Forefront

COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA, BERKELEY

spring 2010

Lessons in the Amazon

Bioengineers teach lifesaving science to young Peruvians

Dean's message

Speaking of engineering

ROY KALTSCHMIDT

Al Pisano is acting dean of engineering while S. Shankar Sastry is on leave this spring.

Teresa Trowbridge (B.S.'84 Engineering Physics) describes her job at Skyline Solar in Mountain View: "Years ago, when people asked me what I did, and I told them semiconductors, that always stopped the conversation. Now I say solar development, and people get excited. They relate to it."

You can meet Trowbridge here in *Forefront* (p. 19) and in the April issue of our online monthly *Innovations*, where you'll find reporter Rachel Shafer's full story on five Berkeley Engineering alumni working in the Silicon Valley on green tech.

But what struck me about that quote is the inherent communications challenge of being an engineer. Unless you're retrofitting Memorial Stadium or designing a laundry-folding robot, engineering is not always the best subject for party talk. Although we are increasingly indispensable in building everything from space shuttles to solar panels, few who benefit know the first thing about engineering. As David Douglas and Greg Papadopoulos say in their new book, *Citizen Engineer*:

> *The increasing complexity of products leads to greater dependence upon engineering; yet most people don't understand engineering or the underlying sciences and technologies. This situation can be scary to the general public, and can lead to bad public policy and misconceptions that hold back new innovations. There is a pressing need for engineers to become more proactive with society—to engage, to communicate, and to lead.*

In his latest book, *The Essential Engineer*, Henry Petroski argues that engineers will be the primary players in solving global challenges like sustainability and health care. Even so, he says, along with medicine and "high technology," engineering often gets subsumed under the general category of "science" rather than meriting an identity of its own.

How can we elevate the profile of our profession? As engineers, we need to communicate this message about what we do to the public at large: Engineers provide a vital service to society. We get some help in this effort from mass media like TV's *Crime Scene Investigation* and movies like *Iron Man*, where engineers can be nerds and heroes at the same time. But, the burden of "messaging" falls squarely upon each one of us.

Talk about engineering every chance you get, to anyone and everyone who will listen. Talk about the great things you and your fellow engineers are doing every day to make the world a better, safer, greener and healthier place.

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

—ALBERT P. "AL" PISANO
Acting Dean, College of Engineering
FANUC Professor of Mechanical Systems

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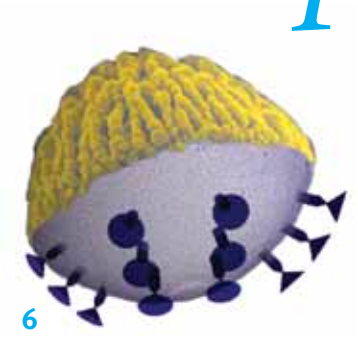

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On the cover
Read the story on page 8.

A Peruvian boy learns how to use a microscope as part of an outreach project led by Berkeley bioengineers to bring a science education to rural, developing areas of the world.

COVER PHOTO BY JAMIE LIU
BACK COVER PHOTO BY NICK LAMMERS

Letters
TO THE EDITOR

BioE back story

While it is nice to see space devoted to bioengineering (fall 2009, p. 9), and I am sure it is true that the department was launched in 1998, your story does a disservice to those of us who graduated in the field many years before. In the 1960s, the college had an engineering science department with five sub-disciplines, including bioengineering, from which I graduated in 1972.

My eighth grade career project had been on bioengineering, and that set the stage for my college goals. Even in the early '60s we were suggesting such things as memory assistive devices. The era was just coming to grips with the overlapping and synergistic nature of many fields, and there was at times an uneasy truce between the medical and engineering communities in terms of access, introduction of technologies and patient interaction.

I continued on for a doctorate in bioengineering at the University of Washington, where Robert Rushmer, head of cardiology in the medical school, had established the Center for Bioengineering. We have all seen tremendous changes over the years in how engineering disciplines have greatly aided diagnosis, treatment and health care delivery, all visions of folks from an earlier era.

So I found myself working for Boeing in Seattle, assuming the ideal job would be just around the corner. Well, that was 1980, and I am still with Boeing, so the lesson there is to be ready to adapt. The great education I got at Cal prepared me well and was second to none.

—**DANIEL S. JOSEPH** (B.S.'72 BioE)
The Boeing Company, Colorado Springs, Colorado

From the editor:
Our historians tell us there were several programs in engineering science and mechanical engineering with a bioengineering emphasis. While students who completed them technically received degrees from their admitting department, they have been considered bioengineering alumni for communications purposes since the department was officially created. We thank Dr. Joseph for providing this glimpse into the early days of the field.

Connecting the dots

I have to wonder, are the students protesting UC Berkeley fee hikes incapable of connecting the dots? If the California budget has less money, something has got to give. Cal students could protest fee increases much more effectively by creating a demand for out-of-the-box budget solutions. Not only should a bunch of Cal engineering students have plenty of ideas for making constructive suggestions on state budget issues; they would be big news because of their technology credibility.

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

Making smart phones safer

I am bothered by the photo that accompanies the story, "Smart phone, smart user" in your last issue (fall 2009, p. 3). The Wikipedia article on the subject (go to **http://en.wikipedia.org/wiki/Mobile_phones_and_driving_safety**) cites 11 studies showing that using a hands-free cell phone is no safer than a handheld one. Perhaps professor Bayen's group will come up with a cell phone that is "less dangerous" when used while driving, but I am hesitant to even use the word "safer." The nature of the problem is immediately obvious to anybody who has tried to get a person's attention while that person is talking on the telephone. (Please try this at home or in the office, not while driving.)

I recall buying my first new car (a 1957 Triumph TR3) when I was a freshman in college. It did not have a radio, and I insisted that an after-market radio be installed under the dashboard. The car salesman said that he did not think radios belonged in sports cars because they distract the driver. Times change, and I applaud Dr. Bayen for trying to keep us as safe as possible as they change.

—**ROBERT G. PLANTZ** (B.S.'62, Ph.D.'71 EECS)
Professor Emeritus of Computer Science
Sonoma State University, Santa Rosa, California

Professor Bayen replies:
Thank you for your valuable comments. We are working on using the GPS in phones to gather traffic data. As with other multifarious phone capabilities, the choice of when and whether to query traffic data belongs to the driver, through using the voice interface or not, or pulling off the road or not. The problem you are talking about is a broader problem. As Transportation Secretary Ray LaHood pointed out, the issue is distracted driving. The real question is whether or not to ban phone usage at the wheel (with or without a headset), a problem that some other countries like the UK have addressed. In addition, you say, "Perhaps professor Bayen's group will come up with a cell phone that is 'less dangerous' when used while driving." To clarify this point for our readers, we are developing software, not creating new phones.

Correction: *The photo illustrating the above-referenced story was inadvertently cropped to exclude the dashboard mount holding the phone to the right. We apologize for any confusion.*

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.

Reverberations of magnitude 8.8: lessons for California and beyond

A hemisphere away, Chile's 8.8 earthquake struck closer to the U.S. West Coast than one might think.

Both regions are seismically active, with "megathrust" faults off their coastlines, where subducting and overriding tectonic plates meet and trigger the biggest quakes on Earth. Both feature modern buildings and well-designed infrastructure systems constructed to comparable seismic codes. Both have older and faulty construction susceptible to seismic failure.

COURTESY NSF-SPONSORED GEER ASSOCIATION

Members of the NSF-sponsored Geoengineering Extreme Events Reconnaissance Association (GEER) team, co-led by UC Berkeley professor Jonathan Bray (not pictured), inspect a sinkhole at the Port of Coronel in Chile, part of an international effort by engineers to understand effects of the 8.8 earthquake. "Most probably, the sinkhole was associated with the presence of drainage pipes where the material washed out when the sand layer liquefied," explains team member Dominic Assimaki, assistant professor of civil and environmental engineering at Georgia Tech, who photographed the damage.

The Pacific Northwest expects its own big quake one day. In California, we're overdue. What can the West Coast learn from Chile's massive temblor?

Less than two weeks after the quake, UC Berkeley earthquake engineering faculty were on the ground (and in the air), documenting the damage and analyzing what held up and what failed.

At a briefing back on campus, team members shared initial findings. Engineered buildings generally performed very well, reported structural engineer Jack Moehle, professor of civil and environmental engineering. But some newer, multistory buildings with irregularities to accommodate underground parking sustained greater damage. Reinforcement detailing that is prevalent in California but not used in Chile could have protected these buildings.

Hospitals, in particular, performed poorly, but not because of structural damage, which was relatively minor, reported William Holmes, a structural engineer. Rather, nonstructural elements like electrical systems, piping, lay-in ceilings and elevators malfunctioned, leading to widespread evacuations. California hospitals are in the process of performing state-mandated retrofits to secure these nonstructural elements, but hospitals outside the state remain vulnerable.

Soil also played a critical role. Buildings, bridges, highways, ports and other facilities built on looser or weaker soils suffered more damage as the ground liquefied or softened and deformed during shaking, said geotechnical engineer Jonathan Bray, Berkeley professor of civil and environmental engineering.

Though not surprising to many earthquake engineers, the findings serve as valuable reminders of what needs to be done to prepare for a large quake. "We don't want a repeat performance here," Bray said.

See more at **www.eqclearinghouse.org/20100227-chile** and **www.geerassociation.org.**

BY RACHEL SHAFER

PEG SKORPINSKI

Clinton packs the house at Zellerbach

Tu Tran was lucky. The flood of students requesting free tickets to Bill Clinton's campus appearance in Zellerbach Auditorium crashed the event's website, and when IT staff restored it, the Feb. 24 event sold out in minutes.

Tran, a senior bioengineering/rhetoric major, managed to snag a ticket. A native of Thailand, he was 5 years old when Clinton took office in 1993. Tran went, he says, not to bask in the glow of a former U.S. president, but to hear Clinton's ideas on international development and philanthropy.

Clinton didn't disappoint the 2,000 students, faculty and staff in attendance. His call-to-action speech on global poverty and social responsibility urged students to "put yourselves on the line" to combat inequality. "You're living in a time in human history when the individual citizen . . . can have more influence over the outcome of affairs than ever before," he said. Clinton was on campus at the invitation of the Blum Center for Developing Economies.

"It was very inspiring, even unreal," Tran said afterward. Also ASUC executive vice president, Tran put Clinton's message into action, spearheading a summit held last month to organize UC-wide earthquake relief efforts in Haiti.

BART NAGEL

NE's Peterson joins DOE commission

Per Peterson, Berkeley professor of nuclear engineering and current department chair, is one of 15 leading nuclear power and policy experts from across the country appointed to the U.S. Department of Energy's (DOE) new Blue Ribbon Commission on America's Nuclear Future.

Appointed by Energy Secretary Steven Chu, who is also former director of Lawrence Berkeley National Laboratory and a former UC Berkeley physics professor, the commission is charged with providing recommendations for developing a long-term approach to safely managing the nation's nuclear waste and used fuel. It will conduct a comprehensive review of policies for managing the back end of the nuclear reactor fuel cycle and recommend alternatives to storing used fuel at Yucca Mountain in Nevada.

Peterson has expertise in advanced reactor systems, nuclear waste processing and nuclear materials management. He was recently a member of a National Research Council committee reviewing DOE Office of Nuclear Energy research and development programs. He also served as member and chair on numerous advisory committees for the national laboratories, including Lawrence Livermore and Los Alamos National Laboratories.

Other members of the commission include scientists; representatives of industry, environmental and labor organizations; and former elected government officials, all with a wide range of expertise in nuclear energy and policy. The group, which is co-chaired by former Indiana Congressman Lee Hamilton and former National Security Advisor Brent Scowcroft, will produce a final report within 24 months.

TR35 AND THE WINNERS ARE...

Last year brought good news to three young Berkeley engineers—Ali Javey, Michelle Khine and Dawn Song—who joined 32 other elite researchers worldwide recognized by *Technology Review* as 2009's Top Young Innovators Under 35.

PEG SKORPINSKI

ALI JAVEY

UC Berkeley assistant professor of electrical engineering and computer sciences

INNOVATION / Javey developed a precise method of arranging nanowires on electronic circuits using a roller printer device to "paint" the wires into straight rows.

APPLICATIONS / By establishing greater manufacturing control, Javey's innovation facilitates the development of nanowires as a next-generation material for advanced electronics like inexpensive solar cells and high-resolution displays.

COURTESY UC MERCED

MICHELLE KHINE

(B.S.'99, M.S.'01 ME; Ph.D.'05 BioE)
UC Irvine assistant professor of biomedical engineering

INNOVATION / Khine developed a fast, inexpensive method of manufacturing microfluidic devices using thermoplastic sheets of polystyrene from the children's arts-and-crafts toy, Shrinky Dinks®.

APPLICATIONS / Khine's concept significantly lowers the barrier to entry for anyone needing to prototype microfluidic devices, accelerating development of potential applications such as low-cost diagnostic chips for detecting diseases.

RACHEL SHAFER

DAWN SONG

UC Berkeley associate professor of electrical engineering and computer sciences

INNOVATION / Song developed a system of automated software analysis that defends against viruses, worms and other malicious software known as malware.

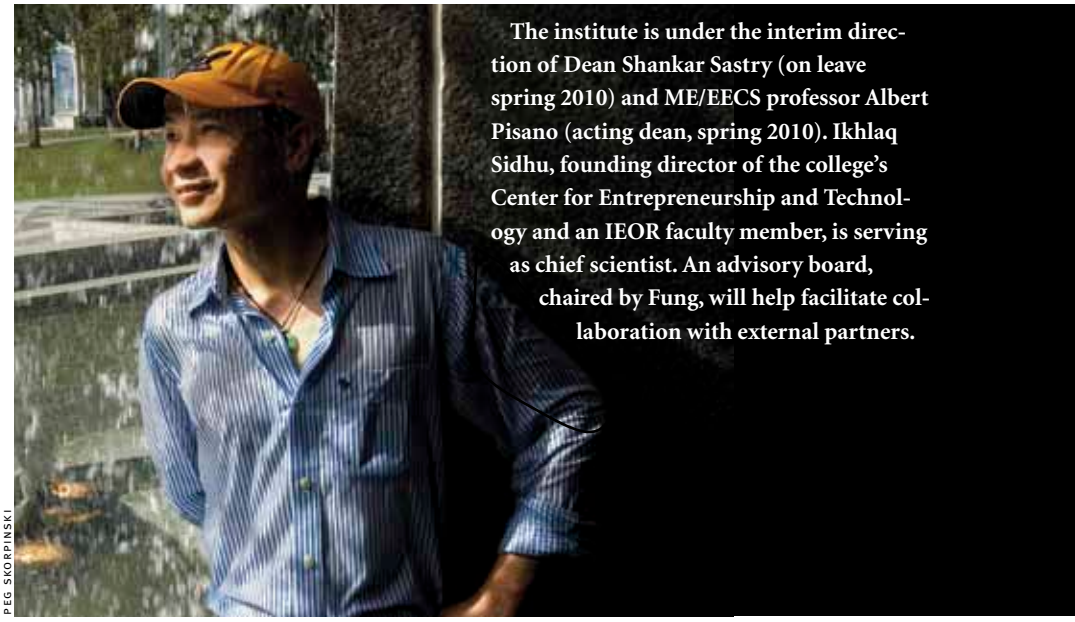
APPLICATIONS / Song's approach enables automated software analysis for security applications, which includes identifying root causes of malicious code attacks, creating filters to secure computers, and significantly reducing the time it takes computer security analysts to fight malware.

See more at **www.technologyreview.com/TR35.**

Calling all engineering leaders

Put an engineer in charge and good things will happen. Alumnus Coleman Fung (B.S.'87 IEOR) even envisions a day when a Berkeley engineer will reside in the White House. Fung's recent $15-million gift to Berkeley is launching a new College of Engineering institute that will prepare engineers for executive roles in industry, government and the nonprofit sector.

"Our students must step outside of their technical comfort zone to change and improve our world," says Fung, founder of the New York–based software firm OpenLink and supporter of numerous Berkeley initiatives. The Coleman Fung Institute for Engineering Leadership will offer professional master's programs for students who want to sharpen their business acumen in tandem with their technical expertise. Coursework will increase students' global leadership and entrepreneurial capabilities in energy, health care and other fields where emerging technologies can be of use.



PEG SKORPINSKI

The institute is under the interim direction of Dean Shankar Sastry (on leave spring 2010) and ME/EECS professor Albert Pisano (acting dean, spring 2010). Ikhlaq Sidhu, founding director of the college's Center for Entrepreneurship and Technology and an IEOR faculty member, is serving as chief scientist. An advisory board, chaired by Fung, will help facilitate collaboration with external partners.

Hot minds, hot careers:

It's good to be in computer science these days. EECS continues to be the most popular engineering major at Berkeley, with an undergraduate enrollment of 922 students, about one in three undergraduate engineers.

Maybe that's because computer science and engineering are among the top five most lucrative majors, according to the National Association of Colleges and Employers, which surveyed the highest-paying graduate job offers last year.

In fact, software engineer and computer systems analyst were the second and third best U.S. careers to have in 2009. Says who? The jobs website *Careercast.com*, which ranked careers on income as well as employment outlook, environment, physical demands and stress level. (Actuary took number one, in case you're wondering.)

Even America's pop culture princess can't resist a glowing computer screen. Going on sale this October is "Barbie® I Can Be...™ Computer Engineer," the newest arrival in a long line of occupation-themed Barbies, which include *Star Trek* officer and NASCAR driver.

Barbie's new career was decided by popular vote, when Mattel held its first-ever online voting campaign asking Barbie's public to select her next occupation, and computer engineer won the most votes. The doll's designers worked closely with the Society of Women Engineers and National Academy of Engineering to develop an authentic geek chic look, complete with smart phone, laptop and Bluetooth headset.

COURTESY MATTEL

Breakthroughs

BERKELEY RESEARCH AT THE ENGINEERING FOREFRONT

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

Adding biofuel to the fire

Plants aren't just for eating or admiring. Chemical engineer and bioengineer Jay Keasling, who is also CEO of the Joint Bioenergy Institute, is manipulating strains of *E.coli* bacteria to produce a usable biofuel directly from plant mass. The bacterium is genetically altered to break down biomass, specifically hemicellulose from plant cell walls, into fermentable sugars, then convert them into fuel. The process is capable of making chains of long hydrocarbons characteristic of biodiesel, jet fuel or kerosene, and Keasling's team is also working on producing the shorter chain hydrocarbons characteristic of gasoline. Because *E.coli* is well understood, hardy and fast growing, it could become a cheap and efficient microbial factory for mass producing fuels of the future.

www.scientificamerican.com/article.cfm?id=bacteria-transformed-into-biofuel-refineries

COURTESY THE RESEARCHERS

Dashingly HANDSOME

For some, the sight of a scurrying cockroach might incite a shriek, but engineers in the lab of electrical engineering and computer sciences professor Ronald Fearing are learning many things from these resilient insects. One result is graduate student Paul Birkmeyer's DASH, the dynamic autonomous sprawled hexapod, an easily manufactured 10-cm robot built from cheap but durable cardboard and two small motors to steer and power its six rotating legs. At 16 grams, DASH can reach speeds of up to 1.5 meters per second and easily withstand falls of up to 28 meters without breaking, making it a prime candidate for locating survivors following events like the recent earthquakes in Haiti and Chile and future disasters.

http://www.youtube.com/watch?v=LsTKAtBBkfU

Just say no to Botox

Irina Conboy of bioengineering may have discovered a better way to fight the march of time. Her research team and collaborators in Denmark recently pinpointed important biochemical pathways linked to the aging of human muscle. They found that one such pathway, mitogen-activated protein kinase (MAPK), plays a key role in the regulation of human tissue regeneration. By manipulating this and other pathways, the researchers prompted old human muscle stem cells to restore their youthful vigor. The results offer hope that one day we can stay healthier and look younger longer by delaying the onset of muscle wasting, which is common to aging and degenerative disorders.

www3.interscience.wiley.com/cgi-bin/fulltext/122613619/HTMLSTART

CANCER CELLS, BEWARE

Imagine, for a moment, microscopic spaceships injected into the body to destroy cancer. Nanoprobes developed by Luke Lee of bioengineering and his team of researchers target cancer cells, inject them with therapeutic drugs and send back information on how the cells are reacting to treatment. Inspired by the biology of natural coral, these nanocorals feature a roughened gold surface on one side that achieves sensing capability through a technique called surface-enhanced Raman spectroscopy, or SERS. The nanocorals, Lee reports, could eventually become important tools for diagnosing and treating cancer.

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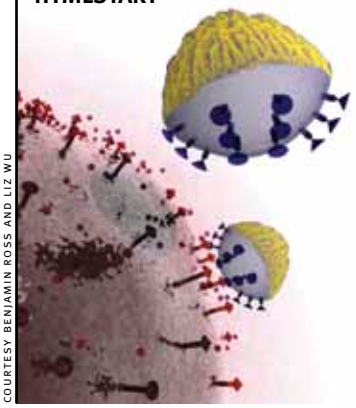
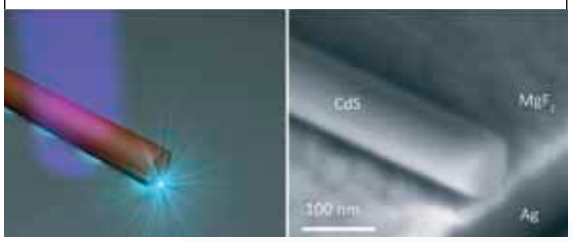


COURTESY BENJAMIN ROSS AND LIZ WU

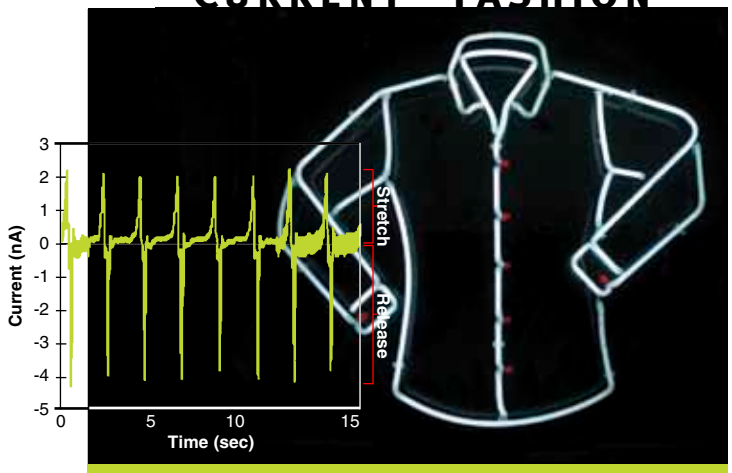
COURTESY XIANG ZHANG LAB

World's tiniest laser

It's no optical illusion. Xiang Zhang of mechanical engineering has created the world's smallest semiconductor laser, a new breakthrough in optics and laser physics. His research team demonstrated a novel technique that crunches visible light into a space smaller than a single protein molecule and keeps the light energy from dissipating as it moves. By coupling a cadmium sulfide nanowire—measuring 1/1,000th the width of a human hair—with a silver surface separated by a five-nanometer gap, the researchers created a non-metallic environment that significantly preserves light energy. Nanolasers of the future may be used in DNA research and optics-based telecommunications and computing.
http://berkeley.edu/news/media/releases/2009/08/31_nanolaser.shtml

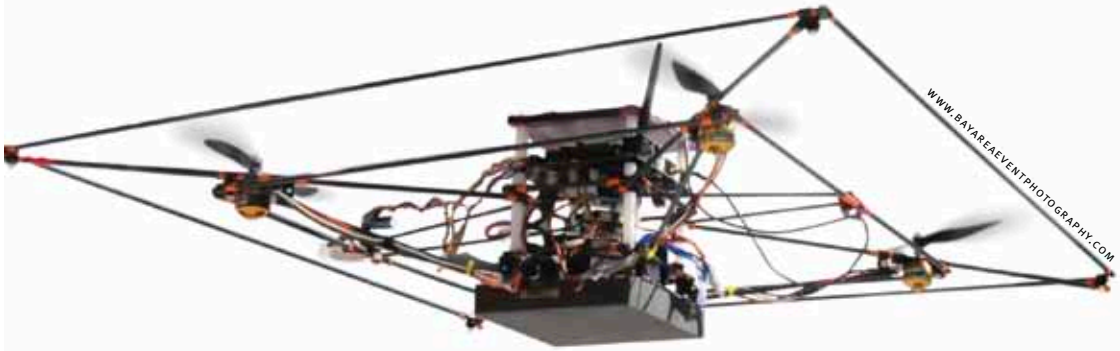


"Current" Fashion



GRAPH COURTESY THE RESEARCHERS

It gives new meaning to the expression "power suit." Humans expend thousands of calories every day in executing simple movements like extending an arm or turning a head. Mechanical engineer Liwei Lin and his research team are thinking twice about the energy generated by these natural movements. They are developing a fiber nanogenerator with "piezoelectric" properties capable of converting mechanical energy captured from any little stretch, stress or twist of the human body into electricity. With no discomfort to the wearer, the tiny nanofibers could be attached to or fabricated into clothing and used to power small electronics.
http://pubs.acs.org/doi/full/10.1021/nl9040719



WWW.BAYAREAEVENTPHOTOGRAPHY.COM

Robots in the sky

They spin. They hover. They even do backflips. Small, aerial robots with surprising agility avoid crashing into one another and return to their trajectory, demonstrating that one day super smart cars and airplanes may safely avoid crashes as well. The proof of concept is part of ongoing work by Claire Tomlin of electrical engineering and computer sciences and her joint Berkeley-Stanford STARMAC team to develop collision-avoidance technologies for use in search and rescue, optimal path planning and other applications. Their autonomous flying craft feature four propellers, a sophisticated computing and microprocessor system, sensors, GPS and landing gear, all built on a square, lightweight, carbon fiber frame and guided by advanced algorithms.
http://hybrid.eecs.berkeley.edu/starmac/