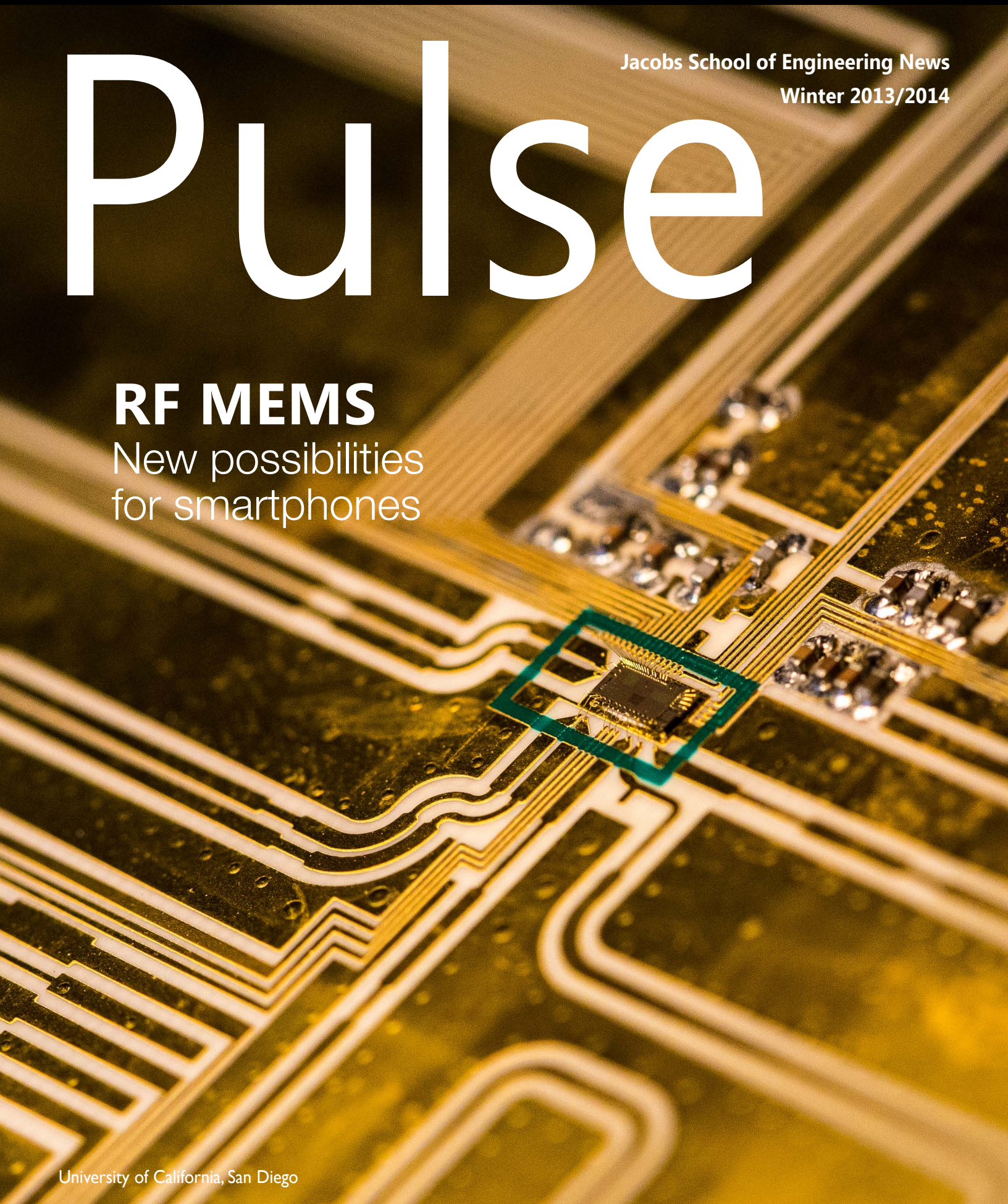
UCSD Jacobs | School of Engineering

Three Associate Deans Named
Student Startup Inspires Kids to Code

Pulse

Jacobs School of Engineering News
Winter 2013/2014



RF MEMS
New possibilities
for smartphones

University of California, San Diego

It's a pleasure to have the opportunity to write my first dean's column at the Jacobs School of Engineering. These first months have been incredible. Each week, I encounter more great things happening here in education, research, entrepreneurism and positive impact on industry and society. This is truly a world-class engineering school.

At the same time, I see opportunities for us to take the Jacobs School to the next level of excellence. One important step in this process is building a leadership team that shares my enthusiasm and my dedication to the School. I am honored to welcome three accomplished and highly regarded professors as associate deans. Please join me in congratulating Pamela Cosman, Jan Talbot and George Tynan. Together we will engage the entire engineering community through our focus on students, faculty, and research—and on identifying resources to support new initiatives in these areas.

In this issue of Pulse, we highlight several education and outreach projects aimed at increasing and broadening the pool of engineering students. I'd like to thank each person involved in this work for their passion and dedication. You will be hearing much more about engineering education at the Jacobs School in the near future.

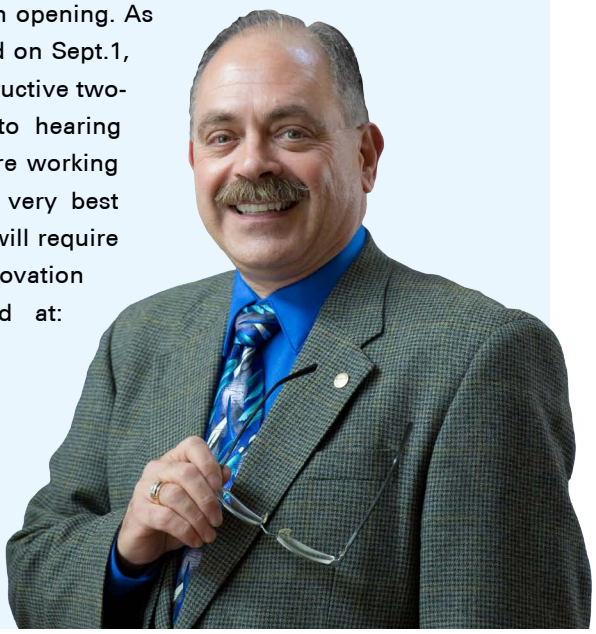
We also feature, in this issue, a taste of the Jacobs School's research enterprise, which is deeply rooted in both fundamental inquiry and practical applications. I am very much enjoying the process of learning what is happening in all of our labs, interdisciplinary research groups and Centers. There are so many exciting projects to share in upcoming issues of Pulse.

This issue's cover story discusses several exciting prospects for incorporating RF MEMS into handsets. Some of the fundamental research that is enabling the transition to consumer technologies happened here at the Jacobs School—and this is just one of our many wireless communications success stories.

We also touch on a few "omics" projects—the Jacobs School is at the forefront of today's omics revolutions, which are built upon genomic sequencing. Our leadership role can be attributed at least in part to the long-standing collaborations on this campus between engineers, computational scientists and medical researchers. These kinds of collaborations will be even more important in the future, and I look forward to many exciting advances at the interface of engineering, life sciences and medicine.

I'd like to close my first column with an opening. As I have said several times since I arrived on Sept.1, I am a big believer in honest and constructive two-way communication. I look forward to hearing from you. My leadership team and I are working hard to make the Jacobs School the very best engineering school in the nation. This will require conversation, collaboration and innovation on many levels. I can be reached at: DeanPisano@eng.ucsd.edu

ALBERT P. PISANO, DEAN



Jacobs School of Engineering

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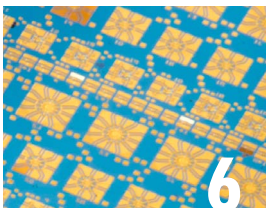

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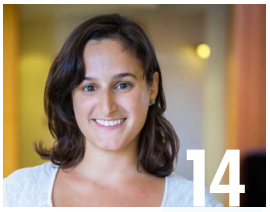

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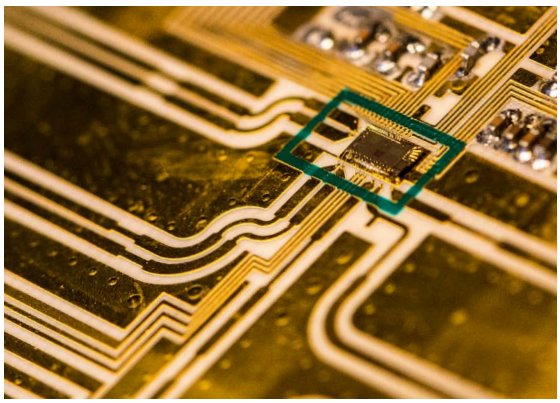
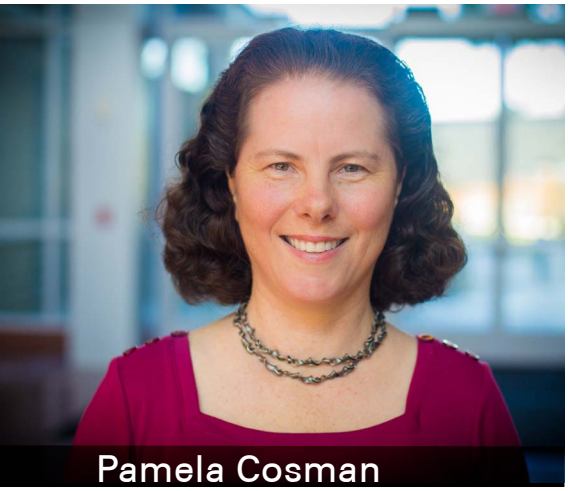


Cover shot: An experimental circuit from the laboratory of Gabriel Rebeiz in the Department of Electrical and Computer Engineering. Fundamental work on RF MEMS done in this lab has helped mature RF MEMS to the point that it's poised for widespread use in smartphones for tunable antennas, filters, power amplifiers and more. (pg. 6)

New Associate Deans

Three Engineering Professors Step Up



Pamela Cosman
Associate Dean for Students
Professor in the Department of Electrical and Computer Engineering

Jan Talbot
Associate Dean for Faculty Affairs and Welfare
Professor in the Department of NanoEngineering

George Tynan
Associate Dean for Research
Professor in the Department of Mechanical and Aerospace Engineering

"I'm working hard to get every aspect of the Jacobs School of Engineering moved up a notch. This place is great, but we need to become greater—and that's a big job. Within the Jacobs School, I work closely with the department chairs, the Center directors and now the associate deans. Each set of advisors provides a different set of perspectives—and together we are getting close to a comprehensive view of this wonderful, multifaceted machine called the Jacobs School of Engineering."

- Albert P. Pisano, Dean, Jacobs School of Engineering

Pamela Cosman

Associate Dean for Students

Responsibilities include:

- Management of student programs
- Student diversity, equity, and inclusion
- Curriculum organization and content

"At various points during my undergraduate and graduate school years, I had a range of wonderful and miserable experiences related to advisors, to courses, and to extracurriculars. It can make such a big difference if a school is paying attention to the whole student experience. One related issue I look forward to raising is the incentive structure for faculty at the Jacobs School. I think we need to reorient incentives in order to better recognize faculty excellence in teaching as well as involvement in things like undergraduate research, student organizations and departmental service."

Jan Talbot

Associate Dean for Faculty Affairs and Welfare

Responsibilities include:

- Tenure and promotion cases
- Faculty recruitment and retention
- Faculty diversity, equity, and inclusion

"One of my priorities will be to help the Jacobs School recruit the best faculty—people who will bring the resources, students, and collaborators that will take us to the next level. Faculty equity and diversity are also under my purview—these are issues that the Jacobs School has struggled with. Our new dean has been successful in these areas in several different settings. Al knows how to make changes, and I will be working with him to do just that."

George Tynan

Associate Dean of Research

Responsibilities include:

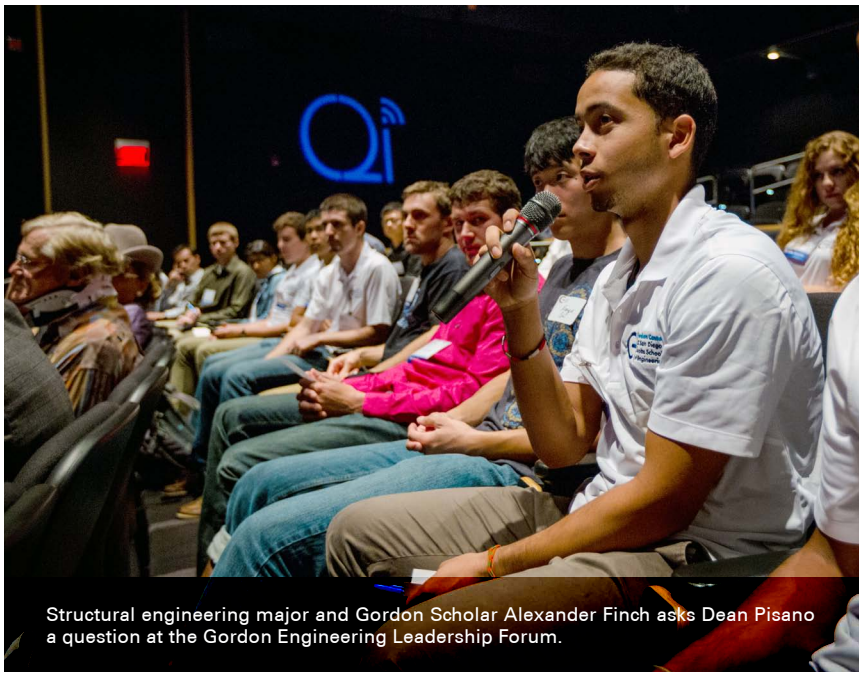
- New School-wide research opportunities
- Management of research infrastructure
- Build national and international research partnerships

"I think the biggest constraint on most faculty is time. One of my tasks is to facilitate discussions regarding collaborations and new centers that are compelling enough to get the attention of faculty, to get people to say, 'I'm willing to carve out some time and energy to try to see if we can make this happen.'"

Dean Albert P. Pisano Shares Experiences at Gordon Engineering Leadership Forum

"You are the integral of all the successes you help other people have. That's the most powerful way for you to achieve."

- Al Pisano



Structural engineering major and Gordon Scholar Alexander Finch asks Dean Pisano a question at the Gordon Engineering Leadership Forum.

Dean Pisano shared experiences from his path to becoming an engineering leader at the first Gordon Engineering Leadership Forum of the 2013-2014 academic year. When asked about multidisciplinary research, Pisano highlighted his belief that collaborative projects should allow engineers, basic scientists and clinical researchers to all do fundamental work in their own areas of expertise. "Biologists are not here to pour cells into our engineering experiments," Pisano quipped. "Equal-partner collaborations are the sweet spot. The BRAIN Initiative is going to be one of our first break-out moves."

Print Rocket. Test Rocket.

UC San Diego became the first campus to successfully design, build and test a 3D-printed rocket engine when a group of aerospace engineering students conducted a static fire in the Mojave Desert on Oct. 5. "It was an amazing feeling," said Deepak Atyam, the leader of the student effort and a Gordon Scholar. "We could feel the power of the engine in the bunker. It's something you really can't describe." The test marked a key step in showing that 3D printing is a viable manufacturing method for rocket engines, said Professor Forman Williams, the students' advisor. The students are now part of the Jacobs School's Moxie Center for Student Entrepreneurship.

Learning by Shaking

Over the past seven years, more than 7,000 sixth-graders from 26 schools in San Diego County have built and shaken K'NEX structures on shake tables at the Jacobs School. Engineering students run the outreach program through the UC San Diego chapter of the Society of Civil and Structural Engineers and are now expanding it to other Southern California universities. "We not only inspire kids to choose engineering careers, but also develop young engineers into more effective communicators and more engaged citizens," said co-founder Colin Haynes, a Gordon Scholar and structural engineering Ph.D. student at the Jacobs School.

Left: Metal contact RF MEMS switches. This technology could be incorporated into smartphones as tunable filters that mask undesired frequency bands.

RF MEMS: New Possibilities for Smartphones

The antennas in most of today's smartphones do not function efficiently in 3G and 4G/LTE wireless environments. This leads to slower download speeds, reduced voice quality, lower energy efficiency and more dropped calls. A technology commonly used in satellite and defense applications—RF MEMS or Radio Frequency Micro-Electro-Mechanical Systems—is now poised to improve smartphone performance in the near future by way of higher antenna efficiency.

"If you can make smartphone antennas 2 or 3 dB more efficient, you basically halve your download times. Truly, if we accomplish this with RF MEMS technologies, it's a huge deal," said electrical engineering professor Gabriel Rebeiz. His labs have accomplished many fundamental RF MEMS research breakthroughs, created proof-of-concept applications, and led key technology transfer efforts. This work has advanced RF MEMS to the point where large-scale incorporation into smartphone antennas appears probable if not inevitable.

"We demonstrated that you can get a better antenna, a better filter, a better power amplifier using RF MEMS. These were the first demonstrations. Industry took this work and adapted it to their own situations," said Rebeiz. He was awarded the 2014 IEEE Daniel E. Noble Award for Emerging Technologies "for pioneering contributions enabling commercialization of RF MEMS technology and tunable micro- and millimeter-wave systems."

A 2012 article in MEMS Journal predicted that the RF MEMS market would expand by a factor of 200 to $150 million by 2015, driven by implementation in handsets and tablets.

In addition to antennas, RF MEMS technology could find its way into tunable filters for smartphone radios that might one day replace the tens of individual filters built into today's smartphones. With the rise of carrier aggregation—which is the use of multiple frequency channels to divide data, such as a video, that is being sent or downloaded in today's advanced wireless networks—filters are increasingly important, explained Bilgehan Avser, an electrical engineering graduate student in the Rebeiz lab.

"Metal-contact and capacitive switches could turn out to be extremely important for tunable RF front ends of next-generation communication systems," said Avser.

Cellphone base stations could also see RF MEMS implementations. But applications beyond tunable antennas could take more time to be implemented in commercial handsets and tablets, Rebeiz noted.

Tunable Antennas

In recent years, antenna size—and by extension radio frequency performance—has lost ground in phones to larger screens and thinner form factors that exclude larger antennas. At the same time, the demands placed on these antennas have increased. For example, even though antennas have gotten smaller, they are being asked to cover lower-frequency bands that would normally require larger antenna form factors.

"The smartphone antenna, which has long been neglected, now is of prime importance for how to make the smartphone more efficient," said Rebeiz.

Incorporating RF MEMS into smartphone antennas yields "tunable" antennas that work efficiently across one or two frequency bands at a time. The frequency at which they function most efficiently, however, can be changed—and RF MEMS metal-contact switches and variable capacitors are used to make the antennas tunable.

"With RF MEMS, you can take an inefficient wideband antenna and turn it into an efficient tuned antenna," said Rebeiz.

In this context, RF MEMS serves as a low-loss switched variable capacitor capable of changing the antenna's resonant frequency, which is the frequency at which the antenna operates most efficiently.

Rebeiz has been a leader in RF MEMS research for more than a decade. Much of the early research focused on defense and satellite communication applications such as phased-array systems with sophisticated "beam steering" antennas. In this arena, RF MEMS technologies enable the electronic steering of multiple antennas that function together in order to steer signals to a precise location and ensure the signal does not interfere with other systems. Another application: rugged hand-held radios that work efficiently at many different wireless frequencies.

"We laid out the fundamental work to make RF MEMS a reality, through investigation of so many fundamental problems of MEMS. We solved a lot of these problems and transferred the advances to industry," said Rebeiz.

His research group's contributions include making MEMS robust in the face of process stresses incurred during micro-fabrication, as well as temperature extremes. They also

Electrical engineering professor Gabriel Rebeiz, the Wireless Communications Industry Endowed Chair Professor, holding a dual-band frequency tunable antenna (see image below).

helped demonstrate the vast potential that RF MEMS hold for commercial applications.

In September 2006, Rebeiz became the founding director of the UCSD/DARPA Center on RF MEMS Reliability and Design Fundamentals. As the leader of this eight-year collaboration between universities, the U.S. Federal Government and industry, Rebeiz works to ensure that knowledge on RF MEMS advances are widely available in order to further spur innovation.

Many of the graduate students who worked on RF MEMS projects while at UC San Diego are now working on related challenges in industry—at companies like Cavendish Kinetics and WiSpry that are commercializing RF MEMS technologies, and at companies such as Apple, Qualcomm, Intel and Samsung that are looking to incorporate RF MEMS and other tunable technologies into their products.

"Our RF MEMS work has been a good ride. It has been exactly what I feel research should be. You take a problem. You spend 12 to 14 years on it. You solve its fundamental issues. You transfer it to industry," said Rebeiz. "Have we solved all of the problems? No. But we have gone from 10 percent of understanding of RF MEMS to 90 percent."

A dual-band frequency tunable antenna for carrier aggregation systems. Varactor diodes (black cube above) tune the antenna's frequency. RF MEMS capacitive switches to replace the varactor diodes and improve antenna performance are being developed in the Rebeiz lab.

Single-Cell Genome Sequencing Gets Better

Bioengineers at the Jacobs School have created a better way to sequence genomes from individual cells. The breakthrough, which relies on microwells just 12 nanoliters in volume (see image below), is one of many recent "omics" innovations from researchers across the Jacobs School and UC San Diego. The single-cell genome sequencing advance from Kun Zhang's lab could help researchers understand what causes Alzheimer's disease. The work could also enable scientists to identify tough-to-culture microbes living in ocean water and within the human body—by probing single cells.

The new sequencing approach, called MIDAS, yields genomes that exhibit comparatively little "amplification bias," which has been the most significant technological obstacle facing single-cell genome sequencing in the past decade. This bias refers to the fact that the amplification step is uneven, with different regions of a genome being copied different numbers of times. Minimizing bias is crucial for identifying meaningful differences between genomes, such as those found within different neurons from an individual with Alzheimer's or Parkinson's disease, or schizophrenia.

"Omics" Hotbed

Bioengineering and computer science researchers from UC San Diego and their collaborators are well established leaders in developing, implementing and teaching genomics and other "omics" technologies. Here are just a few recent examples.

Jeff Gole (Bioengineering Ph.D. '13) holds arrays of 12-nanoliter-volume microwells. Confining genome amplification to individual microwells increases the effective template-genome concentration and improves amplification uniformity.

Watch an animated video of the new sequencing technique: http://bit.ly/1bsHk1V

Shankar Subramaniam's bioengineering lab developed a new method for analyzing RNA transcripts—the transcriptome—from samples of 50 to 100 cells. The transcriptome serves as a proxy for which genes are being expressed and at what levels at a given moment. The new methods for assessing the transcriptome from small numbers of cells are already being applied to brain cancer, liver function and stem cell biology projects. This work is part of a shift—initiated in part here at UC San Diego—to approaching biological and health questions from a systems perspective.

"If you want to address a particular disease, the days of just looking into one gene, one protein or one signaling pathway are over. You need to look at all levels of complexity," said Vipul Bhargava (bioinformatics Ph.D. '13) the first author on the transcriptome paper.

Bernhard Palsson's research group has also been at the bleeding edge of systems biology for years. They recently used the genomic sequences of 55 *E. coli* strains to reconstruct the metabolic repertoire for each strain, work that could prove useful in developing ways to control deadly *E. coli* infections and to learn more about how certain strains of the bacteria become virulent. Meanwhile, processes developed by Genomatica, a sustainable chemicals company that spun out of the Palsson lab by alumnus Christophe Schilling, are being used by corporations around the world.

On the education front, as a complement to UC San Diego's Bioinformatics and Systems Biology program, the bioengineering department launched a systems biology undergraduate major called "BioSystems" in Fall 2013.

Computer science professor Pavel Pevzner, also a single-cell genome sequencing pioneer, co-created a Bioinformatics Algorithms MOOC on Coursera which had 19,000 active students as of late November. http://bit.ly/1hSQBpe.

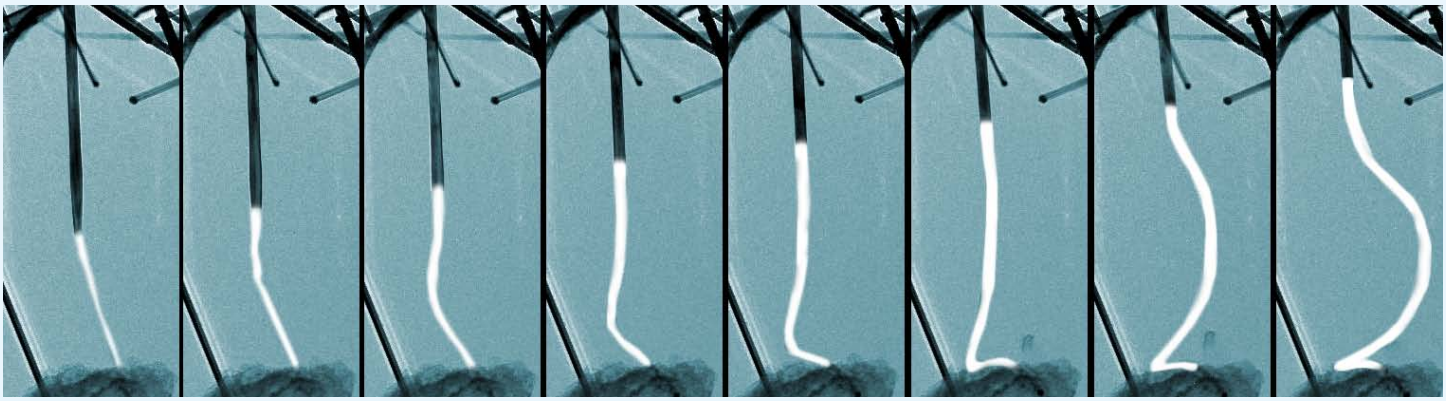
Omics research at UC San Diego involves researchers and industry partners from across the Mesa and the world. The new J. Craig Venter Institute, which opened this Fall on the UC San Diego campus, is injecting even more momentum into the omics scene in San Diego.

The Jacobs School was in the spotlight in the December issue of Popular Science, where our shake table and a robot designed to inspect power lines by mechanical engineering graduate student Nick Morozovsky both received Best of What's New awards from the magazine.

The Large High Performance Outdoor Shake Table can handle structures weighing up to 2200 tons without height restrictions. The table's powerful hydraulic actuators can move at up to six feet per second, creating realistic simulations of the most devastating earthquakes ever recorded. The table has been a boon for researchers across the nation, including the Jacobs School's own earthquake engineering group, which includes NEES Co-PIs Joel Conte, Enrique Luco, Jose Restrepo and Benson Shing.

SkySweeper, designed in the Coordinated Robotics Lab led by professor Tom Bewley, is a robot made of off-the-shelf electronics and plastic parts printed with an inexpensive 3D printer. The prototype could be scaled up for less than $1,000, making it significantly more affordable than the two industrial robots currently used to inspect power lines. Watch the robot in action: http://bit.ly/1bSB6Fn

"The Best of What's New Awards is our magazine's top honor" said Cliff Ransom, executive editor of Popular Science. "Each winner is handpicked and revolutionary in its own way."



For Better Batteries, Mind the Band-Gap

Notice the advancing white line (L-R) in the time sequence of transmission electron microscope images above. This line illustrates the use of band-gap and interface engineering to control how and where lithium (Li) ions diffuse into a silicon-coated germanium nanowire. Creating chemical potential barriers for Li ions, the equivalent of energy barriers for electrons and holes, can control their diffusion (lithiation) at nanoscale dimensions and could lead to new electrode architectures that produce better performing lithium-ion batteries. This work involved a collaboration between electrical engineering professor Shadi Dayeh and colleagues from Los Alamos National Laboratory, Sandia National Laboratories and UC San Diego. Watch the video: http://bit.ly/19JuTdc

Bioengineers Draw High-School Students into Research

The Target: Understanding Age-Related Heart Disease

Bioengineering graduate student Gaurav Kaushik describes the research project to High Tech High students.

As humans age, genetic changes can occur in the heart that are correlated with poor heart function. Do these changes also contribute to a shortened lifespan? Bioengineering professor Adam Engler is working on this question—and he recently added a group of high school students in San Diego to his research team.

The 11th-grade biology students from High Tech High School ran an eight-week fruit fly study guided by Engler and bioengineering graduate student Gaurav Kaushik.

The flies' hearts had been engineered to have age-related gene expression changes that mirror those found in the aging human heart. Fruit flies are a useful model organism for genetic studies of the human heart—cardiac proteins in the fruit fly are 82 percent similar to those in humans. Also, fruit flies' six-week lifespans allow researchers to study disease cycles in an accelerated mode.

The students' data are in, and Engler is eager to dive into the analysis for this NIH-funded project. He'll be involving his high-school colleagues in the analysis in order to give them a hands-on view of the scientific process from protocols to publications.

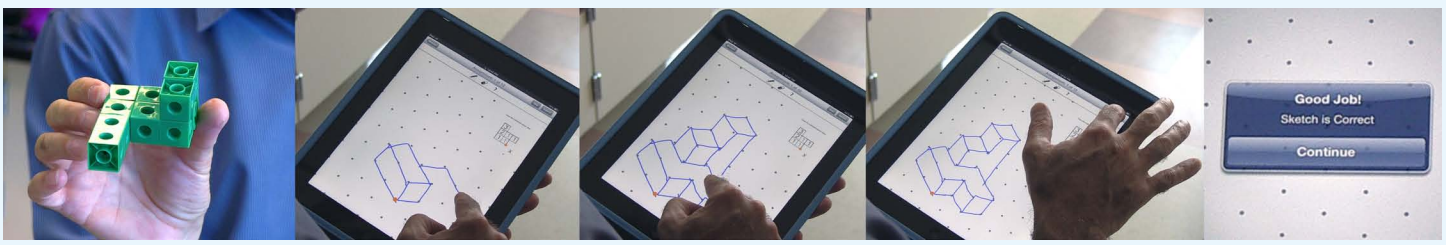
"The problems of the 21st century, such as heart disease, cannot be solved unless we take an interdisciplinary approach. This is why I am thrilled that the students will be working on this project in both their biology and mathematics classes," said High Tech High teacher Jesse Wade Robinson.

App Strengthens Spatial-Visualization Skills

As engineers, we visualize the shape of a device in our mind before we build it. This is spatial visualization, and it's important for science and technology careers. While many children pickup spatial visualization skills—while playing with construction toys for instance—others struggle. On average, women perform lower on standardized visualization tests. To address this issue, researchers at Michigan Tech University developed a spatial visualization course.

Enter Nate Delson, a beloved teacher and lecturer in mechanical and aerospace engineering at the Jacobs School. Seeing so many of his students using iPads to take lecture notes, he realized tablets could be a perfect platform for teaching spatial visualization. With funding from UC San Diego's Qualcomm Institute, a team of programmers, faculty, and student workers developed an iPad App which teaches students how to sketch 2D and 3D shapes with their fingertip or stylus, which is important for learning spatial visualization. "The advantage of sketching on a tablet computer over a piece of paper is that we automatically grade the users' sketch and give them immediate feedback," said Delson.

For more info, go to: http://tinyurl.com/spatialvis



Kids Can Code Too

Kids shouldn't have to wait until college to learn programming —and to learn that it can be fun. That's the premise that led computer science Ph.D. students Sarah Esper and Stephen Foster to develop CodeSpells, a first-person player video game designed to teach students in elementary through high school how to program in Java. The pair, along with biochemistry Ph.D. student Lindsey Handley, also launched ThoughtSTEM, a startup that provides computer science workshops, afterschool programs and camps for children ages 8 to 18.

CodeSpells is the only video game that completely immerses programming into the game play. The player is a wizard in a land populated by gnomes. (See image above) The wizard writes spells in Java within the game.

CodeSpells is available for free download for Windows and MAC at: http://bit.ly/l1peZD

Esper and Foster recently received a $50,000 grant from the National Science Foundation's I-Corps program to explore the technology's potential for commercialization. The NSF NSF I-Corp program "really has allowed us to focus on figuring out who our customers might be and how well our product fits their needs," Esper explained.

The two computer science Ph.D. students decided to focus on schools and school districts as their potential targets. After conducting scores of interviews with teachers and principals, they now have a better picture of how to modify CodeSpells to meet educators' needs. For example, the game might have to teach a broader set of skills, not just Java. Meanwhile, ThoughtSTEM has been prospering too. The program started with about two dozen students in a conference room in the computer science building. It now serves about 150 children every week. Students can attend Sunday sessions at UC San Diego and in Coronado, through after-school programs at Gompers Preparatory Academy and Notre Dame Academy, and through home-school programs. Esper is also teaching a ThoughtSTEM computer science class through UC San Diego Extension, allowing middle and high school students to earn college credit. A winter break camp at the Reuben H. Fleet Science Center is in the works.

"It's very, very exciting," Esper said. "Seeing how much everybody wants this to be part of their life keeps us motivated."

Two students in the ThoughtSTEM program try their hand a soldering.

Computer science graduate student Sarah Esper tested the CodeSpells software at Spreckels Elementary School in San Diego.

New Faculty at the Jacobs School

VIKASH GILJA

Assistant Professor, Electrical and Computer Engineering

Gilja's research focuses on brain-machine interfaces (BMIs) with a specific interest in translating basic research into clinical applications. Using statistical signal processing, machine learning and real-time embedded systems, he develops BMIs that effectively use neural signals to control prosthetic devices for individuals with paralysis and neurodegenerative disease. More generally, he is interested in the development of diagnostic and therapeutic methods that leverage novel techniques and insights from neuroscience to better understand and address neurological and psychological disorders. His approach uses large scale datasets and closed loop control experiments with a variety of neural measurement techniques, including functional imaging and electrophysiology.

Ph.D. 2010 Stanford University

Most recently: Research Associate, Stanford University

SHYUE PING ONG

Assistant Professor, NanoEngineering

Intersecting the disciplines of materials science and information science, our research combines materials informatics approaches with first principles calculations to probe nature's laws and design novel materials for energy. We develop robust architectures for creating and storing large materials datasets, apply rigorous data mining techniques to discover patterns, and use the insights gained to design technologically relevant materials with superior properties. We also conduct virtual first principles experiments to investigate relationships between materials chemistry, structure and property. Current technological areas of focus include new energy storage chemistries and solid-state batteries.

Ph.D. 2011 Massachusetts Institute of Technology

Most recently: Sr. Research Associate and Program Manager, Samsung MIT Alliance in Materials Design for Energy Applications

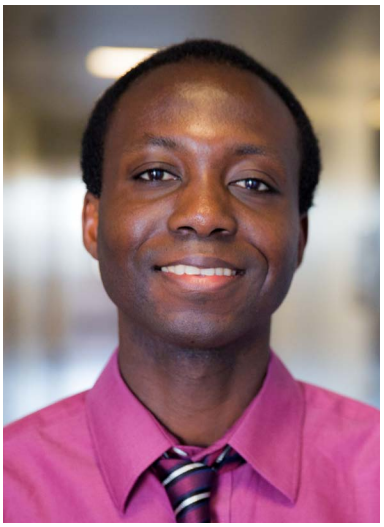
KESONG YANG

Assistant Professor, NanoEngineering

Yang uses computer-based modeling and simulation techniques to study structure-property relationships of nanoscale materials with various applications from energy production and storage to electronic information technology. As a postdoctoral fellow at Duke University, Yang developed a tool that visualizes the electronic structure properties of more than 17,000 compounds. His recent work on topological insulators (TIs), which could be essential materials for the next generation of electrical components, was reported in *Nature Materials*. Yang's research describes a novel high-throughput methodology for the search of TIs, opening a new research direction in computational materials science.

Ph.D. 2010 Shandong University

Most recently: Postdoctoral Fellow, Duke University



BOUBACAR KANTE

Assistant Professor, Electrical and Computer Engineering

Kanté's multidisciplinary research interests are in the areas of wave-matter interaction, from microwaves to optics and related fields such as nanophotonics, nanoscale photon management, and biophysics. Grounded on the fundamental physical principles and the on-demand dimensionality of nanomaterials, his research addresses tantalizing experimental and theoretical physical questions in the field of nano-optics and intelligent nano-materials to address global energy, defense, and health questions. He is particularly interested in the theoretical modeling, fabrication and characterization of metamaterials for application in information science. Kanté made his mark in the academic community when he demonstrated the first non-magnetic metamaterial invisibility cloak.

Ph.D. 2010 Université Paris-Sud

Most recently: Postdoctoral Researcher, UC Berkeley

JIUN-SHYAN "JS" CHEN

William Prager Endowed Chair Professor in Structural Mechanics, Structural Engineering

Chen's research focuses on computational solid mechanics, multiscale materials modeling and prediction of extreme events. More specifically, he investigates various finite element and mesh-free methods for nonlinear, large deformation and high strain rate mechanics. His research team also applies multiscale computational methods to homeland security applications, manufacturing processes, geomechanics problems, DNA modeling applications, skeletal muscle behavior modeling, and simulation-based disaster prediction and mitigation.

Ph.D. 1989 Theoretical and Applied Mechanics, Northwestern University

Most recently: Chancellor's Professor in the Civil and Environmental Engineering Department, UCLA

DAVID SAINTILLAN

Associate Professor, Mechanical and Aerospace Engineering

Saintillan's research centers on the study of fundamental fluid mechanics problems involving complex fluids and complex flows on small scales. His research team uses a combination of modeling, theory and numerical simulations to study the dynamics and properties of flows involving a microstructure suspended in and interacting with a viscous fluid, as arise in many biophysical, environmental and technological processes. Recent problems of interest have included the modeling of electrokinetic phenomena in particle suspensions, the emergence of collective motion in biologically active fluids, and the dynamics and transport of polymers and elastic filaments in microscale flows.

Ph.D. 2006 Stanford University

Most recently: Assistant Professor, University of Illinois Urbana-Champaign

Probing Bitcoins

Bitcoin transactions may be anonymous, but they're also completely transparent. This makes stealing easier, but cashing in on the theft without getting caught a lot more difficult. That's one of the findings from "A Fistful of Bitcoins," a computer science paper that takes an in-depth look at how the virtual currency has been used since its introduction back in early 2009. Led by computer science Ph.D. student Sarah Meiklejohn, researchers documented more than 16 million transactions and more than 12 million public keys—the addresses Bitcoin users use for their transactions—as of April 13, 2013.

"Once you do something with that currency, we can learn more and more about who you are and who you interact with," said Kirill Levchenko, a research scientist in the Department of Computer Science and Engineering at the Jacobs School and one of the paper's co-authors.

Levchenko, who earned his computer science Ph.D. from UC San Diego in 2008, suggested that Meiklejohn look into Bitcoin. "It's a very unique phenomenon—a purely digital currency, not backed by any government," he said.

Contrary to popular belief, Bitcoin is not used mainly for commerce. Most users either play games, such as Satoshi Dice, with the currency, or engage in some form of currency speculation by moving Bitcoin from mining pools where it is created to exchanges where it can be converted to dollars, Levchenko said.

Researchers further refined their analysis and were able to trace back a large number of public keys to specific clusters—for example, 1.6 million public keys were connected to the underground marketplace Silk Road, the public currency exchange and marketplace Mt. Gox and a few other services. Undergraduate student Marjori Pomarole created a visualization of the Bitcoin user network, including vendors, gambling services, mining pools that create the currency, fixed-rate exchanges that process transactions, wallets where the currency is stored and investment schemes (see graphics on this page). The visualization underscores the importance of gambling services in the Bitcoin network. In addition to analyzing the network, researchers conducted 344 transactions of their own, purchasing everything from silver quarters, to coffee, to a calculator and a used CD.

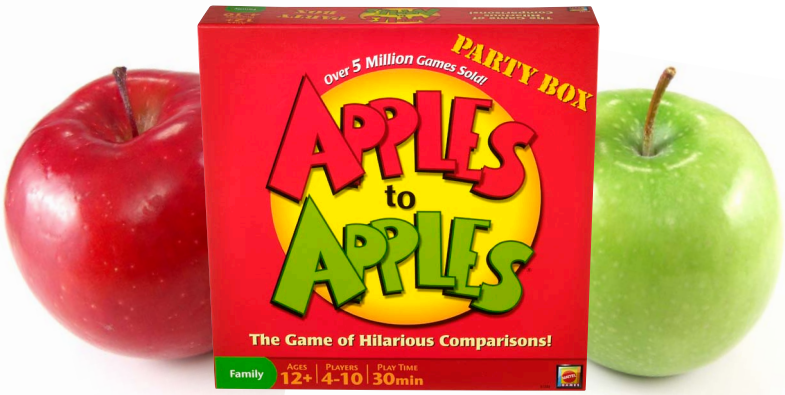
This one-year expedition through the Bitcoin network was quite the experience for Meiklejohn, whose specialty is actually cryptography. "It's a different world," she said. "If someone steals your funds, you can see where they're going."

This, in the end, is what makes the Bitcoin network less than ideal to launder money, the researchers pointed out. Even when criminals use sophisticated methods to conceal their tracks, such as slowly peeling away small amounts of money over a long period of time from an address, they still can be tracked.

While working on the paper, Meiklejohn found herself engaged in a fairly unusual activity for a computer science Ph.D. student. Two of her co-authors are Stefan Savage and Geoffrey Voelker, computer science professors who sometimes work with investigative blogger Brian Krebs, a former Washington Post reporter. Russian hackers planned to mail heroin purchased via the Silk Road to Krebs' house to frame him.

Meiklejohn helped Krebs confirm that the hacker had actually bought the drugs before Krebs alerted the FBI. "The hacker posted, publicly, a Bitcoin address on a forum," she told KPBS. Since then, Meiklejohn has helped reporters from various news organizations understand the Bitcoin network. The media attention took her by surprise, but was welcome. "A lot of the reporters I worked with raised a lot of good questions," she said.

Sarah Meiklejohn is the lead author of "A Handful of Bitcoins."



"Apples to Apples" Creator = Alum

Did you know that the smash-hit board game of comparisons "Apples to Apples" was created by Jacobs School alumnus Matthew Kirby (B.S. '87 Engineering Science) "I believe [Apples to Apples] was truly philosophically and spiritually created at UCSD. Everything I experienced [helped], from the professors in lectures to the alcohol-fueled intellectual conversations late at night," said Kirby in a recent profile in UC San Diego's student newspaper, the Guardian. Kirby recently finished a pirate-themed board game, "Picaroon." Pre-orders as well as information on how schools can sell the game as a fundraiser are online at: www.picaroonboardgame.com Read Kirby's full profile in the Guardian at: http://bit.ly/1ff5L3p

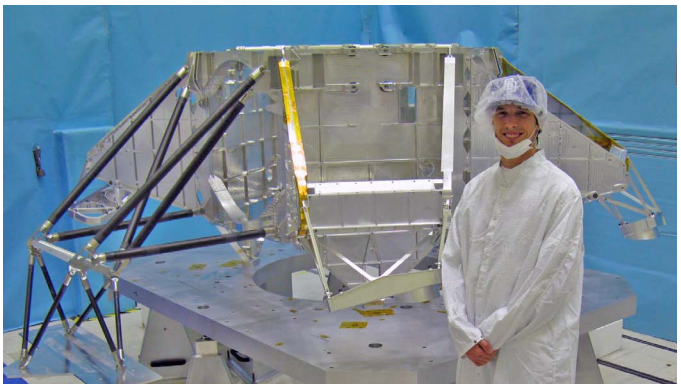
CSE 25th Anniversary Reunions

Missed the 25th Anniversary reunions for the Department of Computer Science and Engineering in San Diego and the San Francisco Bay Area? Take a walk down memory lane with this 10-minute video starring some of the department's historical figures, including Walter Burkhard, William Holden and T.C. Hu—and some unfortunate 80s fashion choices in class pictures.

http://bit.ly/1iyOrco

LinkedIn Networking at the Jacobs School

The Jacobs School's LinkedIn group now has close to 5,000 members. Are you among them? It's a good place to network, keep tabs on the professional successes of fellow alumni, and learn about alumni events and big news from the Jacobs School. The group also contains a number of subgroups, including groups for academic departments, the Team Internship Program (TIP), and the new Data Science master's degree program that the Jacobs School plans to launch in Fall 2014. A few alumni who joined recently are highlighted below: Join the group online at: http://linkd.in/1bEbWMb



JACK T.C. DAVIS

Mechanical design engineer, SpaceX

Previous: Mechanical design engineer, JPL

Bachelor's and master's, aerospace engineering, 2005 and 2012

Davis is pictured (above) with an early version of the descent stage for the Mars Space Laboratory, better known as Curiosity.

EDWARD OLGIN

Chief engineer/principal network engineer, Fuse Integration

Previous: Chief engineer/principal network engineer, IMG Networks

Bachelor's, electrical, electronics and communications engineering, 2006

SHAWNNAH CASTILLO

Software technical project manager at Invetech

Previous: manager, software development, Covidien

Bachelor's, computer science, 2000

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