University of Houston Cullen College of Engineering

[Parameters]

Spring 2013

Building the GRID of the future

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

Dean's Message

One great challenge of engineering is solving the problems of today while considering the implications of these solutions for the future. At the University of Houston Cullen College of Engineering, we are extremely proud of our focus on finding not only the best solutions to the problems we face in the present, but on finding the best solutions for the foreseeable and unforeseeable future – for finding the solutions which guarantee us that, yes, tomorrow will be a little brighter than today.

To ensure that our future is, quite literally, a little brighter, many researchers at the Cullen College are working hard to solve the electricity problems of today while keeping their eyes on the electricity grid of the future. In this issue of *Parameters,* we give you an inside look at the research of five remarkable faculty members who are helping to engineer the grid of the future.

First, we showcase the exciting superconductivity research at the Cullen College, which has proven so successful that the project recently received an early award of $1 million from the Department of Energy's Advanced Research Projects Agency – Energy (ARPA-E) due to the team's impressive progress. We then introduce you to a researcher who is designing high-efficiency, superconducting wind turbines. Next, we feature a researcher determined to engineer more efficient polymer solar cells. Lastly, we highlight one of our industry consortiums, which seeks to make sense of smart grid data through funding provided by its first official member, CenterPoint Energy.

Also in this issue is a special introduction to retired astronaut Dr. Bonnie J. Dunbar, who has joined us as the director of the new UH STEM Center and faculty member in the departments of mechanical and biomedical engineering. Adding to our growing list of distinguished faculty members, Dr. Dunbar represents one of six National Academy of Engineering (NAE) members who have joined the Cullen College in the past three years. Currently, nine NAE members serve as faculty at the Cullen College. As a special welcome to Dr. Dunbar, her feature in this issue of *Parameters* is accompanied by a video of our Q&A session with her, which can be accessed from the Cullen College website.

Warm regards,

Joseph W. Tedesco

Joseph W. Tedesco, Ph.D., P.E.
Elizabeth D. Rockwell Dean and Professor

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Industrial Engineering
Gino Lim

Mechanical Engineering
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Communications Director
Audrey Grayson

Editor
Toby Weber

Graphic Designer
Andy Rich

Photography
Justin Calhoun, Nine Nguyen, TBS Photography

Contributing Writers/Editors
Esmeralda Fisher
John Lienhard
Laura Tolley

Contact us:
Office of Communications
Cullen College of Engineering
University of Houston
E301 Engineering Bldg. 2
Houston, Texas 77204-4009

Phone 713.743.4220
Fax 713.743.8240
E-mail parameters@egr.uh.edu
Website www.egr.uh.edu

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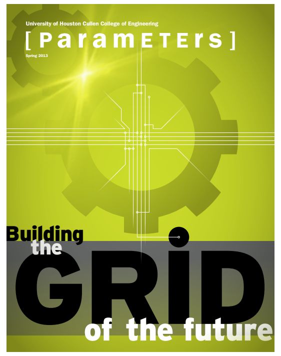


The Grid of the Future

Researchers at the University of Houston Cullen College of Engineering are working to make superconductivity the industry standard for efficient distribution of electrical power. Their research aims to make the country's infrastructure work smarter, not harder.

FEATURES

PARAMETERS - SPRING 2013

Q&A: Bonnie Dunbar

Bonnie Dunbar, retired astronaut, veteran of five space missions and a member of the National Academy of Engineering, joined the University of Houston Cullen College of Engineering as professor of mechanical and biomedical engineering and director of a new university STEM Center (science, technology, engineering and mathematics). Dunbar, who received her Ph.D. in biomedical engineering from the Cullen College, will lead efforts at the university to improve enrollment and retention in the STEM fields and offer educational resources aimed at improving scientific literacy among the general population.

You've dedicated much of your post-astronaut career to STEM education initiatives. How did you get involved in this field?

After completing my space flight career, I was selected as assistant director at the NASA Johnson Space Center, with responsibility for university research and relations. In 1998, we were actively engaged in designing and building the International Space Station. Many of our contractors were expressing concerns that they couldn't find engineers… especially U.S. citizen engineers. We soon realized that the pipeline for engineering students was starting to decline, and, in fact, many high school students either didn't know what an engineer did, or graduated without the required math and physics to enter an engineering curriculum.

We decided to be more proactive at the high school level, starting the Texas Aerospace Scholars program for high school juniors at the NASA Johnson Space Center. High school juniors from throughout Texas would spend a week working shoulder-to-shoulder with our scientists and engineers to design a mission to Mars. It was tremendously successful – for most of the students it connected the dots between math and science, and how these subjects were used to solve real problems and to design, create and build the world around us.

It was for this STEM background that I eventually was recruited by the Seattle Museum of Flight to be their president and CEO. It is more than an aerospace museum – it is also a STEM "informal" education center. Approximately 140,000 students participate in its programs annually.

What brought you to UH?

I received a visit from Dean Tedesco, who provided an exceptional opportunity: to teach in engineering and to establish a STEM Center at the university. Teaching will include developing a course centered on human space exploration, which will be designed to inspire our freshmen and sophomores to continue onto graduation.

The STEM Center is perfectly aligned with the direction of the university – which reached a Tier One research ranking – and both state and national goals for STEM recruitment. I also met with and was very impressed by UH Chancellor and President [Renu] Khator. I believe that under her leadership, that this is a team effort which has the commitment of not only the university, but also of the community. We all recognize the challenge. The solution must be integrated: the university community, the K through 12 community, business, government and the media – we need to unite together to execute a solution that will work.

So the goal is to feed the STEM pipeline?

Yes, but that pipeline is complex. We need to inspire more students, and earlier, to study math and science, and to pursue science and engineering careers. And we need to ensure that when they graduate from high school they are not just inspired, but their preparation in math, physics, and work and study skills will allow them to succeed, wherever they decide to continue their education.

We also desperately need more teachers who are certified in math, science, physics and chemistry. For those not yet certified, we hope to help make them more comfortable with the academic content, more technologically literate.

And we also intend to work with parents because parents have a significant influence on their children.

There is general consensus that this is a national crisis. This was well described in the National Academy of Engineering report, "Gathering Above the Rising Storm." We must act now to stay economically competitive and to be prepared to meet the "grand challenges" of the future.

How do you go about doing all of this?

We're not building a new large infrastructure. All of the STEM-related colleges at UH, including the College of Engineering, already have excellent [STEM-related] programs. First, we will help to coordinate across the colleges, provide more visibility through an integrated STEM website, provide more community outreach and provide a single STEM office focal point for the university.

The newly designed website, which will be launched soon, will serve a diverse audience: not just students, but faculty and teachers, parents and other stakeholders. Students will be able to find programs for middle school, high school and undergraduate levels. Teachers will be able to find STEM programs designed for them, employers will be directed to the Engineering Career Center, and parents will be able to learn what academic outcomes their children must have to major in various science and engineering fields. We will also have a feature on "fact or fiction" based on what is being reported in the media.

However, if we are to make meaningful and rapid change, we must also solve the public media messaging about scientists and engineers. Mathematicians, chemists, engineers and physicists are solving the problems we face everyday. These professionals are historical and current heroes of society and civilization – but not often recognized as such. They not only design solutions for communications, transportation, shelter, food, environmental preservation, medicine and energy, they create this amazing world which connects us together as we have been in no other time in history, and also allow us to explore our earth and the surrounding universe as never before. It is through engineers and science that we are able to transition from dreams and discussions into "actually making it happen." How can we better communicate this to the general public as well as our elected leaders? We are most definitely open to recommendations in this regard.

Top to bottom: *An image of earth captured during Dunbar's second flight on the Columbia Space Shuttle (STS-50); Official crew portrait for STS-32, the ninth launch of Space Shuttle Columbia; Dunbar aboard Space Shuttle Columbia. Photo credits: NASA*

Watch the video of this Q&A with Dr. Dunbar at www.egr.uh.edu

Find the STEM Center online: *UHSTEM* *@UH_STEM_Center*

Subsea M.S. to be Offered Online

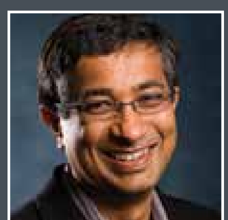
Last year, the University of Houston's Cullen College of Engineering won permission to offer the nation's first and only master's degree in subsea engineering. This fall, nearly all the program's courses will be offered online.

Subsea engineering focuses on the design and maintenance of the infrastructure and tools used in offshore petroleum exploration and retrieval. The program began by offering courses toward earning subsea engineering certificates in the spring semester of 2011. In the fall of 2012, the college won approval from the Texas Higher Education Coordinating Board to offer an M.S. in the field.

According to Matt Franchek, program director and professor of mechanical engineering, the program is designed for professional, working engineers. By adding an online option, "we're offering these professionals greater flexibility in their studies. At the same time, by going online we're allowing engineers across the country and even outside the U.S. [the opportunity] to earn a master's in the field."

Students in the Houston area will be able to take online courses but will still be required to come to the university for some computer lab simulation work, Franchek noted. Those further away will be able to complete these simulations through distance-learning applications.

In other subsea news, the program recently received a $905,000 gift from National Oilwell Varco (NOV) to establish the National Oilwell Varco Computational Engineering Laboratory. The lab will be used to perform detailed computational calculations on complex subsea equipment and will support the subsea engineering curriculum and students, enabling them to complete capstone design projects using the latest in computational subsea engineering tools.



Former ChBE Chair to Lead UH Energy

Ramanan Krishnamoorti has stepped down as chairman of the Cullen College's chemical and biomolecular engineering department to serve as special assistant to University of Houston president/chancellor Renu Khator for UH Energy, a collection of the university's preeminent energy research and education programs.

Krishnamoorti will lead UH's efforts to develop a strategic plan for UH Energy involving education, training, research and the expansion of UH's Energy Research Park (ERP). The initiative includes faculty and researchers in UH engineering, law, business, natural sciences and technology.

In recent years, UH has identified energy as a key strategic focus for research and teaching. The overall vision for UH Energy and the ERP is to build a premier research and education facility for students and faculty as well as establish a unique environment for the best minds to forge new business approaches to the way energy is created, delivered and used.

"The UH Energy initiative is an exciting and important mission, given its location in the world's energy capital," Krishnamoorti said. "I will be working on developing a comprehensive strategic plan designed to capitalize on the abundance of energy-related talent and resources here at UH."

"I also will be working on growing our global partnerships with industry in regards to education and research," Krishnamoorti added. "This strategic plan also will involve the development of degree and non-degree programs using online and offsite delivery mechanisms."

Mike Harold, M.D. Anderson Professor of chemical and biomolecular engineering, has been named the new department chair. Harold previously led the department from 2000 to 2008. He is currently director of the university's Texas Center for Clean Engines, Emissions & Fuels and is editor of the AIChE Journal, the flagship publication of the American Institute of Chemical Engineers.

UH CO-HOSTS Brain-Machine Interface Conference

The world's leading figures in the field of brain-machine interfaces came to Houston in February to create a roadmap for bringing the field's advanced research to clinical settings.

The 2013 International Workshop on Clinical Brain-Neural Machine Interface Systems was co-hosted by the University of Houston and The Methodist Hospital Research Institute. Jose Luis Contreras-Vidal, professor of electrical and computer engineering in the university's Cullen College of Engineering, served as the event's chairman.

Attendees to the invitation-only conference included researchers in robotics, neuroscience, neural engineering and other fields, as well as clinicians, regulators, industry, entrepreneurs and more. The event was also denominated a "National Robotics Initiative Workshop" by the National Science Foundation and the National Institute of Neurological Disorders and Stroke, which were also major sponsors of the workshop, along with TIRR Memorial Hermann and UH.

According to Contreras-Vidal, the past few years have seen incredible advances in brain machine interface systems, which can be used to control advanced prosthetic limbs and robotic exoskeletons, for example. A pressing question now is how to bring these advances to the clinic in the quickest, safest and most responsible manner.

Given the large number of patient populations and technologies involved in brain-machine interface systems, a final roadmap will likely take months to years to produce. Conference attendees, however, agreed on some basic aspects of its framework, such as the need to put patient-centered metrics at the center of BMI-related research and clinical developments as well as the value of both invasive and non-invasive technologies for recording brain signals.

For more information, visit bmiconference.org.

ENGINEERING extras

UH Plans Health Science Center

» The University of Houston System Board of Regents has approved the creation of a Health Science Center at UH. UH is now seeking approval of the Health Science Center from the Texas Legislature. If legislative approval is secured, the university will plan for an official launch of the center in fiscal-year 2014. The center's work will include patient care, workforce training, and research and community outreach.

UH Ranks High Among International Students

» The University of Houston ranks among the top 25 colleges and universities in the nation for hosting the most international students on its campus in 2011-2012, according to the Institute of International Education (IIE). The second-most ethnically diverse urban research university in the country, UH hosts nearly 5,000 international students, predominantly from China, India, Vietnam, Nigeria and South Korea. Support services for these students include the Office of International Studies and Programs, the International Students and Scholars Services Office, and the UH Language and Cultural Center, which helps them become acquainted with American culture and more fluent in the English language.

UH Holds Entrepreneurism Event Geared To Women

» Women faculty, researchers and professionals in the STEM fields recently gathered for "Understanding the Entrepreneurial Landscape: What Women STEM Faculty Need to Know," an event held at the University of Houston Hilton. Hosted by the UH Cullen College of Engineering, the UH College of Natural Science and Mathematics, the UH College of Technology and Rice University, the one-day conference gave women faculty and post-doctoral researchers an inside look at the business of successfully commercializing university-based science and technology. Leaders from the entrepreneurial and academic communities discussed the unique experiences that women researchers and entrepreneurs face in a business environment.

cullen college news *@UHengineering*

Building the GRID of the future

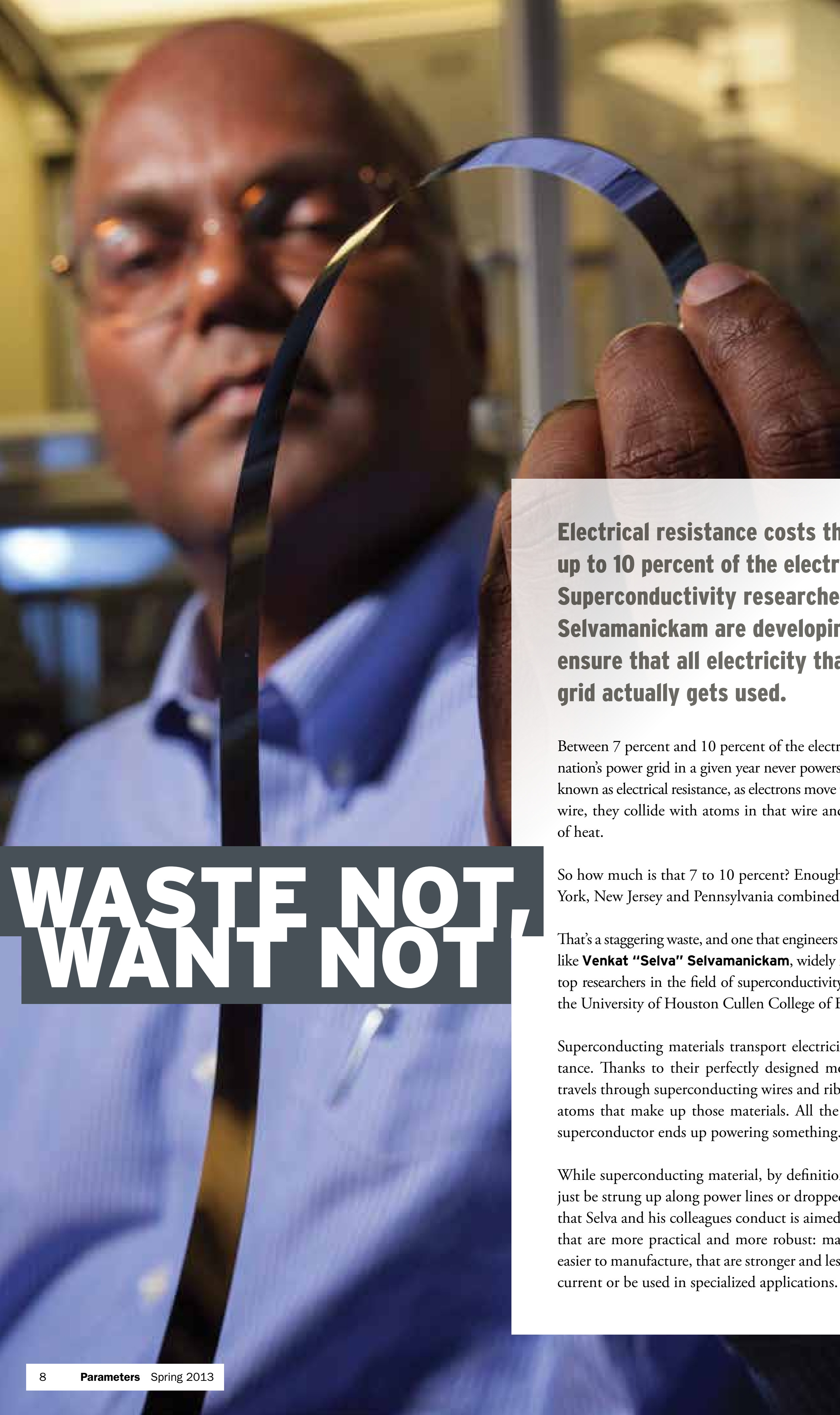
If all goes well, the electric power grid of the future won't be much different from today's grid – at least from the customer's perspective: most of us would still have lighting at the flick of a switch, temperature-controlled air conditioning and plenty of electrical outlets to plug our computers into.

However, such a future depends on alternative sources of energy, such as wind and solar, making important contributions to the power supply. It will also require new smart grid technologies to improve service by matching electricity generation to demand.

At the University of Houston Cullen College of Engineering, researchers are striving to make this future possible. Mechanical engineering researchers like Venkat Selvamanickam and Philippe Masson are developing economically compelling superconductor-based wind turbines that are smaller and more powerful than anything currently on the market. Gila Stein from the Department of Chemical and Biomolecular Engineering is using funds from her NSF CAREER Award to research the fundamental science underpinning polymer-based solar cells. And Zhu Han and Amin Khodaei from electrical and computer engineering have formed what may be the first academia-based industry consortium dedicated to analyzing data generated from new smart electric power grid components to help utilities improve service, plan capital investments and forecast power demands.

by **Toby Weber**

photos by **Justin Calhoun**



WASTE NOT, WANT NOT

Electrical resistance costs the United States up to 10 percent of the electricity it generates. Superconductivity researchers like Venkat Selvamanickam are developing materials that ensure that all electricity that travels on the grid actually gets used.

Between 7 percent and 10 percent of the electricity that travels through the nation's power grid in a given year never powers anything. In a phenomenon known as electrical resistance, as electrons move through copper or aluminum wire, they collide with atoms in that wire and then dissipate in the form of heat.

So how much is that 7 to 10 percent? Enough to power the states of New York, New Jersey and Pennsylvania combined, for a full year.

That's a staggering waste, and one that engineers can help eliminate. Engineers like **Venkat "Selva" Selvamanickam**, widely regarded as one of the world's top researchers in the field of superconductivity and a faculty member with the University of Houston Cullen College of Engineering.

Superconducting materials transport electricity with zero electrical resistance. Thanks to their perfectly designed molecules, the electricity that travels through superconducting wires and ribbons never collides with the atoms that make up those materials. All the power that goes through a superconductor ends up powering something.

While superconducting material, by definition, operates perfectly, it can't just be strung up along power lines or dropped into a device. The research that Selva and his colleagues conduct is aimed at making superconductors that are more practical and more robust: materials that are cheaper and easier to manufacture, that are stronger and less brittle, that can carry more current or be used in specialized applications.

Selva has proven expert at these tasks. After earning his Ph.D. from the Cullen College in 1992, he entered industry, where he rose to vice president and chief technology officer of superconducting wire maker SuperPower, Inc. While there, he developed a novel method of manufacturing superconducting ribbon. Selva heats different materials that vaporize and then deposit on a metallic ribbon traveling across a reel-to-reel system (think of an old cassette tape). With this technique, Selva and his collaborators have set multiple world performance records for superconducting materials.

In 2008, Selva returned to the Cullen College as M.D. Anderson Chair Professor of mechanical engineering. Two years later, he was named director of the applied research hub of UH's Texas Center for Superconductivity. In these roles he has maintained a close relationship with SuperPower and its R&D team. The group, in fact, has relocated from New York to the University of Houston's Energy Research Park in order to continue their collaborations with Selva.

One can see why. Since his return to UH, Selva and his collaborators have won major awards on a near yearly basis. In 2009, they received an International Technical Achievement Award from Wire & Cable Technology Magazine. In 2010 and 2012 they won R&D 100 Awards, "the Oscars of Innovation," from R&D Magazine. Perhaps most impressive, in both 2009 and 2010, his high-temperature superconducting wire research was ranked the top research project in the Department of Energy's superconductivity program, as voted on by an international panel of 12 experts in the field.

One of the most recent honors Selva and his collaborators have received isn't technically an honor, but a major vote of confidence from the Department of Energy's Advanced Research Projects Agency – Energy (ARPA-E), which funds high potential, high impact research. Not only did ARPA-E give them an early grant extension for a project led by Selva, but the agency was so impressed by the team's work that it actually increased the project's total funding by $900,000.

The research group is composed of Selva and his UH collaborators, SuperPower, the DOE's National Renewable Energy Laboratory, Tai-Yang Research and TECO-Westinghouse Motor Company. They are developing wind turbines that use superconducting wire to generate electricity, which would allow for more efficient and more affordable units.

Wind turbines, however, generate magnetic fields, which results in magnetic flux lines – essentially the pull of magnetism – running through and moving within the superconducting wires. These flux lines interfere with the wires' ability to transport electricity, lowering its performance. The result is less efficient, more expensive turbines.

In response, Selva and his collaborators are introducing small particles (measuring just a few billionths of a meter) of non-superconducting material into the superconducting wire. These particles essentially pin down the flux lines, holding them in place. With their movement inside the wires halted, the superconducting material's performance is restored.

The ultimate goal for the three-year project is to improve the performance of superconducting wire used in wind turbines by 400 percent. To achieve this, the research team was given $2.1 million for the first 18 months of the grant period, set to end in June 2013. At that point, a review of their progress would have determined whether the team would get the final $1 million to continue their work.

Just nine months into the grant, though, the researchers had already achieved impressive results. While they were aiming for a 50 percent improvement by the end of 2012, they hit the 65 percent mark by the end of September.

ARPA-E administrators were so impressed by the team's progress that they released the final $1 million ahead of schedule, on top of awarding the researchers the additional $900,000 to perform their work.

"They saw the progress we made in the first three quarters," Selva said. "They said that rather than wait until June of next year to make a decision, they would give us a performance-based acceleration of the award. Not only that, they actually found more funds, so they increased the total project to $4 million."

The extra funding, said Selva, will allow the group to accelerate its research and bring more people into the research team via graduate student and post-doctoral positions. "This is something I feel very happy and proud about," said Selva. "Just getting funding is a good thing, but to get funded based on performance, on what you've achieved, is very gratifying."

HARNESSING THE WIND WITH "A BLANK SHEET OF PAPER"

Superconducting wind turbines could generate electricity much more affordably than their more traditional counterparts.

Making these devices work, though, will require an entirely new turbine design.

Philippe Masson has wanted a career as an academic researcher since his undergrad days. So it's ironic that, with that goal finally achieved, his three-year stint at a high-tech start-up is playing such a pivotal role in his work.

Masson is an assistant professor with the University of Houston Cullen College of Engineering and a member of the applied research hub of UH's Texas Center for Superconductivity. Hired last year through a grant from the state of Texas' Emerging Technology Fund, he is now a key member of the UH-led team tasked with building high-efficiency superconductor-based wind turbines. "The objective of the project is to develop a new conductor and then show the impact it has on the cost of energy," said Masson. "Based on that conductor, we're designing a new generator from a blank sheet of paper." (For more on the superconductor research at the center of this project see p. 8.)

The ultimate measure of this work will be a new cost-of-energy model being developed by NREL, the National Renewable Energy Laboratory, an official collaborator on the project, Masson said. While the performance of the superconducting wire itself will obviously play a central role in how well the turbine scores, other factors such as manufacturing, installation and maintenance costs will contribute to the final outcome of this effort. Helping design and develop the entire turbine with such factors in mind is one of Masson's primary goals.

"We need to consider the contributions of all these things," said Masson. "I took this approach during my three-year stay in industry. I dealt with an idea all the way from design and optimization through manufacturing. We had to build a prototype and extrapolate how much it would cost in mass production."

Taking these logistical and real-world considerations into account means that not every aspect of design will be aimed toward producing the most powerful generator possible, Masson stated. If a particular component offers only a small increase in efficiency but requires a much larger initial investment or more maintenance costs down the road, it is not likely to be included in the final project.

The use of superconducting wire in the turbine greatly increases the complexity of such design effort, said Masson. On the most basic level, no one has ever built a high-temperature superconducting device of the size this group is attempting to build. That alone adds to the degree of difficulty. There are many unanswered and even unasked questions about how to do what they are doing and simple extrapolations from other devices and existing research can't solve every problem.

Then there are the challenges of working with the superconducting wire itself.

This particular superconductor, YBCO (yttrium barium copper oxide) must be cooled in order to maintain its superconducting properties. The turbine Masson is designing, then, must include a cooling system that is not required in traditional wind turbine designs. What's more, the mechanical design – how the different components come in contact and work together – must account for and try to prevent excessive heat transfers.

Another significant challenge is simply getting the superconductor into its necessary coil shape and sealing it in protective epoxy without damaging it. For this task, Masson is designing a machine that can wrap the superconducting wire without bending or kinking it. "You need a special machine to do that because at all points you need to control the tension of the superconductor," he said. "You also need to be able to do wet winding, where you can form the coil while also sealing it in epoxy or something similar."

Not all of Masson's efforts on this project deal with logistical concerns and technology development. He's also tasked with answering some questions of basic science that, if left unanswered and unaddressed, could dramatically lower the performance of these turbines.

Chief among these is the interaction of various mechanical factors and electromagnetic properties at play in a superconducting wind turbine. "Mechanically and electromagnetically, there's a lot going on in a wind turbine," he said. "In the generator you have an AC field and current, but you also have a rotating electromagnetic field and a transport current. Everything is out of phase and nobody has studied that."

Using computer simulations, Masson is exploring how these interactions impact energy losses during turbine operation. His findings so far are eye opening, with losses that are two to three times higher than estimated. The next step in this process, he said, is conducting experiments to validate these theoretical models and then factoring in these findings in the final turbine design.

If all this – logistics, technology, basic science research – seems like a lot to tackle, that's because it is. In Masson – an academic with a background in business, a researcher with expertise in superconductivity, a technician with experience in logistics – the Cullen College has found just the right person to take a custom designed superconducting wire and build the best possible wind turbine around it.

WRINGING POWER FROM POLYMERS

Supported by a CAREER Award, Gila Stein is working to improve the efficiency of polymer solar cells while maintaining their existing advantages over their silicon-based counterparts.

Gila Stein knows that, from a commercial perspective, polymer-based solar cells don't make much sense. She's just out to change that.

Stein, an assistant professor of chemical and biomolecular engineering with the University of Houston Cullen College of Engineering, is rethinking and reworking how these solar cells are made in an attempt to dramatically improve their ability to convert sunlight to electricity.

Using current fabrication techniques, polymer solar cells have reached approximately 11 percent efficiency in the lab and only about 2 percent in the field, Stein said. Standard silicon solar cells, on the other hand, have topped 20 percent efficiency in real-world installations.

So why bother with polymers? Because in most ways other than energy conversion, they actually do make sense – a lot more sense than silicon solar cells, in fact. Polymer-based cells are lighter and more durable than silicon cells, they are cheaper and easier to produce, and they have a lower raw materials cost.

Hence, Stein is working to build a more efficient polymer solar cell, aided by a $500,000 CAREER Award from the National Science Foundation as well as an $80,000 grant from the State of Texas' Norman Hackerman Advanced Research Program.

Stein's research in this field will focus on the solar cell's active layer. This layer consists of the polymer film that receives sunlight and produces electrons, as well as the material that receives these electrons (which in Stein's research is a spherical carbon molecule known as fullerene), and the interface between the two.

Existing polymer solar cell fabrication techniques don't control the active layer structure. One popular fabrication method, for example, consists of mixing polymer and fullerene in solution, spreading the solution out and evaporating the liquid.

"It's very disordered and poorly controlled," said Stein. "We're focusing on ways to control the distribution of polymer and fullerene instead of just relying on a spontaneous process that is incredibly sensitive to processing conditions and varies substantially from one polymer to another."

Still in the first months of a five-year grant, Stein has been focusing primarily on developing methods to fabricate the polymer film in such a way that it has a rational, controlled structure.

One aspect of this, she said, is decoupling the nanostructure of the polymer from its molecular structure. She has, in fact, already published one paper on controlling the nanoscale structure of the polymer film and is preparing another on efforts to control the molecular structure.

The nano-themed paper, which appeared in the July 20th issue of ACS Applied Materials and Interfaces, outlines her team's use of electron beam patterning to create conductive, cross-linked microstructures. Working in the University of Houston's Nanofabrication Facility, Stein and her research group were able to adjust the size, shape and density of these structures – an important advance for the study of polymer-based solar cells.

"The ultimate goal of this project is to improve the efficiency of polymer-based solar cells. Developing the ability to control the characteristics of the structures on the polymer film will allow us to study which combination of shape, density and size results in best electricity generation," she said.

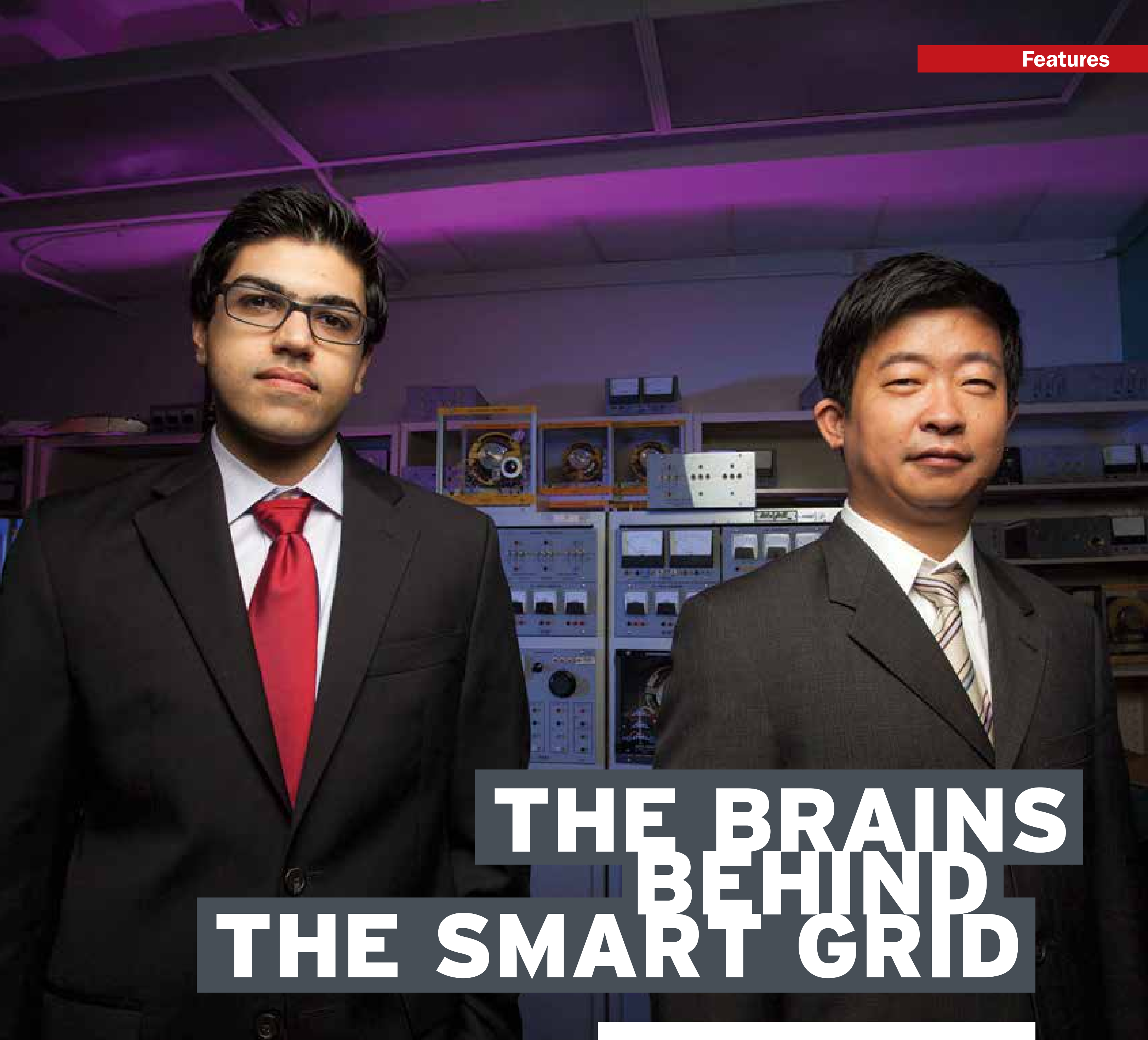
Stein has also demonstrated the ability to at least partially control the polymer film at the molecular level through post-deposition processing. By washing the polymer in certain solvents, Stein explained, "we can flip the crystal orientation so that they're basically aligned with the electric field."

"We dissolve the old crystals and reform them along different directions. These are pretty disordered structures, so they are not all perfectly aligned, but there's a nominal alignment," she said.

For the work of Stein and other polymer solar cell researchers to be considered successful, they will need to reach a commercially viable level of sunlight-to-electricity conversion, which is generally held to be at about 10 to 15 percent efficiency in the field. Even when that is reached, however, polymer-based cells might not displace inorganic solar cells in large installations, Stein said. The gap in performance and stability is just too large and will likely remain, given that inorganic cells are themselves being researched and optimized for better performance.

Instead, commercial polymer solar cells would likely be used off the traditional electric grid for powering small devices. They could be integrated into backpacks, briefcases, or tents to power small devices.

"Polymer solar cells are not going to be most efficient, but they should be the cheapest," she said. "Maybe they don't make it to rooftop installations, but for other applications, they could be quite useful."



THE BRAINS BEHIND THE SMART GRID

Smart grid components are already generating billions of reports on electricity usage each day. Cullen College researchers are dedicated to finding the information amid a vast amount of data.

The smart grid isn't so smart after all, at least on its own.

The collection of meters and monitors that gather and report real-time information on electricity generation, transmission, distribution and usage represents the most significant change in the history of the electric power grid. By analyzing smart grid data, the theory goes, electric utilities will be able to forecast electricity demand more accurately, invest more wisely in new power generation capacity, reduce green-house gas emissions, improve grid reliability and much more.

The problem, though, lies in the sheer volume of data generated by the smart grid. A smart meter sitting at a customer's home or business typically produces an electricity usage report every 15 minutes. Some metropolitan areas already have millions of installed smart meters that combine to produce hundreds of millions of reports each day. Finding meaningful information and trends among those big data sets is a huge challenge.

That's where **Zhu Han** and **Amin Khodaei** come in. Han is an associate professor in the University of Houston Cullen College of Engineering's electrical and computer engineering department; Khodaei, a research assistant professor in that same department. Together, they have formed the Electric Power Analytics Consortium, the first and only university-based industry consortium dedicated to making sense of smart grid data.

The consortium was founded earlier this year and has signed Houston-based CenterPoint Energy as its first official member. It exists to develop computational techniques and mathematical models to make the best use of the data gathered from smart meters and other components of new smart electric power grids.

"Right now companies are collecting this data but don't have viable business and mathematical models to capture the benefits of this capital-intensive investment," said Khodaei, the consortium's co-principal investigator. "They have some vision, but they need university skills and expertise to extract important knowledge from the data and transform it into business ideas."

The structure of the consortium is somewhat unusual for academic research, noted Han, principal investigator and director of the consortium.

Typically, when businesses fund university research they do so through individual grants given to professors to explore specific problems. Through the consortium, though, companies in the electric power industry pay an annual membership fee. During regular consortium meetings, members discuss industry challenges and how smart grid data can be leveraged to solve them. The dues these members pay will allow the consortium researchers to develop solutions to these challenges, often by funding graduate student and postdoctoral researcher positions.

Pictured: Amin Khodaei (left) and Zhu Han.

Beyond the obvious benefits – more research funding for the professors; better data analytics for the companies – this arrangement offers additional benefits to all parties involved. Data analytics professionals working for the utilities will have access to the academic papers generated by the consortium, as well as to expert researchers who can help them solve specific problems. By funding additional graduate student/postdoc positions in the field of smart grid data analytics, the utilities are increasing the number of trained and talented people in this sector who will be available for hire in the future.

At the same time, Han said, by forming partnerships with these firms, the consortium researchers gain access to real-world data on electricity generation transmission, distribution and usage. Working with this raw real-world data instead of data gathered from simulations will make the data analysis tools they develop far more sophisticated and accurate.

And through their regular meetings and the different perspectives they bring to the table, the researchers and companies will all gain deeper insights into the future of the smart grid and smart grid technologies.

According to Han, the first official meeting of the consortium took place in February. Based on that conversation, one of the first topics the researchers will address will be developing algorithms to improve recovery times after a severe weather event such as a hurricane. By using smart grid data to identify key points in the grid, utilities will be able to dedicate manpower to the repair of those points, resulting in the quickest restoration of service to the greatest number of customers.

Other proposed research areas include management of smart meter data; transmission and distribution expansion planning; customer participation in grid operations; customer satisfaction; asset management; distributed energy research integration; smart homes and buildings; cyber-security; catastrophe modeling; and the impact of plug-in hybrid electric vehicles on the grid.

All these topics, and really any and everything else having to do with electricity generation, transmission, distribution and usage, are open to research by the consortium and its members.

"There's incredible potential in smart meters and smart grid technology," said Han. "This consortium will allow us to work closely with industry members so we can really understand their challenges and find the best ways to solve them through data collection and analysis."

Flexible, Stretchable Battery Research
Earns CAREER Award

Assistant professor of mechanical engineering **Haleh Ardebili** has won a five-year, $400,000 National Science Foundation CAREER Award to explore the fundamental science underpinning flexible, stretchable lithium ion batteries.

According to Ardebili, such batteries could be integrated into textiles or worn around the wrist like a bracelet, opening them up to many potential applications.

One of the biggest hurdles to developing these batteries is understanding how bending and stretching will impact their ability to store and discharge energy. "If it stretches, we have to make sure it does not lose its electrochemical performance," Ardebili said. "That's the motivation to study the fundamental side of it. We want to understand the relationship between the mechanical strain and stress applied to the battery and how it performs."

This relationship, Ardebili added, will be greatly influenced by the different components used in the batteries. She will therefore work to develop battery components that offer the best combination of stability and performance, with a particular focus on developing polymer nanocomposite electrolytes that offer high ion conductivity and that maintain their physical integrity even when bent or stretched.

"Technology has been moving in this direction for some time," said Ardebili. "Whether they're used in flexible electronics, for medical applications or for something else, these batteries can provide an additional feature that electronics developers can work with."

Nanoporous Gold Disks
Boost Molecular Detection

Wei-Chuan Shih, assistant professor of electrical and computer engineering, has developed a novel substrate for surface-enhanced Raman Spectroscopy that radically improves the technology's ability to sense molecules. Possible applications include everything from medical diagnostics to environmental monitoring. His findings were published in a recent issue of the journal Nanoscale.

In standard Raman spectroscopy, a laser is shined on an area that is believed to contain unknown molecules. How that laser light scatters, as evidenced by its change in color, can reveal whether and what kind of molecules are present.

In surface-enhanced Raman spectroscopy, the sample being studied is placed on a surface with plasmonic properties. Essentially, when a laser is shined on such a surface, it creates an enhanced electrical field. This field in turn enhances the ability of nearby molecules to scatter the laser light. As a result, a smaller number of molecules can generate more scattered light, resulting in improved detection sensitivity.

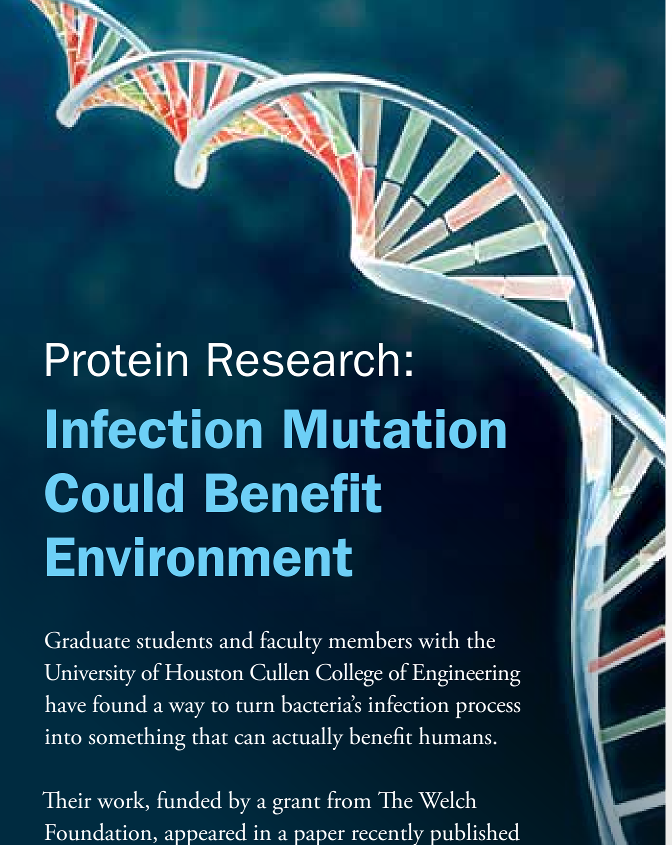
Shih's advance centers around a hierarchical gold nanostructure – nanoporous gold disks each measuring 500 nanometers (nm) in diameter and 75 nm thick with an internal porous network 7 nm in diameter. The nanofabrication of this structure is carried out in the lab of electrical and computer engineering professor Jack Wolfe.

The synergy between the disk shape and the internal pores, Shih said, drastically improves the ability to sense nearby molecules, resulting in an enhancement factor of roughly 100 million compared to standard Raman spectroscopy. "I think the magic arises from plasmonic coupling between the disk shape and the nanopores. You don't see this improvement in a uniform nanoporous thin film," Shih said.

In addition to being more sensitive, there is low variability among the gold disks, yielding more consistent results from one test to another. What's more, the disks on the substrate can be cleaned with water or even a bath of hydrosulfuric acid, allowing the sensing surface to be used in a harsh environment or to be regenerated.

Wei-Chuan Shih

Assistant Professor of Electrical and Computer Engineering



Protein Research:
Infection Mutation Could Benefit Environment

Graduate students and faculty members with the University of Houston Cullen College of Engineering have found a way to turn bacteria's infection process into something that can actually benefit humans.

Their work, funded by a grant from The Welch Foundation, appeared in a paper recently published by the Journal of Biological Chemistry. The article was authored by Ph.D. student **Balakrishnan Ramesh** and post-doctoral researcher **Victor Sendra**, working with their faculty mentors, associate professor **Patrick Cirino** and assistant professor **Navin Varadarajan**, both in the college's chemical and biomolecular engineering department.

The paper outlines their work on a class of proteins known as autotransporters. Bacteria produce autotransporters and then move them to their outer surface, where they're involved in a number of processes, including recognizing other bacteria and infecting human cells.

Working outside the cell, the research team used well-known recombinant DNA techniques to engineer a piece of DNA that would create mutated autotransporter proteins. They then inserted this DNA into bacteria, where it produced the recombinant proteins.

These mutated autotransporters, however, are far more intricate than naturally occurring ones, requiring complex disulfide chemical bonds to maintain their proper shape. Many researchers believe it is not possible for autotransporters that utilize disulfide bonds to follow the normal pathways to move out of bacteria, Ramesh noted.

This research team, however, has engineered disulfide-utilizing autotransporters that have moved to the bacteria's outer surface, a feat achieved by adjusting where exactly on the protein the genetic modification appears. Possible uses of this finding include vaccine development and degrading or consuming pollutants.

Professor Wins
$1M Water Monitoring Grant

Debora Rodrigues, assistant professor of civil and environmental engineering, has won a $1 million grant from the Qatar National Research Fund to develop a water monitoring system that guards against disease- and corrosion-causing bacteria in water systems in real time.

Rodrigues is developing the technology in collaboration with Abdelhak Bensaoula, research professor of physics and electrical and computer engineering, and Mounir Boukadoum, a professor of microelectronics engineering at the Université du Québec à Montréal and an adjunct professor of electrical and computer engineering at UH.

The system they are creating is designed to be placed in pipelines that carry water to and from water treatment plants. At its heart is a class of molecules known as aptamers, which can be designed to detect specific bacteria. The aptamers Rodrigues is using will be built to bond with disease-causing bacteria and bacteria that causes corrosion in water pipelines.

In addition to bonding with harmful bacteria, these aptamers will have another important characteristic: when they do form a bond, they will emit fluorescence. At that point, an optical sensing tool will record the fluorescence. Factoring in environmental conditions, if the threshold fluorescence is met due to a certain minimum concentration of hazardous bacteria, the system will send an alert to authorities overseeing water systems. "The idea is to predict so you can solve a problem before it gets bad," Rodrigues said.

Faculty Developing
Battlefield Drug Delivery System

Mechanical engineering professors **Karolos Grigoriadis** and **Matt Franchek** are working with physicians at the University of Texas Medical Branch (UTMB) at Galveston to develop a system that automatically delivers medications and fluids to the cardiovascular system. The research team has won a three-year grant from the Office of Naval Research that includes $561,000 supporting the UH investigators.

The automated system, intended for battlefield or other emergency situations, will include a set of cardiovascular medications, such as those intended to raise or lower blood pressure or heart rate, which will be attached to an IV line inserted into the patient. Simple monitoring equipment will feed information on the patient's condition into a computer that controls the system. From there, algorithms will use that information to determine which medications and dosages to deliver to the patient.

Developing these algorithms is where much of the UH work lies, said Grigoriadis. Using data provided by UTMB-Galveston, the research team will first create mathematical models of how the cardiovascular system responds to different medications. "The first objective of this research is to provide a quantitative model of the effects of the drugs on physiological variables like blood pressure and heart rate. With that information, we will try to automate the delivery of these drugs and fluids through a system that can be used on a battlefield, a hospital, or during emergency care."

The algorithms, Grigoriadis noted, will be able to adjust the medications being delivered depending on how the patient is responding. They will also take into account how different drugs interact with each other and calculate the best combination of medicines for a particular patient.

Faculty News

photo by Justin Calhoun

Shankar Chellam

Professor of Civil and Environmental Engineering

Education

Ph.D. Environmental Science and Engineering
Rice University

Career Overview

Chellam completed his Ph.D. dissertation “Laminar Fluid Flow, Particle Transport, and Permeate Flux Behavior in Crossflow Membrane Filters” under Mark Wiesner at Rice University. For the next four years he worked in the Applied Research Department of Montgomery Watson Inc. There, he was tasked with developing, implementing and evaluating innovative water treatment techniques. He joined the Cullen College’s department of civil and environmental engineering in 1999 as an assistant professor, was first promoted to associate professor in 2004, and then to professor in 2008. He has authored/co-authored more than 75 peer reviewed journal publications, five book chapters and has given nearly 20 invited conference/workshop presentations along with scores of academic seminars.

Research Interests

A portion of Chellam’s research involves identifying the elemental fingerprints of anthropogenic and natural air pollution sources. By measuring unique metallic markers, he quantifies the contributions of petroleum refineries, motor vehicles, as well as urban and desert dust to ambient airborne particulate matter. Such information can help determine important sources of particulate pollution and contribute to informed policy decisions regarding air quality management. He is currently studying the real-world emissions of gasoline-driven vehicles by collecting samples in the Washburn Tunnel – Texas’ only tunnel open to traffic – which runs under the Houston Ship Channel and is off-limits to large diesel-driven vehicles. Chellam also conducts extensive research in the area of innovative water purification methods. His research includes developing electrochemical methods of coagulating viruses, bacteria and colloidal matter. These large groupings of material can then be removed with membrane filters at lower cost and with lower energy consumption. He also develops innovative virus disinfection methods that exploit photocatalytic properties of fullerene nanoparticles. Chellam stressed that his research team, including doctoral students Neranga Gamage, Charan Tanneru, Nick Spada, and Mutiara Ayu Sari and postdoctoral researcher Ayse Bozlaker, play central roles in all these efforts.

Accolades

CHEMICAL AND BIOMOLECULAR ENGINEERING

Mike Harold has been appointed chair of the department of chemical and biomolecular engineering and interim associate dean of research and facilities.

Ramanan Krishnamoorti was selected by the Indo-U.S. Science & Technology Forum as one of the U.S. partners for establishing an Indo-U.S. joint center on applications of nanoparticle assemblies.

Dan Luss was selected as a National Academy of Inventors Charter Fellow.

Jeffrey Rimer’s article titled “Controlling Crystal Polymorphism in Organic-Free Synthesis of Na-Zeolites” was featured on the cover of the February 20th issue of the Journal of the American Chemical Society (JACS). Rimer’s article was also chosen as the spotlight publication in this issue of JACS.

Navin Varadarajan won a research grant for $1.28 million from the Cancer Prevention Research Institute of Texas (CPRIT) to research immunotherapy.

CIVIL AND ENVIRONMENTAL ENGINEERING

Craig Glennie received the 2013 Talbert Abrams Award for his paper, “Calibration and Kinematic Analysis of the Velodyne HDL-64E S2 LiDAR sensor,” published in the journal Photogrammetric Engineering & Remote Sensing (PE&RS). The award was given by the American Society for Photogrammetry and Remote Sensing for the best journal paper in PE&RS.

Jerry Rogers has been named to two national-level engineering committees: for the American Society of Civil Engineers’ (ASCE) Annual National Conference in Panama City, Panama in 2014, Rogers will sit on the History and Heritage Committee’s (HHC) Subcommittee on the Panama Canal Centennial History (1914-2014); Rogers will also serve on the American Water Resources Association (AWRA) 50th Anniversary Committee.

Cumaraswamy Vipulanandan received the Abraham E. Dukler Distinguished Engineering Faculty Award from the UH Engineering Alumni Association.

ELECTRICAL AND COMPUTER ENGINEERING

Shin-Shem Steven Pei and **Jiming Bao** are co-authors of “Growth from Below: Bilayer Graphene on Copper by Chemical Vapor Deposition,” an article published last year in New Journal of Physics (NJP) which has been selected for inclusion in the exclusive Highlights of 2012 collection. The full list of selected article highlights is available at www.njp.org/highlights-2012.

MECHANICAL ENGINEERING

Benton Baugh was selected as a National Academy of Inventors Charter Fellow.

Yashashree Kulkarni was named Bill D. Cook Assistant Professor in 2012. The Bill D. Cook Fellowship is a mechanical engineering endowment designed to attract and reward emerging young faculty.

Venkat Selvamanickam received the Entrepreneur/Innovation Award from the UH Engineering Alumni Association. Selvamanickam was also elected as a senior member of the Institute of Electrical and Electronics Engineers (IEEE).

Pradeep Sharma has been selected for a Fulbright Scholarship under the Fulbright Specialist Program. Sharma was also selected as a fellow of the American Society of Mechanical Engineers (ASME), the highest elected membership level within ASME. In addition, he was chosen by the Indo-U.S. Science & Technology Forum as one of the U.S. partners for establishing an Indo-U.S. joint center on energy storage.

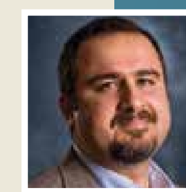
Gangbing Song received the 2012 Educational Activities Board Meritorious Achievement Award in Informal Education from the Institute of Electrical and Electronics Engineers (IEEE). Song also received the 2012 Celebrating Excellence Award for Excellence in Education from the International Society of Automation.

New Faculty

Bonnie Dunbar, Ph.D.

Professor, Mechanical Engineering & Biomedical Engineering

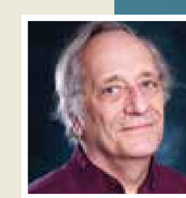
Dunbar is a retired astronaut, veteran of five space flights and a member of the National Academy of Engineering. A Cullen College alumna, she returned to UH this January to lead a new University STEM Center (science, technology, engineering, mathematics) dedicated to improving STEM literacy in the general population and inspiring more young people to earn degrees in the STEM fields. As an engineering faculty member, she also plans to develop and teach a new undergraduate course designed to inspire and retain engineering undergraduate students. The course will explore how engineering has shaped the world throughout history and will be presented through the lens of aerospace and space exploration.



Nuri Ince, Ph.D.

Assistant Professor, Biomedical Engineering

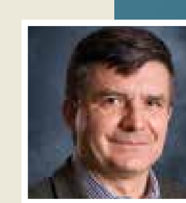
Ince is an expert in the field of translational neuroscience, with an emphasis on neural signal processing. His current research includes an NSF-funded effort to improve deep brain stimulation for Parkinson’s Disease patients by developing methods to identify the targeted brain regions during probe implantation. He is also working to decode movement intentions in the brain recorded by multi-channel electrocorticography grids. The ultimate goal of this project is to allow amputees and individuals suffering from spinal cord injuries to control advanced prosthetic devices through a brain-machine interface.



Michael Myers , Ph.D.

Associate Professor, Petroleum Engineering

Myers, a long-time adjunct professor in the Cullen College’s petroleum engineering M.S. program, joined the college as an associate professor on March 1 of this year. His research interests include understanding the transport, electrical and mechanical properties of shale gas/tight gas reservoirs; the prediction of rock properties (static and dynamic) from 2D and 3D images of rocks; measuring and modeling the mechanisms for acoustic dispersion in reservoir rock; and understanding the stress conditions and material models that allow the formation of deformation bands in unconsolidated sands.



Ahmet Omurtag, Ph.D.

Assistant Professor, Biomedical Engineering

An expert in computational neuroscience with experience developing new clinical tools in an entrepreneurial setting, Omurtag’s research includes the creation of a wireless EEG system robust enough to be used in non-traditional environments, particularly emergency rooms. He also plans to research combining EEG with other sensing/signal-ing/imaging technologies, including magnetic resonance imaging and functional near-infrared spectroscopy in order to utilized the best features of each, as well as developing motion-sensing technologies for medical applications.

Outstanding Students 2012/2013

The UH Cullen College of Engineering has chosen two mechanical engineering students as Outstanding Senior and Junior for the 2012-2013 academic year, in honor of National Engineers Week. Senior John Alred and junior Ryan Hannemann were selected for superlative academic performance, representing a group of high-achieving students from each of the college's undergraduate programs.

OUTSTANDING SENIOR

John Alred

Before college, **John Alred** became interested in mechanical engineering while working at a job involving automotive mechanical systems. Although he began his academic career as a biomedical engineering major, he switched to mechanical engineering shortly thereafter. Alred is an active member of the Program for Mastery in Engineering Studies (PROMES) action committee, which organizes volunteering events, as well as the Honors Engineering Program, in which he serves as the tutoring officer.

Since his sophomore year, Alred has conducted research with Pradeep Sharma, M.D. Anderson Chair Professor and mechanical engineering department chair. Alred works on theoretical research in nano-scale materials science, particularly quantum mechanical simulations and molecular dynamic simulations.

"If you can see what's going on at the atomic level, you can build up from that and see why different phenomena happen," Alred noted.

Alred will graduate in spring 2013, and looks forward to continuing his research in materials science in graduate school. In the future, he hopes to conduct high-level research at an industrial level. He is actively seeking opportunities with companies that are expanding research and development.

OUTSTANDING JUNIOR

Ryan Hannemann

Ryan Hannemann has always been interested in the mechanics of things, and even specialized in engineering while serving as a member of the U.S. Army. Returning home to Houston, Hannemann chose to continue his education in mechanical engineering at the University of Houston, noting that the well-rounded curriculum enables students to learn aspects of many other fields of engineering.

Hannemann emphasized that engineering students at the University of Houston have a definite advantage in the job market. "We're so lucky to be in Houston," he said. "We're just integrated into the oil and gas network because of location."

Aside from the benefit of an education in the "Energy Capital of the World," Hannemann said that the key to landing your dream job is to focus on grades and networking. "Try [to] keep your G.P.A. as good as you can, and start networking early," he said.

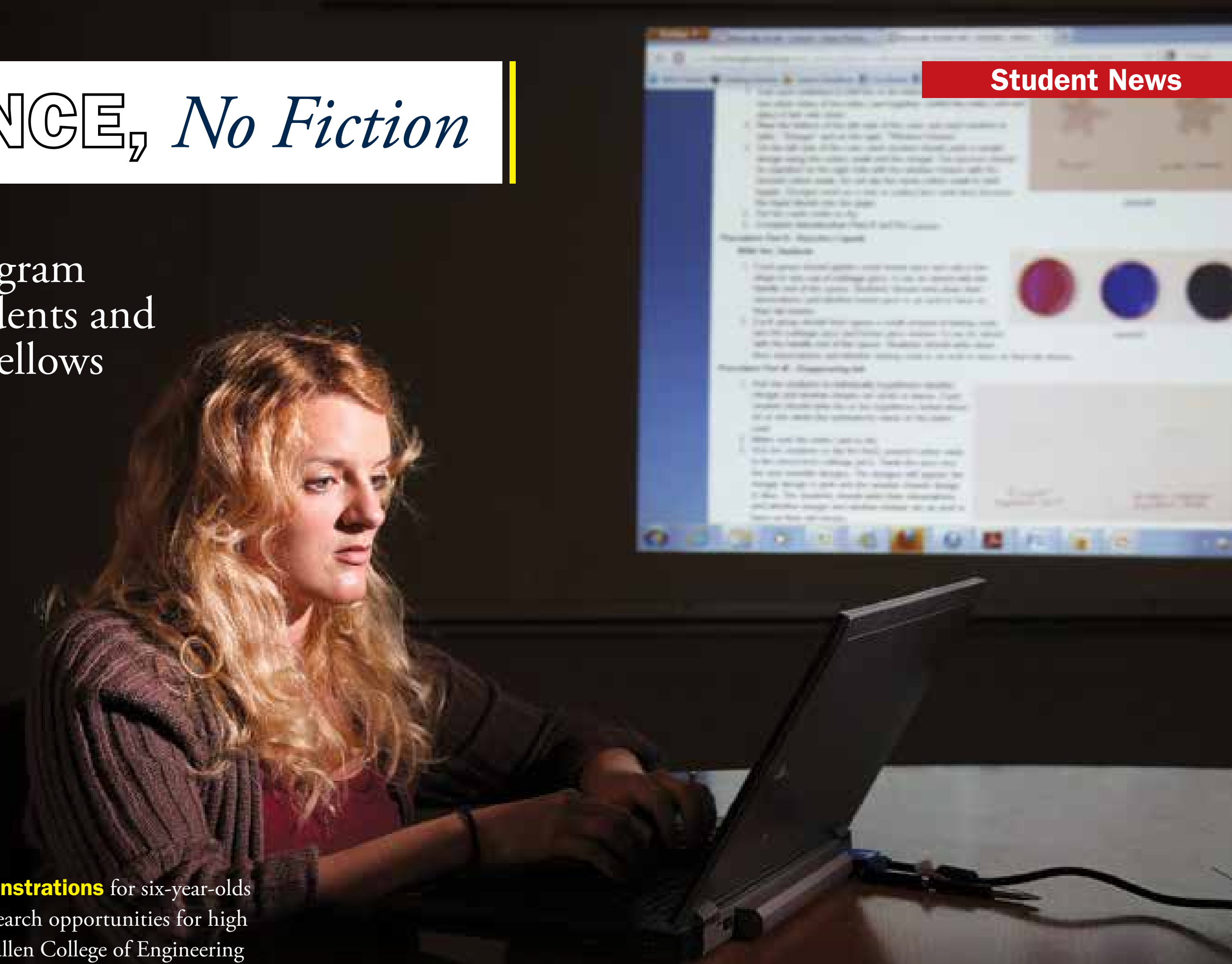
Hannemann also stressed the value of the University of Houston's Cullen College of Engineering career fairs as an important resource for landing that "dream job" after college.

"Go to the career fairs. Those career fairs are so effective, and the fact is the majority of people I talk to aren't using them," Hannemann explained. "Create that networking base beforehand; it makes it easier when you talk to company reps at the career fairs. Also, try and volunteer for the career fairs. I usually volunteer whenever I can. It's not a waste of your time, it's an investment."

In the near future, Hannemann's goal is to supplement his engineering background with an education in business by earning an M.B.A.

photos by TBS Photography

SCIENCE, *No Fiction*



GK-12 Program Boosts Students and Graduate Fellows

by Toby Weber

From robotics demonstrations for six-year-olds to nanotechnology research opportunities for high school teachers, the Cullen College of Engineering has dedicated much time and effort to programs that ultimately drive enrollment in the STEM fields (science, technology, engineering and mathematics).

One of the most significant of these efforts is the college's GK-12 program. Supported by a grant from the National Science Foundation, this program places graduate students in classrooms throughout the Houston area to teach cutting edge science and technology to those just beginning to think about college (if they've thought about it at all).

One graduate student who served as a GK-12 fellow is **Rachel Howser**, a Ph.D. candidate in the college's civil and environmental engineering department. For two years, Howser spent 10 hours a week talking engineering, physics and even nanotechnology to students at Barber Middle School in Dickenson, Texas.

In this role, Howser was asked to supplement the classroom work of the full-time teachers. Often, she said, she achieved this by tying the lesson to popular culture, offering lessons like the science behind disappearing and reappearing ink or invisibility cloaks in the world of 'Harry Potter.'

"Most of the activities were pretty hands-on, either a demonstration or a lab. I would play a clip from 'Harry Potter' or some other science fiction movie and then would ask whether we could do this in the real world," she said.

> "I would play a clip from 'Harry Potter'…
> AND THEN ASK WHETHER WE COULD DO THIS IN THE REAL WORLD."

By evaluating the student journal entries, where they re-told the lessons in their own words, Howser could tell that the advanced science and engineering concepts she presented were sinking in. Just as important: by the end of her fellowship, many of the students sent Howser notes saying that they now understood what engineers did, whereas they didn't even realize the field existed before.

Her students weren't the only ones to benefit from the program, though. One of the goals of the GK-12 program is to help engineers hone their ability to communicate advanced topics in an accessible manner.

"I feel like I became a much better public speaker," Howser said. "One of the big reasons the government funded this project is that they want people with high levels of education in STEM fields to be able to communicate advanced topics to a lay audience. I feel like I did accomplish that. I became much better at taking these high level ideas and explaining them so even a sixth grader can understand them."

The Challenge of Engineering

At the UH Cullen College of Engineering, students participate in a variety of research and design activities that allow them to master principles of engineering, present what they have learned and connect the engineering curriculum with making the world a better place.

ChBE PhD Candidate Wins 3 AIChE Awards

Alexandra Lupulescu, a Ph.D. candidate in the Department of Chemical and Biomolecular Engineering at the University of Houston, was selected as the winner of the Catalysis and Reaction Engineering Division Poster Competition held during the 2012 American Institute of Chemical Engineers (AIChE) Annual Meeting in Pittsburgh. Her was poster titled "Employing Molecular Modifiers to Tailor the Crystal Morphology of Zeolite Catalysts."

As part of assistant professor Jeffrey Rimer's research team, Lupulescu focuses on optimizing zeolites, a type of catalyst used in a variety of chemical processes.

Lupulescu was also the second place winner of the 2012 AIChE Environmental Division's graduate student award, for a paper co-authored with Rimer titled "Tailoring Silicalite-1 Crystal Morphology with Molecular Modifiers," published in Angewandte Chemie International Edition.

She was also selected by the CRE Division Travel Awards Committee to receive an award for travel to the AIChE Annual Meeting.

photo by Nine Nguyen

UH Chem-E Car Team Places Fifth at National Competition

The University of Houston Chem-E Car team competed at the 2012 American Institute of Chemical Engineers (AIChE) National Competition recently, taking fifth place – the highest that UH has achieved at the national level.

Students representing UH were An Dinh (team lead), Edward McDowell, Joshua Dillon, Rishabh Mahajan, Sheli Wilson, Stephen Havard and Tanya Rogers. They named their award-winning car "The Zombie Cougalac."

Chemical engineering student teams from around the country were challenged to design and construct a size-limited car that is powered by a controlled chemical reaction. The car's performance was evaluated by its ability to travel a specified distance of 21 meters with a load measuring 300 milliliters. Distance and load parameters were given to the teams an hour before the competition.

Since the UH team's second-place win in the regional competition in April, the entire car was rebuilt to make it more competitive at the national level. The team converted all of the car's materials to either stainless or aluminum for chemical compatibility. As a commitment to U.S. manufacturing, the team sourced parts and supplies produced domestically.

Engineering Students Analyze NAE Grand Challenges

Students from the University of Houston recently participated in a poster presentation related to the National Academy of Engineering (NAE) Grand Challenges program, in which women engineering students chose to investigate critical areas of emphasis for engineers in the 21st century.

Students selected a topic of interest from among the list of challenges, explored issues related to solving the challenge, investigated the state of current research by scientists and engineers in the field and gained an understanding of how the challenge impacts quality of life. The program gave freshman women the opportunity to discuss their progress with faculty mentors, and their findings were then summarized in a poster presentation at the UH Cullen College of Engineering.

Find more stories online at: www.egr.uh.edu

UH Team Wins Best Overall in Design Challenge

Three University of Houston electrical engineering students were recognized as the top design team at the Texas Space Grant Consortium (TSGC) Design Challenge Showcase. Seniors Lazaro "Danny" Rodriguez, Dhruval Bhatt and Bryant Lopez – known as the "Space Coogs" – won three awards, including best poster, best oral presentation and best overall design team for their Smart Fabric Communicator.

The team created a wireless communicator – similar to a Star Trek badge – for astronauts to engage in conference calls with one another as well as mission control while aboard the International Space Station. The communicator will be embedded in a shirt with an interface that uses conductive threads. It will use WiFi already installed on the station to connect to a voice over IP server which manages the conference calls. The communicator automatically logs into a general conference call and can accommodate two private calls, with volume and mute buttons embedded in the cloth.

Cory Simon, a human interfaces engineer at NASA, served as the team's mentor and guided them through the NASA proposal process. Professor John Glover of the UH department of electrical and computer engineering supervised the team's project as part of their senior design coursework.

Power Production

Taken from *The Engines of Our Ingenuity*, Episode #277

Dr. John Lienhard

I ask you to do an experiment. I ask each one of you to run up several flights of stairs as fast as you can. Use your watch to measure how long it takes to do it. Say you run up three flights, and it takes you twenty seconds.

Now multiply the height of the stairs by your weight. If you weigh 150 pounds, and the three flights go up 40 feet, then you've done 6,000 foot-pounds of work in 20 seconds. That's 300 foot-pounds a second. A horsepower is 550 foot-pounds a second, so you've generated just over half a horsepower.

If you're in good shape, you can generate a whole horsepower in a short burst like that. But what if you climb all day? Can you climb a 6000-foot mountain in 8 hours? That's only about thirty foot-pounds a second, about a twentieth of a horsepower.

This gets interesting when you compare your power with the machines that serve you. Suppose human beings had to power the generator that supplied a 150-watt light bulb. It would take 15 people doing five-man eight-hour shifts to keep that light burning. An automobile engine that generates 100 horsepower does the work of 2000 people. But when those people have to rest at the end of eight hours, the automobile keeps right on going.

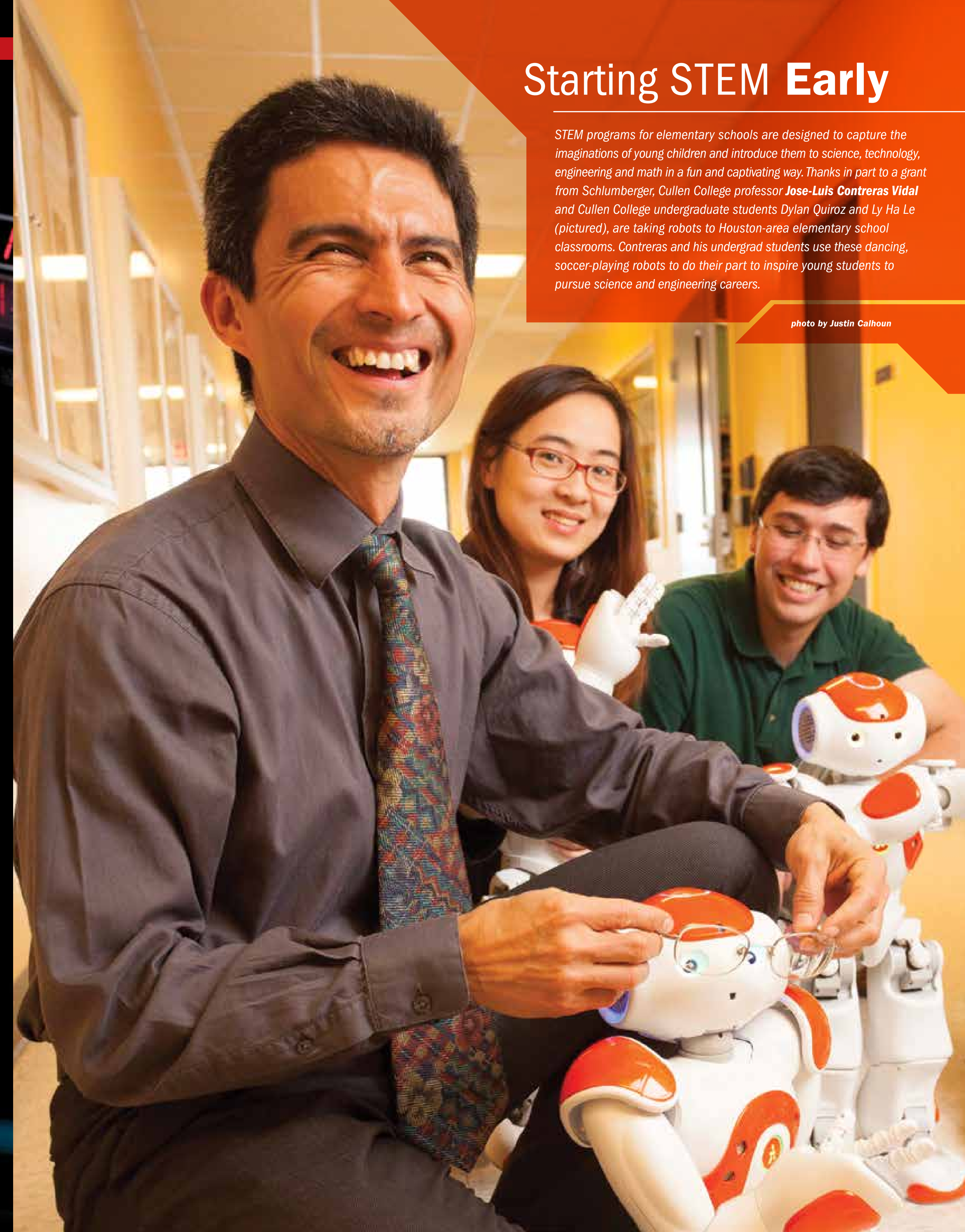
The engines of our ingenuity are big and powerful, and we're no match for them. We've become absolutely dependent on huge supplies of power. But the very magnitude of our power plants threatens our well-being. If they burn fossil fuel, they don't just spoil the air around the plant, they endanger the whole planet. If they use nuclear fuel, we can't figure out what to do with their waste. Solar collectors, in any form, eat up huge amounts of real estate.

So try my experiment. You'll see what an astonishing difference in scale we've created between our machines and ourselves. We're like mice directing the movements of elephants. Too many of our machines can crush us with a wrong step.

In the end, our only protection from those great beasts is restraint: restraint in the use of energy, restraint in our wants, restraint in the use of our ingenuity. Take a long close look at the enormous gulf between us and our machines. Learn how to view those machines with a well-balanced mixture of fear and respect.

***The Engines of Our Ingenuity** is a nationally recognized radio program authored and voiced by John Lienhard, professor emeritus of mechanical engineering and history at the University of Houston and a member of the National Academy of Engineering. The program first aired in 1988, and since then more than 2,800 episodes have been broadcast. For more information about the program, visit www.uh.edu/engines.*

***The Engines of Our Ingenuity** celebrated its 25th on-air anniversary on Jan. 4, 2013.*



Starting STEM **Early**

*STEM programs for elementary schools are designed to capture the imaginations of young children and introduce them to science, technology, engineering and math in a fun and captivating way. Thanks in part to a grant from Schlumberger, Cullen College professor **Jose-Luis Contreras Vidal** and Cullen College undergraduate students Dylan Quiroz and Ly Ha Le (pictured), are taking robots to Houston-area elementary school classrooms. Contreras and his undergrad students use these dancing, soccer-playing robots to do their part to inspire young students to pursue science and engineering careers.*

photo by Justin Calhoun

UNIVERSITY of HOUSTON | ENGINEERING

UH Cullen College of Engineering
Office of Communications
E301 Engineering Bldg. 2
Houston, TX 77204-4009

Tools of the Trade

As part of its ongoing effort to support entrepreneurship among its faculty and students, the University of Houston Cullen College of Engineering hosted an Intellectual Property and Entrepreneurism series that began on March 8. The three-part training series was designed for engineering faculty, post docs and students. It covered all manners of Intellectual Property (IP) and principles of entrepreneurism. Topics included commercializing research, protecting inventions, liability issues, financing, patents, license agreements, trade secrets, branding, marketing and more. The training was conducted by Aaron Levine and Matt Todd, partners and co-chairs of the New Ventures & Corporate Transactions Group at Novak Druce Connolly Bove + Quigg.

Prior to this series, the UH Cullen College also hosted “Understanding the Entrepreneurial Landscape: What Women STEM Faculty Need to Know” last year. Co-hosted by the UH College of Natural Science and Mathematics, the UH College of Technology and Rice University, the one-day conference gave women faculty and post-doctoral researchers an inside look at the business of successfully commercializing university-based science and technology.