the Central Freeway, projects he says helped to revitalize several dormant neighborhoods.

1960s

VINCE DILWORTH (B.S.'67 ME) of San Ramon, California, has worked as senior program manager and director of the American Society of Mechanical Engineers since leaving United Airlines after 9/11. Dilworth also served as president of Berkeley Engineering Alumni Society.

NORMAN H. FRANKS (B.S.'68 ME) of Ukiah, California, works at DC Power Systems in Healdsburg, California, a full-service wholesale distributor of solar electric systems for business, residential and government applications.

STEPHEN R. KLINGER (B.S.'63 ME) of Manhattan Beach, California, writes, "Five years into retirement and enjoying it. My wife and I have been traveling over most of Europe's rivers and to Russia and Finland. We square dance a couple times a week and snow ski about 25 days a year. In late 2009 we will be traveling to Chile, Argentina and Brazil."

STANLEY H. LUCAS (B.S.'62 ME) of Long Beach, California, writes, "Restoring a standard gauge steam locomotive."

DAVID R. SELWAY (B.S.'61, M.S.'63 ME) is a docent at the Blackhawk Museum in Danville, California. He's restoring a 1967 McLaren M1C racing car with fellow Berkeley Engineering alumnus Fred Jessen (B.S.'63, M.S.'64 ME).

JOHN S. WOODWARD (B.S.'65 CEE) writes, "Retired, living near Arnold, California. Fishing, woodworking and volunteering at Calaveras Big Trees State Park."

PAUL S.L. WU (B.S.'63, M.S.'64 ME) retired from his job as a design engineer at Hewlett-Packard in 2008.

1950s

EDWARD W. COBLE (B.S.'51 CE) writes, "Moved from Los Altos to Walnut Creek last year. Too hot here!!"

DONALD H. LOLLICH (B.S.'51 ME) of Concord, California, retired in 1985 from Shell Oil after 34 years as a project engineer.

EVERETT W. MAGUIRE (B.S.'50 CEE) of Pacific Palisades, California, is a retired construction lawyer. He graduated from UCLA School of Law in 1957.

MARVIN L. SCHINNERER (B.S.'58 EECS) of Albany, California, writes, "Bike touring New Zealand and Australia since retirement in 1996. Also lead Sierra Club Wilderness trips."

JACOB SHPAK (B.S.'55 ME) of Walnut Creek, California, a former manager of engineering for C&H Sugar Company, writes, "Retired in 1991 after a most fulfilling engineering career and am now reconstructing my life after losing the love of my life, Margot."

DONALD S. TOOMB JR. (B.S.'51 Eng. Physics) of Claremont, California, retired from nuclear power development and satellite surveillance engineering and is now exploring amateur radio (call sign N6AFO).

ALBERT C. "CREW" WAITE JR. (B.S.'53 Eng. Physics) of Fort Collins, Colorado, retired after 40 years with Bell System, later Telecordia, in 1993. He and his wife, Joan, traveled to Peggy's Cove near Halifax, Nova Scotia, Canada, in 2008.

1940s

FREDERICK E. COOPER (B.S.'40 EECS) of Pasadena, California, writes, "I retired 32 years ago from my consulting engineering business. Now trying to teach disadvantaged young people how to earn money with their computers."

HARLEY M. MCCAMISH (B.A.'48 ChemE) of San Rafael writes, "I'm in a full-care retirement facility (a good one). Not up to much—I have most of the problems to be expected at my age."

JAMES M. MILLER ('49 EECS) of Lake Isabella, California, retired from McDonnell-Douglas Aircraft Company in 1982.

FRED W. "WESTON" STARRATT JR. (B.S.'49 Metallurgy) of San Rafael, California, writes for several maritime magazines.

1930s

JOHN L. PEARSON (B.S.'38 CE) of San Leandro, California, was the most senior alumnus at last spring's True Blues Luncheon at the Faculty Club, honoring engineering alumni of the Class of 1959 and earlier. Employed by the California Public Utilities Commission and Department of Transportation, Pearson worked for six years on the Key System, the public transit system that once connected East Bay cities with San Francisco by means of a light rail on the lower deck of the Bay Bridge. Now retired, he has a son and a granddaughter who are also engineers.

PAUL C. SHERIDAN (B.S.'30 CEE) of Sacramento writes, "At 99 years, I'm still bowling and playing bridge. My doctor says she has nine patients over age 90, and I'm the oldest and healthiest."

Klinger

Waite

in memoriam

GEORGE CRAMER, an EECS graduate student, died in August at age 24. The Staten Island native was an accomplished pianist and oboist who received the Wagner College Young Musician's Competition Award in 2002 and played with the Richmond County Orchestra. He received his engineering bachelor's from Cooper Union and was working on his master's at Berkeley on a full scholarship. Also an avid biker and member of Faith United Methodist Church in Port Richmond, he had completed his thesis and moved to Sunnyvale, California, in search of a job. He will be awarded his master's degree posthumously in December.

PAUL T. HARPER (B.S.'51 EE) of Los Altos, California, died last December. During his professional career he worked for Ampex, IBM, Lockheed and Pan Am. He served as a radio operator for Pan Am during World War II and was a member of the Naval Reserve. While at Lockheed he had several patents and started his own business based on a digital clock he invented.

ALEXANDER MOISENCO (B.S.'41 EE) died in July at age 93. He and his wife, Betty (Jenkins) Moisenco (B.A.'43 Political Science), had lived in Groveland, California, for 35 years but recently moved to Pleasant Hill, California, to be closer to family. Moisenco remained in close contact with his friends from Alka Hall, where he was once a resident, and had recently enjoyed a visit from Charles Auerbach (B.S.'42 Chemistry).

RICHARD G. ORCUTT (M.S.'51, Ph.D.'56 CE) of Reno, Nevada, died in May at age 85. He was a professor of engineering at the University of Nevada, Reno, from 1956 to 1985. He served in the U.S. Navy during World War II and in the Commissioned Corps of the U.S.

Q&A Tricks of the trade

Principal mechanical engineer Barney Smits is keeping BART safe for its 300,000 riders, himself included.

Name:
Barney Smits (B.S.'92 ME)
Age
54
Title:
Principal mechanical engineer, Bay Area Rapid Transit

COURTESY BAY AREA RAPID TRANSIT

Barney Smits (left) and fellow BART engineers build a model car, which was later disassembled and trucked to Worcester Polytechnic Institute in Massachusetts for fire testing. Stations are also routinely evaluated for fire load potential.

So, what do you do?
Answer questions, review drawings and specs, respond to the occasional emergency in stations, tunnels, trains or on track ways. I never know where I'm going to end up.

How many miles does BART cover?
About 20 miles of tunnel and 208 miles of total track.

What would people be surprised to know about BART?
BART is considered a two-track system, a north-south railroad. Even though the Transbay Tube goes east-west, the Oakland side is "north" of the San Francisco side.

What BART challenge have you helped solve?
When we brought the San Francisco extension online, that included four stations (South San Francisco, San Bruno, San Francisco International Airport and Millbrae) and six to seven miles of tunnel. I was part of a team of about 10 BART engineers responsible for making sure that everything was safe.

Do you ride BART?
Every day. I take it everywhere I can: to the opera in the city, to the airport. Once you're used to it, it's the absolute best, easiest way to get around.

What do people say when you tell them you're an engineer for BART?
I get a lot of questions like, "Does the Transbay Tube really go under the bay? Is it really right there under the water?"

Well, is it?
Yes, it goes down about 120 to 140 feet and follows the contour of the bay. It's one of the safer places to be in the district. It has seismic expansion joints on each end so it can move in the event of an earthquake. It also has pumps and fire protection, fans and ventilation systems. There are a huge number of emergency systems, all designed to make sure everything is running safely in there.

If you could do anything in the world to update BART, what would the system look like?
I met a New Yorker who said that we should give BART whatever money it needs to go everywhere, because if it goes everywhere then everyone will ride it. I agree.

What's the most common holdup with trains?
It's not one thing. You're dealing with 300,000 passengers every day. You almost have to think of BART as a moving city. Granted, some of [the residents] are only in town for 20 minutes, but still, that's a lot of people. It's really interesting that the trains are able to do as well as they do.

What doesn't everyone know about you?
My first degree is in music from Diablo Valley College, and I was accepted into the San Francisco Conservatory of Music for classical guitar but didn't end up going.

BY MEGAN MANSELL WILLIAMS

Tell us about your job! Write to **forefront@coe.berkeley.edu** or *Forefront* letters, 312 McLaughlin Hall #1704, University of California, Berkeley, CA 94720-1704. You could be featured in the next issue. Please include your name and contact information.

Public Health Service during the Korean War. He also worked with Creole Petroleum Company in Venezuela as a public health monitor for the California Department of Health and as an offsite monitor of fallout from atomic bomb testing in Nevada. His hobbies included hiking in the Sierra and spending time at the cabin he built near Beckwourth, California.

CHARLES M. RICHARDS (B.S.'52 ME) of Los Gatos, California, died last November.

HOWARD V. SCHEFFEL JR. (B.S.'50 ME) of Paradise, California, died in May at age 79. He worked for Copco (now PacifiCorp) in Medford and Klamath Falls, Oregon, then enlisted in the U.S. Air Corps during World War II and was stationed stateside and in West Africa. He attended Cal on the GI Bill. Scheffel later owned and operated a motel in Santa Cruz, California, with his wife, Monica. In 1984 he retired to Paradise, where he enjoyed woodworking and star gazing.

THEODORE W. VAN ZELST (B.S.'44 CE) of Glenview, Illinois, died last July at age 86 after a brief battle with cancer. A leader in materials testing, Van Zelst was responsible for several inventions and designs still in use today, from the Alaska pipeline to the Aswan Dam. He was a pioneer in soil testing, which was little known at the time, and cofounded Soiltest Inc., which became the world's largest provider of materials testing

equipment for soil, rock, concrete and asphalt. He was named Chicago Engineer of the Year in 1988 by the American Society of Civil Engineers. He also received the 1989 Alumni Medal, Northwestern's highest award, and Berkeley's 2002 Distinguished Engineering Alumni Award (now the Berkeley Engineering Innovation Award). He was an outspoken advocate for education, the environment and public policy and was nationally known as the "father of chronic fatigue syndrome advocacy" for his efforts with wife Louann on behalf of the disease that affected one of their daughters.

Engineering matters

THE SCIENCE OF SWEET

BRIAN LEE

Dessert comes first for Anita Chu (B.S.'98, M.S.'99 CEE), professional pastry chef and author of the *Field Guide to Candy: How to Identify and Make Virtually Every Candy Imaginable*, just released in October from Quirk Books. Like Chu's 2008 *Field Guide to Cookies*, the new volume provides a description and history of each treat as well as useful tips for sticky situations. Also a San Francisco structural engineer who designs medical centers, Chu brings a scientific approach to her culinary creations. She doesn't sugarcoat the fact that making candy and confections can be tricky.

"Most candies involve working with sugar and chocolate," she says. "It's a precise science. Make sure you have an accurate thermometer." Here, she offers the low-down on a few of her favorite sweets, just in time for your holiday gift giving or party.

Visit Chu's blog, Dessert First:
http://dessertfirst.typepad.com/dessert_first/

Truffles
"Ganache is chocolate that's been melted and combined with butter. The secret is to emulsify properly. Otherwise it will stay separated, kind of like making vinaigrette, and you don't get that nice, soft texture because it could be gritty or have streaks of unincorporated butter. I've found the most effective tool is a stick blender; a wooden spoon isn't as efficient and incorporates a lot of air."

Peppermint candies
"When you pour the mixture onto a surface, it hardens into a sheet and looks like shiny red glass. You're heating sugar and water and don't want crystals. Don't stir! Leave it alone as it's cooking, and add corn syrup to inhibit crystallization. Add color and flavoring after it's cooled some, or the flavorings will evaporate, especially if they're alcohol based."

Almond buttercrunch
"For the chocolate layer, you have to temper the chocolate so it has a glossy finish and snaps cleanly. If you don't, it sets into a dull, streaky mass. The reason is that the cocoa butter molecules must be crystallized in a certain way. Most professionals have special machines for this, but at home, you can use the seeding method. Put a piece of solid, unmelted, tempered chocolate into your melted chocolate to encourage the proper crystallization."

Taffy
"Taffy is a sugar solution. It's not clear because we're agitating it by pulling, making it crystallize so it becomes opaque. It's really hot when you first cook it, so you put it onto a greased pan and use a bench scraper to turn it in on itself until it starts to cool. Then you can start pulling it by hand. When it really starts to resist, after about 20 minutes, you cut it into pieces."

Fudge
"Most candies can become grainy if you let the cooking sugar crystallize, but with fudge you want this. The key is to control the crystallization for small, even crystals that give the fudge its smooth and creamy texture. After the ingredients are cooked, let them cool to about 110 degrees Fahrenheit; then stir to start the crystallization process. If you start stirring when it's too hot, you get big, hard crystals that don't taste good, don't look good and don't feel good in the mouth."

BY MEGAN MANSELL WILLIAMS

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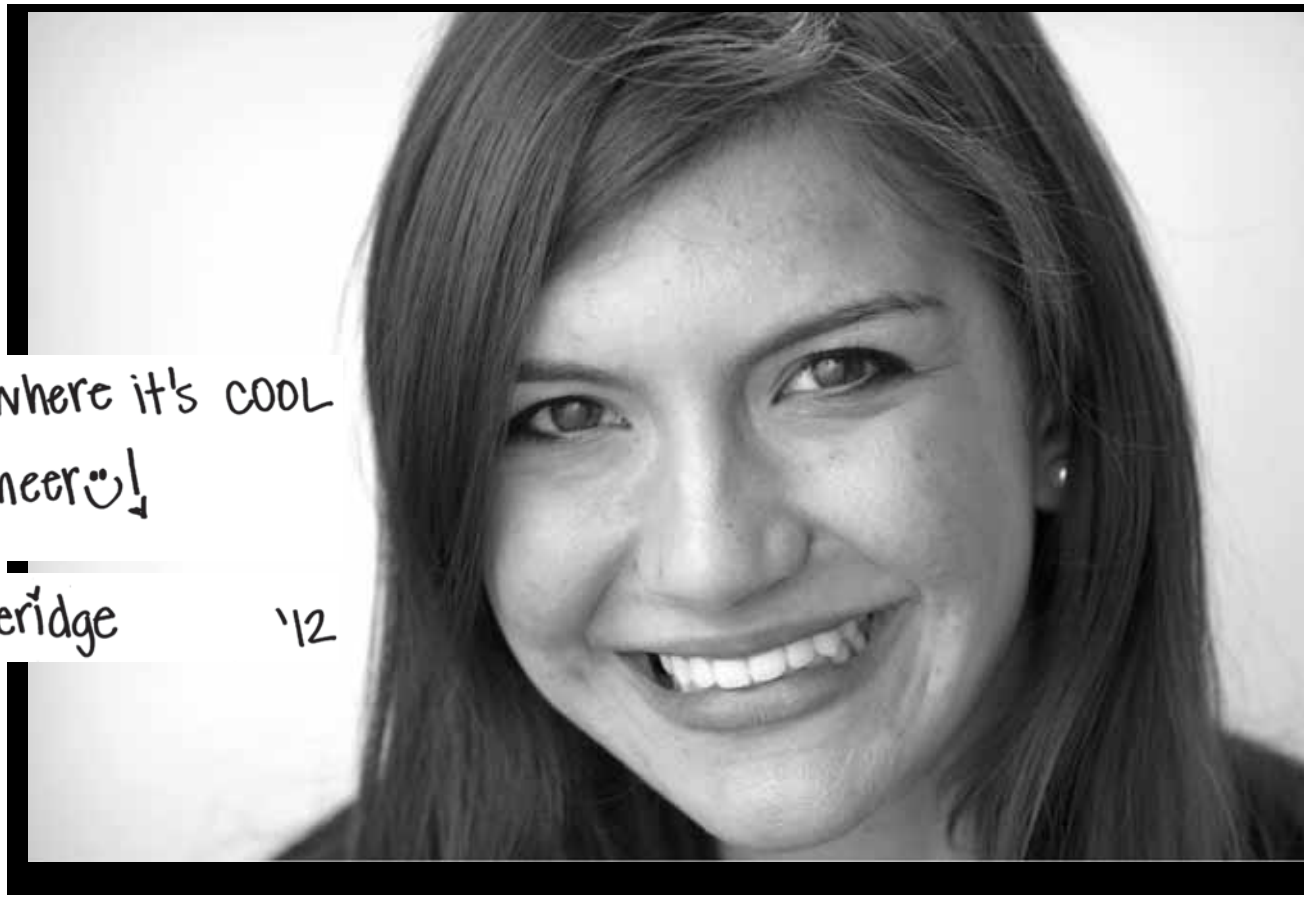

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