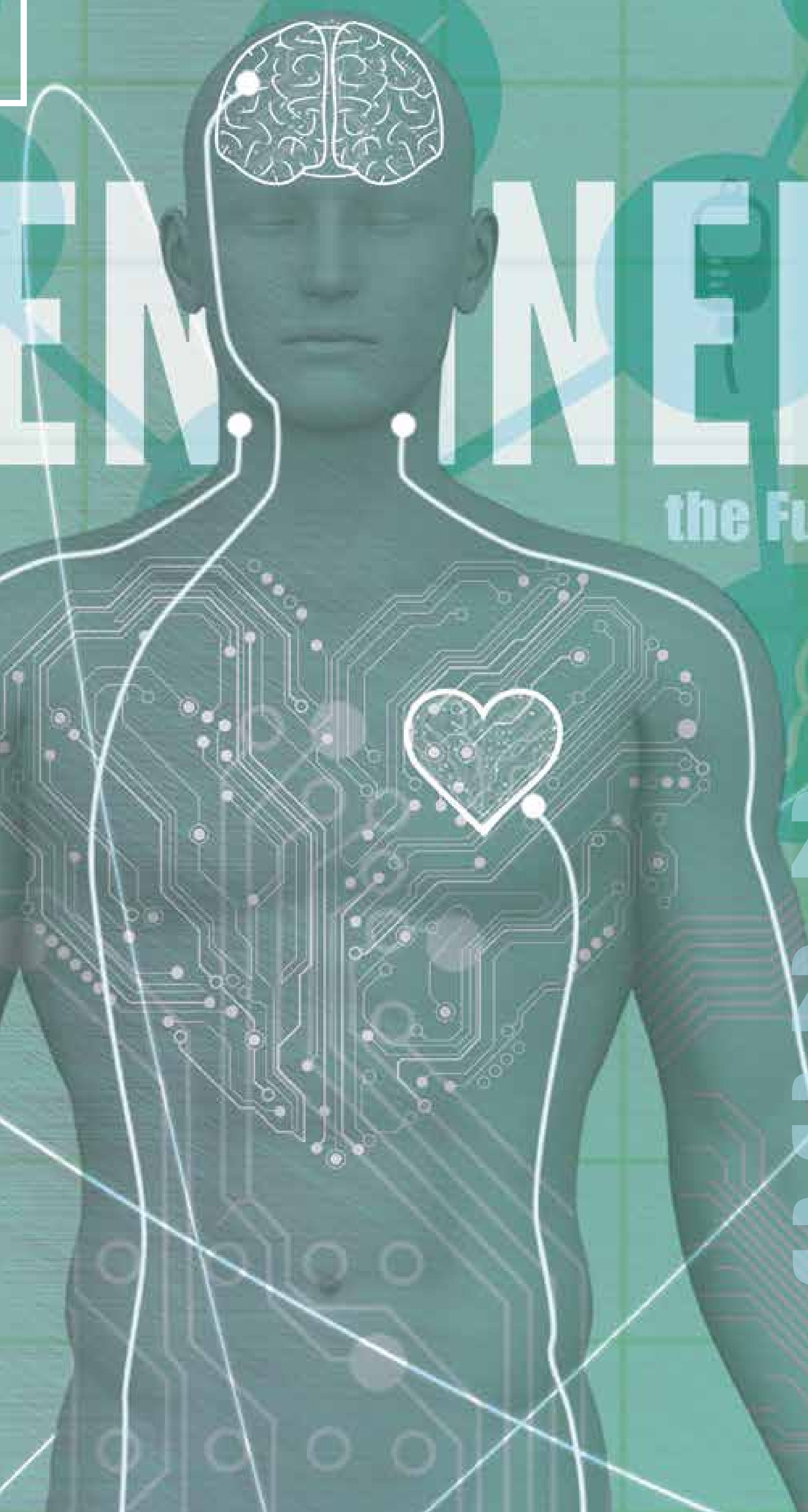
Spring 2014

Parameters

Cullen College of Engineering Magazine



ENGINEERING the Future of Healthcare:

Cullen College Research Improving Patient Care and Outcomes

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Connecting Humans With Thought-Controlled Robots to End Movement Disabilities

26 **Fighting Cancer**
One Cell at a Time

30 **Reading the Signals**
for Better Brain Surgery

34 **Hitting the Target**
Optimizing Radiation Treatments for Cancer

UNIVERSITY of HOUSTON | ENGINEERING

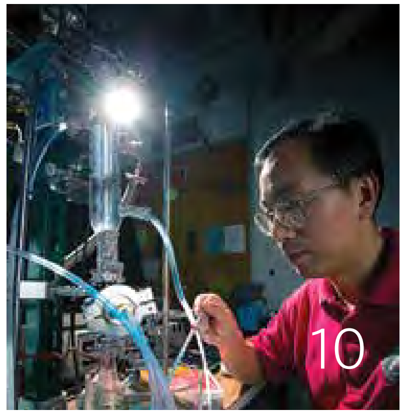
MEET TEAM PRIMER...

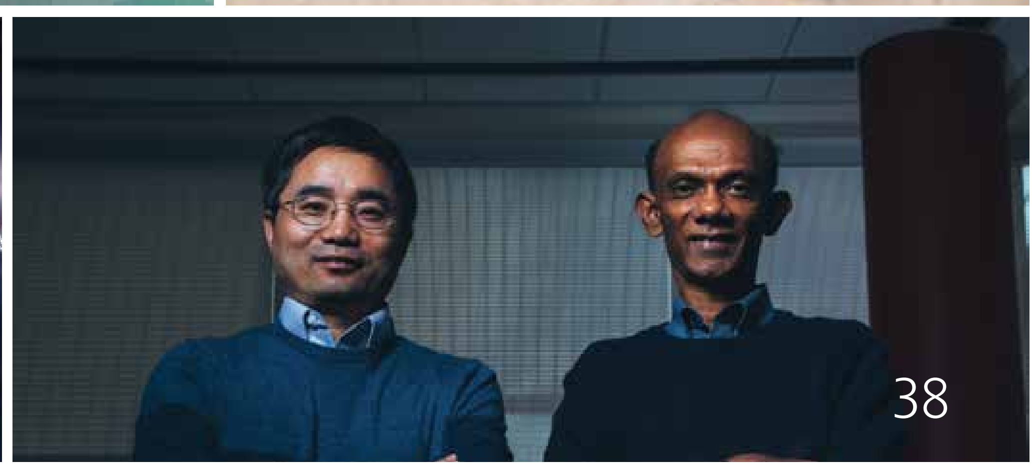
... A group of mechanical engineering undergrads at the University of Houston Cullen College of Engineering who will be competing in the upcoming Shell Eco-marathon in Houston from April 25 to 27.

Turn to page 47 to learn more.

Parameters Spring 2014 I www.egr.uh.edu

UNIVERSITY of HOUSTON | ENGINEERING





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Parameters

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cullen college news

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UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

Dean's Letter

When you think of an engineer, what image comes to your mind?

For some, it may be a civil engineer, constructing the roads, buildings and other infrastructure that make our cities and towns safe, functional and livable. For others – especially those here in the oil and gas epicenter of Houston – it may be a chemical engineer working for an energy company to determine the safest and most efficient ways to conduct oil and gas exploration and production.

What you may not have pictured when I asked this question was an engineer working side-by-side with physicians and healthcare providers to improve patient care, treatment outcomes and healthcare delivery. However, healthcare-focused research is a cornerstone of the engineering profession, and there's no place this is more evident than at the Cullen College of Engineering.

Cullen College researchers are blazing trails in the medical industry every day. We're using every facet of our engineering expertise to tackle some of the most challenging healthcare issues facing Americans, like the loss of mobility after a stroke or how to optimize radiation treatment in lung cancers. And with the world's largest medical center less than five miles from our campus, our advances in medical technology are being implemented in the world's best hospitals and clinics as quickly as we produce them.

This issue of Parameters will focus on our impact as engineers in the healthcare industry. At the Cullen College, we're immensely proud of the achievements of our faculty and students in all of their fields of study, and the medical research being performed is no exception. We're developing tools and technologies that will directly improve the health and welfare of humanity; I can think of no nobler cause than that.

As our college continues to grow, improve and thrive, I'm looking forward to the escalation of our impact in our community and around the world. We will continue to meet challenges head on and emerge stronger, smarter and better equipped to improve our quality of life.

Warm regards,

Joseph W. Tedesco

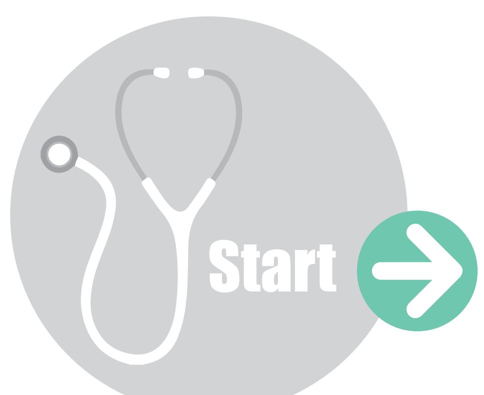
Joseph W. Tedesco, Ph.D., P.E.
Elizabeth D. Rockwell Dean and Professor

Engineering **Snapshots**

ENGINEERS in Medicine

100 years ago, life expectancy in the United States was 53.5 years. Today, it's 78.7 years.

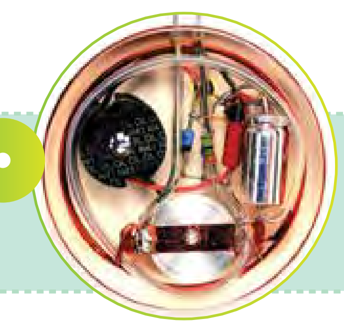
What's behind this incredible quarter-century jump? In large part, new life-saving medical devices and equipment. While anyone who invents is practicing engineering, engineers themselves – defined here as individuals who earned a degree in an engineering field – have developed many of these technologies. Here are just a few.



1895
Mechanical engineer Wilhelm Conrad Röntgen discovers X-rays and develops X-ray technology. Most major hospitals and medical schools adopted the technology within just a few years. Röntgen wins the 1901 Nobel Prize in physics for his work.

1955
Engineer Forrest Bird creates the first reliable mass produced medical respirators.

1957
The closed chest defibrillator is used for the first time. The device was invented by electrical engineer William Kouwenhoven and colleagues at Johns Hopkins University. While conducting their research, the team also noticed that exerting a small amount of pressure on the chest above the heart increased blood flow. From this they developed cardiac massage, the foundation of modern CPR.



1960
The first practical, fully implantable pacemaker is implanted into 10 patients. The device was invented by William Greatbatch, an electrical engineering professor at the University of Buffalo.

1971
Electrical engineer Sir Godfrey Newbold Hounsfield and physician Allan MacLeod Cormack invent the CT scan. For their invention, the pair wins the 1975 Nobel Prize in physiology or medicine.

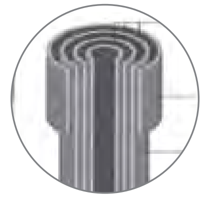
1972
Takuo Aoyagi, an electrical engineer, develops pulse oximetry, which is used to measure the amount of oxygen in the blood.

1982
The Jarvik-7 becomes the first artificial heart to be successfully implanted in a human. The device's lead designer is Robert Jarvik, an M.D. with an M.S. in medical engineering. A modified version of the device is still used today as a bridge to transplantation.

FRACKING

Hydraulic fracturing has been getting a lot of attention in the news. Unfortunately, these stories can use terms that, even for engineers, aren't very clear unless you work in that sector. To help our readers better understand the fracking issue, here are the definitions to key fracking terms.

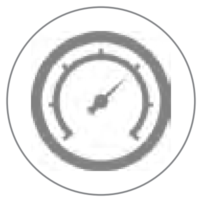
Definitions



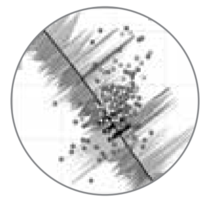
Casing:
The large-diameter pipe placed down in a recently drilled section of a borehole and cemented in place. Among its many purposes, the casing provides a good environment for placing downhole petroleum production equipment and prevents drilling fluids from leaking into the ground and fresh water supplies.

Cementing:
The practice of holding the casing in place by filling the space between the casing and the well hole with cement. Imperfect cementing with gaps and cracks can cause fracking fluids, oil or gas to leak into the ground.

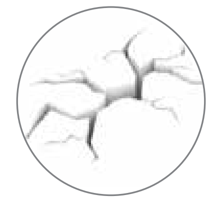
Flow back water:
Water (or other fluids) used in hydraulic fracturing that well operators allow to flow out of a well after a fracture is created. Operators allow these fluids to flow out of the well so they can move on to the next phase of the operation.



Formation pressure:
The pressure of fluids in a reservoir or well's rock pores. In general, the higher the pressure, the more easily the oil will flow to a well, making reservoirs with high formation pressure more economically attractive. Shale and tight gas formations typically have low formation pressures.



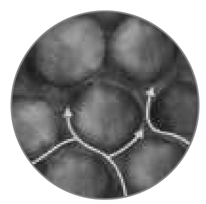
Fracture gradient:
The amount of pressure needed to fracture a rock at a given depth. It is usually measured in pounds per square foot or bars per meter.



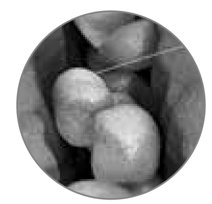
Fracture network:
Petroleum companies carefully plan where to place each fracture in a well or series of wells. These fractures, called a "fracture network," are together designed to yield as much petroleum as possible.

Fracturing fluid:
The mixture of water and other materials or chemicals injected into a well at high pressure in order to create cracks, or fractures. Many environmental groups argue that, once injected, these fluids can end up polluting groundwater.

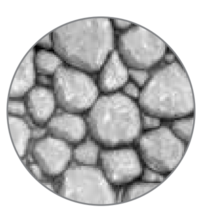
Hydraulic fracturing (AKA fracking):
The practice of injecting fluids at extremely high pressure into a rock formation in order to create cracks, or fractures in the rock. These fractures allow oil and gas to flow from the rocks to the well. The procedure is opposed by many environmental groups, which argue that fracking can cause many problems, including the pollution of groundwater. On the plus side, natural gas releases far less pollution than coal when burned.



Permeability:
The ability of a rock to transport fluids. Rocks with large, interconnected pores, like sandstone, are described as permeable. Shale, with its smaller, fewer and less interconnected pores, is described as impermeable. Shale's inability to transport fluids like oil as well as natural gas leads companies to use hydraulic fracturing on these formations.



Proppant:
Small particles mixed with fracturing fluid that hold fractures open. Proppants can be naturally occurring, like sand, or can be engineered to have specific properties or shapes that can help ensure the flow of oil and natural gas.



Shale:
A soft rock formed from thin layers of mud or clay-like sediment that typically has very small pores. Many shale formations hold large amounts of oil and gas, but their thin layers and low permeability make it difficult for these resources to flow through the rock formation to a well. As a result, efforts to retrieve shale resources were not economically viable until the past few years. Thanks to advances in drilling technology and hydraulic fracturing techniques, though, we're now in a shale oil and (especially) shale gas boom that's reshaping the world's energy markets.

Shale gas:
Natural gas caught in shale formations, usually in pockets between the rock's thin layers.

Tight gas:
Natural gas in rock formations with low permeability, like sandstone. Instead of being trapped in bubbles, the gas is dispersed in the small pores of these rock formations. Somewhat confusingly, while shale oil and tight oil are often used interchangeably, shale gas and tight gas are two different things.

Tight oil:
Oil caught in rock formations with low permeability, like shale.

According the U.S. Energy Information Administration, the United States has the world's second-largest recoverable shale oil reserve and fourth-largest shale gas reserve (http://www.eia.gov/analysis/studies/worldshalegas/).

BANG for your BUCK

What is a bachelor's degree in engineering worth in different cities across the country?

We compare four state universities across the nation – each of which is located in one of the Forbes "Top 10 Engineering Capitals" – to see what an engineering degree will cost you and what your chances of employment are in each city. We also take a close look at the estimated salaries for engineers in each city, as well as the average cost of living.

So, in which city do you think your engineering career might look the brightest?

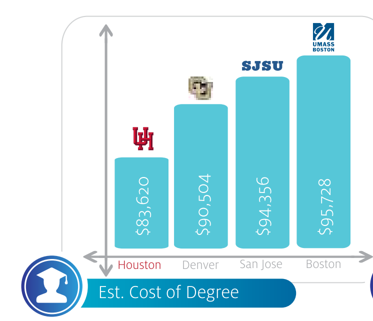
HINT:
They don't call us the "Energy Capital of the World" for nothing!

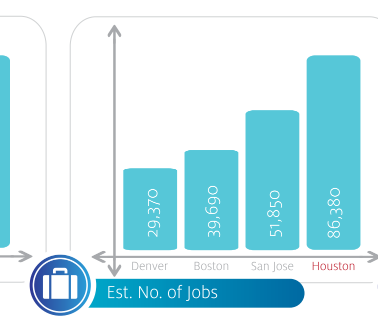
Forbes List:
America's Engineering Capitals

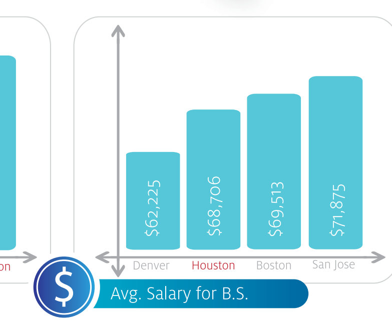
1. San Jose/Santa Clara *
2. Houston/Harris
3. Wichita/Sedgwick
4. Dayton/Montgomery
5. San Diego/San Diego
6. Greenville/Greenville
7. Albuquerque/Bernalillo
8. Boston/Suffolk
9. Bakersfield/Kern
10. Denver/Denver

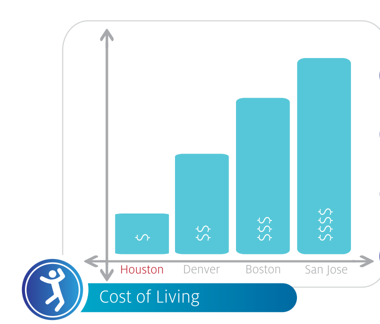
*(City/County)

How It All Adds Up:









	Houston	Denver	Boston	San Jose
Cost of Home	$225,332	$340,703	$491,000	$764,283
Cost of Apartment Rent	$1,274	$903	$1,870	$1,728
Cost of Dry Cleaning	$8.42	$12.87	$13.10	$12.01
Cost of Bananas	$0.48	$0.51	$0.79	$0.83

#1

Lowest Cost of Living
+
Lowest Cost of Degree
+
Highest Number of Jobs
+
Competitive Salaries
+
NASA + the Port of Houston +
World's Largest Medical Center +
2nd Most Fortune 500 Companies in the Nation

Sources: 1. Cost of Degree: Available on Public University Websites 2. Employment Data (Source: Bureau of Labor Statistics 2012 Occupational Employment and Wages Data) 3. Wage Data: (Source: FLC Data Center Wages for 2013- 2014) 4. Cost of Living Data Available at http://www.bankrate.com/calculators/savings/moving-cost-of-living-calculator.aspx

IN THE MEDIA Spotlight

RADIO

88.7 KUHF-FM

CenterPoint, Direct Energy, join UH in electric power research venture
Featuring Zhu Han, Associate Professor of Electrical and Computer Engineering
(Aired March 27, 2014)

Bauer Business Focus: Badri Roysam and electric power research
Featuring Badri Roysam, Chair of the Department of Electrical and Computer Engineering
(Aired April 4, 2014)

Bauer Business Focus: Bonnie Dunbar on spaceflight and STEM education
Featuring Bonnie Dunbar, M.D. Anderson Professor of Mechanical Engineering, Director of Aerospace Engineering and Director of the UH STEM Center
(Aired September 27, 2013)

Fruit flies, chicken nuggets and acid: Tales from the Houston Science Fair
Featuring Bonnie Dunbar, M.D. Anderson Professor of Mechanical Engineering, Director of Aerospace Engineering and Director of the UH STEM Center
(Aired February 20, 2014)

Four UH researchers named to National Academy of Inventors
Featuring Dmitri Litvinov, John and Rebecca Moores Professor of Electrical and Computer Engineering, and Venkat Selvamanickam, M.D. Anderson Chair Professor of Mechanical Engineering
(Aired December 30, 2013)

TV

MSNBC

Melissa Harris-Perry Show
Featuring Bonnie Dunbar, M.D. Anderson Professor of Mechanical Engineering, Director of Aerospace Engineering and Director of the UH STEM Center
(Aired November 18, 2013)

KTRK Channel 13

Program gravitates students to math, science
Featuring UH Engineering Students
(Aired November 13, 2013)

Comcast Newsmakers

UH Energy Symposium Series
Featuring Ramanan Krishnamoorti, Professor of Chemical and Biomolecular Engineering and Chief Energy Officer at UH
(Aired February 5, 2014)

UH Moment

Improving treatment for melanoma patients
Featuring Navin Varadarajan, Assistant Professor of Chemical and Biomolecular Engineering
(Aired January 14, 2014)

One on One With Vernon Ramesar

Dr. Ravi Birla
Featuring Ravi Birla, Associate Professor of Biomedical Engineering
(Aired November 28, 2013)

PODCASTS

The EnergyMakers Show

Dr. William Epling
Featuring William Epling, Associate Professor of Chemical and Biomolecular Engineering
(Aired January 9, 2014)

PRINT

Houston Chronicle

African dust eyed as local air-quality culprit
Featuring Shankar Chellam, Professor of Civil and Environmental Engineering
(Published March 2, 2014)

Mechanical, robotics engineers see demand
Featuring Dong Liu, Associate Professor of Mechanical Engineering, J.R. Rao, Associate Professor of Mechanical Engineering, and Vita Como, Director of the Engineering Career Center
(Published January 31, 2014)

Engineering school curricula evolves
Featuring UH Cullen College of Engineering
(Published December 19, 2013)

Drills spin to keep up with shale well depletion
Featuring Michael Nikolaou, Professor of Chemical and Biomolecular Engineering
(Published December 15, 2013)

Museum presents chemistry for the masses, not scary classes
Featuring Megan Robertson, Assistant Professor of Chemical and Biomolecular Engineering
(Published November 8, 2013)

Engineering grads need internships on resumes
Featuring Vita Como, Director of the Engineering Career Center
(Published November 3, 2013)

Reuters

Guest lecture spots at recognized universities indicate the validity of energy navigator's new unconventional resource evaluation methods
Featuring John Lee, Professor of Petroleum Engineering and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair
(Published November 12, 2013)

Science News

Brain-computer interfaces promise new freedom for the paralyzed and immobile
Featuring Jose L. Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of Electrical and Computer Engineering
(Published November 4, 2013)

Houston Business Journal

Energy VP: Fill industry pipeline with women
Featuring Tina Faraca, UH Cullen College of Engineering Leadership Board Member
(Published January 31, 2014)

Meet the key players in 8 energy markets
Featuring Ramanan Krishnamoorti, Professor of Chemical and Biomolecular Engineering and Chief Energy Officer at UH
(Published November 22, 2013)

Rigzone

UH research is helping oil, gas companies maximize production
Featuring John Lee, Professor of Petroleum Engineering and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair
(Published February 7, 2014)

UH dives deep to advance subsea engineering
Featuring UH Cullen College of Engineering students Nebolisa Egbunike, Ewaen Ogiefo, Ademola Oladinni
(Published January 9, 2014)

ICOSA Energy Magazine

A crucial undergraduate degree returns to the University of Houston (pg. 16)
Featuring Thomas Holley, Professor and Director of Petroleum Engineering, and John Lee, Professor of Petroleum Engineering and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair
(Published February 5, 2014)

FuelFix

US oil boom will slow in 2015, feds forecast
Featuring John Lee, Professor of Petroleum Engineering and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair
(Published January 8, 2014)

Train explosions prompt regulator warning on Bakken oil flammability
Featuring Ramanan Krishnamoorti, Professor of Chemical and Biomolecular Engineering and Chief Energy Officer at UH
(Published January 2, 2014)

UH subsea society seeks to rise to the top
Featuring UH Cullen College of Engineering students Michael Ogiefo and Nebolisa Egbunike
(Published January 2, 2014)

Houston group seeks to put US on the road to natural gas
Featuring William Epling, Associate Professor of Chemical and Biomolecular Engineering
(Published December 22, 2013)

OE Magazine

University launches subsea engineering program
Featuring Matthew Franchek, Professor of Mechanical Engineering and Director of the Subsea Engineering Program, and Phaneendra Kondapi, KBR Adjunct Professor
(Published November 1, 2013)

Phys.org

Earthquake research explores use of high-performance concrete
Featuring Bora Gencturk, Assistant Professor of Civil and Environmental Engineering
(Published April 2, 2014)

Splitting water into hydrogen and oxygen using light, nanoparticles
Featuring Jiming Bao, Assistant Professor of Electrical and Computer Engineering
(Published December 15, 2013)

Houston Community Newspapers (www.yourhoustonnews.com)

UH offers three STEM camps this summer for area youth
Featuring Bonnie Dunbar, M.D. Anderson Professor of Mechanical Engineering, Director of Aerospace Engineering and Director of the UH STEM Center
(Published March 29, 2014)

Science Daily

Diagnosing diseases with smartphones in real time
Featuring Jiming Bao, Assistant Professor of Electrical and Computer Engineering, and Richard Willson, Huffington-Woestemeyer Endowed Chair and John and Rebecca Moores Professor of Chemical and Biomolecular Engineering
(Published March 10, 2014)

CITIES

High Performance in Small Doses

Bora Gencturk in his laboratory at the Cullen College of Engineering.

New, stronger concrete that can better withstand an earthquake isn't much good if it's too expensive to use.

That's the idea behind a research project being conducted by **Bora Gencturk**, assistant professor of civil and environmental engineering. Gencturk recently won a two-year, $175,000 BRIGE award from the National Science Foundation to study ways to selectively use high-performance fiber-reinforced concrete (HPFRC) in buildings.

These types of concrete are made with fibers of polymer or steel, which give the material extra strength and ductility, making it more likely to survive an earthquake without suffering major damage. While that's clearly desirable, the fibers also drive up the price of concrete substantially, limiting the materials' practical uses.

Gencturk's alternative is to use high-performance concrete only at those spots where a structure is likely to fail, specifically at the joint regions of horizontal beams and vertical columns.

To conduct this work, he is relying on two pieces of equipment to which few groups have access. The first is a multi-axial testing system that can very accurately simulate the types of loads beam-column joints are exposed to during an earthquake.

The second tool is a non-contact digital image correlation system. With this system, researchers coat the concrete with a spray-on speckle pattern. They then test how the material holds up to different loads while filming it with two separate cameras. By using individual speckles as reference points, they can then match up images from the two cameras to answer questions about material failure, such as where cracks occur and how they grow.

Combined, these two systems will allow Gencturk to study exactly how beam-column joints made with HPFRCs withstand different loads during earthquakes. Though this grant is his first in what will hopefully be a series of awards on this topic, Gencturk believes this work could lead to design specifications for the use of high-performance concrete at beam-column joints.

Abdeldjelil "DJ" Belarbi

Researchers Writing Bridge Specs for Advanced Materials

A team of researchers from the Cullen College's department of civil and environmental engineering has won a $500,000 grant from the National Cooperative Highway Research Program, a group administered by the National Academy of Sciences and voluntarily funded by state transportation boards, to write design guidelines and specifications for the use of prestressed carbon fiber reinforced polymers (CFRP) in the construction of new bridges.

The group is led by **Abdeldjelil "DJ" Belarbi**, professor of civil and environmental engineering, and includes his colleagues Mina Dawood and Bora Gencturk, both assistant professors in the department.

While its established that these materials can improve the properties of structural components, structural engineers must know exactly how to use them before including them in bridges, buildings and roads. "If you just tell the engineering community that there is a very nice new material they should use, it's not going to happen," Belarbi said.

Depending on their particular makeup, CFRPs are not only stronger than steel, but they may also eliminate corrosion problems associated with prestressed steel – widely viewed as the biggest contributor to premature infrastructure deterioration.

CFRP systems can offer additional advantages by being prestressed. This, Belarbi said, helps limit superstructure deformations as well as the formation of cracks. The greater durability generated by CFRP prestressing systems should allow for the construction of longer span bridges and the more efficient use of materials.

Belarbi and his team will conduct extensive testing on CFRP systems and use their findings to write design specifications for bridges using CFRP-reinforced concrete. These specifications almost certainly will be adopted as part of the official design code published by the American Association of State Highway and Transportation Officials (AASHTO). This code, Belarbi stated, is used by all state Departments of Transportation across the country to create binding rules for bridge design.

EDUCATION

RET Program Earns Spot on President's Higher Education Community Service Honor Roll

Out of more than 800 institutions that applied for this award, UH was one of just 113 named to the Honor Roll with Distinction.

Not only is the University of Houston's Cullen College of Engineering home to world-class research, it's also a recognized leader in science and engineering outreach. The latest proof: the college's Research Experience for Teachers (RET) Program is one of three University of Houston initiatives that together earned UH a spot on the 2013 President's Higher Education Community Service Honor Roll with Distinction.

The honor roll program is run by the U.S. government's Corporation for National and Community Service. It recognizes higher education institutions that "reflect the values of exemplary community service and achieve meaningful outcomes in their communities through service." Out of more than 800 institutions that applied for this award, UH was one of just 113 named to the Honor Roll with Distinction. The formal nomination for the award was submitted by Larry Hill, a research professor with UH's Graduate College of Social Work. In addition to the RET Program, the UH efforts included in the nomination materials were the Houston Public Broadcast System and the College of Optometry's Mobile Eye Institute.

The Cullen College's "Innovations in Nanotechnology" RET Program is led by **Fritz Claydon** and **Stuart Long**, both professors of electrical and computer engineering, and **Debora Rodrigues**, assistant professor of civil and environmental engineering. Funded by the National Science Foundation (NSF), the program brings about 12 middle and high school teachers to the college every summer to conduct nanotech-related research with a faculty expert.

With the assistance of a faculty mentor, teachers are then asked to design lessons for their students based on their time as a researcher. Through the program, dozens of lessons and activities have been posted on teachengineering.org, a highly regarded website dedicated to providing teachers from kindergarten through 12th grade with engaging and informative lesson plans. "Because of the efforts we've made and the success we've had, the NSF is saying that the gold standard for [lesson plan] deliverables is the UH model," said Claydon.

In addition, some of the RET participants have earned national recognition. High school physics teacher Mila Bersabal, a two-time RET participant and current RET Program master teacher, was the 2009 State of Texas winner for the Presidential Awards for Excellence in Mathematics and Science Teaching. Through the RET Program, she devised a lesson plan that had students use light waves to measure the spacing of nanoscale patterns (measured in the billionth of a meter) on CDs and DVDs.

Another notable RET participant is Madeline Landon, a 2009 RET high school student intern. Landon used her time in the program to study the use of seashells to remove harmful lead from drinking water. The project showed that the seashells' chemical makeup caused chemical reactions that removed up to 90 percent of lead from water. This project earned first prize in Environmental Science in the ExxonMobil Texas Science and Engineering Fair and a "second award" in the Intel International Science and Engineering Fair.

"This college is committed to improving science and engineering education throughout the country, and the RET Program is a big part of that," said Claydon. "I'm glad to see that the program has been recognized with this honor. It shows that we're really making an impact. The students, teachers and faculty mentors who support the program deserve a lot of credit for this success."

ENERGY

Cullen College Playing Key Role in Offshore Energy Safety Institute

No one disputes that offshore energy development carries environmental risks. Through its involvement in the new Ocean Energy Safety Institute (OESI), the UH Cullen College of Engineering will play a key role in ensuring the safety of offshore energy production for years to come.

The institute is a partnership of the University of Houston, Texas A&M University and the University of Texas at Austin. The three schools won a competitive, five-year, $5 million grant from the Department of the Interior's Bureau of Safety and Environmental Enforcement (BSEE) to establish the institute. Its mission is vital: Serve as a platform for communications and research among government, academia and industry in the field of offshore energy.

The OESI, which was first proposed after the 2010 Deepwater Horizon oil spill, will provide recommendations and technical assistance to BSEE related to emerging technologies as well as the best and safest technologies that are currently available. In addition, it will develop and maintain an equipment failure monitoring system and train federal employees to enable them to remain current on state-of-the-art technology.

The institute will also promote collaboration among federal agencies, industry, standards organizations, academia and the National Academy of Sciences. Information on issues related to offshore research and best practices will be shared with industry, government and the public through Institute-held forums.

"The institute itself is going to act as a liaison between industry, regulators and the creators of the best available technologies in terms of safety and feasibility," said Ramanan Krishnamoorti, professor of petroleum engineering and chemical and biomolecular engineering at the college and Chief Energy Officer for the University of Houston.

The Cullen College is home to several offshore energy research efforts. UH's participation in the institute should help bring much-deserved attention to these projects, said Joseph W. Tedesco, Elizabeth D. Rockwell Dean and Professor of the Cullen College.

"Offshore resources are going to contribute significantly to energy production in the years to come. The Ocean Energy Safety Institute will play a key role in safely and efficiently developing these resources," said Tedesco. "I'm proud that our researchers are so prominently involved in this initiative and I look forward to seeing their advances adopted by companies in this sector."

NSF, DOE Award $1.2M for Diesel Research

A team of researchers led by **Bill Epling**, associate professor of chemical and biomolecular engineering (ChBE), has won a $1.2 million grant from the National Science Foundation and Department of Energy to develop a new emissions reduction technology for high-efficiency diesel engines.

According to Epling, there's one important fact about emissions reduction that's typically neglected. Catalytic converters, which remove pollutants from exhaust gas or transform them into something less harmful, are uniform along their entire length. During operation, though, the properties of the exhaust gas and the converter itself change from one spot to the next. The temperature of the converter shifts, for example, while the exact mix of exhaust gas pollutants changes.

Epling will use this funding to develop catalysts that improve emissions reduction by factoring in these internal conditions.

"I want to tailor the design of this catalyst to take advantage of these gradients that always exist inside the catalytic converter. Why is the catalyst at the front of the reactor the same as at the back? Except for manufacturing purposes, there's no reason," Epling said.

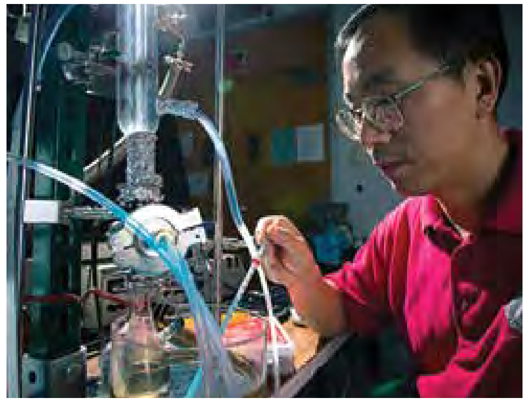
This is especially important for high-efficiency diesel engines. Existing diesel catalytic converters are built to work between 200 and 300 degrees Celsius. The highly efficient diesel engines being developed now can put out exhaust at 150 degrees Celsius or lower. Emission controls for these new engines must be re-worked in order treat this lower-temperature gas and meet environmental regulations.

In addition to Epling, the project's researchers are ChBE faculty members Vemuri Balakotaiah, Lars Grabow, Mike Harold and Dan Luss. Jim Parks, a researcher with Oak Ridge National Laboratories, is also on the team.

Pictured:
Top: Bill Epling in his laboratory at the Texas Center for Clean Engines, Emissions and Fuels at UH.

Middle and Bottom: Graduate students conduct research.

Water-Splitting Nanoparticles Featured in Nature Nanotechnology



Sunlight and water are plentiful and cheap, especially when compared to resources like petroleum. That's why a recent finding by **Jiming Bao** and his research collaborators is so important.

Bao is an assistant professor of electrical and computer engineering with the Cullen College of Engineering. In a recent issue of Nature Nanotechnology, he outlines his work with nanoparticles that can efficiently split water into hydrogen and oxygen. Simply disperse them in water then expose them to sunlight. Since hydrogen itself is a clean and efficient fuel – whether burned or used in fuel cells to generate electricity – such a finding could drastically alter the energy landscape.

Bao's nanoparticles are made of cobalt monoxide and measure just five to 10 billionths of a meter in size. Particles larger than this won't split water, said Bao, but at the nanoscale, the material's electrochemical properties change.

Specifically, cobalt monoxide's band edge position – the property that determines its ability to add or remove electrons from water molecules – shifts. When light hits a nanoparticle, it creates electrons as well as holes, which are spaces where an electron should be. The electrons move to the particle surface and convert water to hydrogen.

At the same time, the holes combine with the electrons in leftover hydroxide ions (one hydrogen and one oxygen along with an extra electron), generating O_2 and H_2. The combination allows the second hydrogen atom to split off from the oxygen.

Water splitting materials, Bao said, are not unheard of. What makes this so important is how much hydrogen these particles generate in comparison: up to 50-times more than existing catalysts. That's the type of figure that could forever change the future of the energy industry.

But there is one major drawback to these particles that will prevent them from having an immediate impact: they only work for an hour. After that, their ability to split water drops rapidly. Still, the finding proves that highly efficient water splitting is possible. That alone is a major advance, said Bao. "The next step is to engineer the material to increase its lifetime. Now we have to come up with ways to regenerate it or redesign it so it will last longer."

Researcher Seeking the 'Holy Grail' of Catalysis

Lars Grabow has been given a $750,000 grant to solve a multi-billion dollar problem.

Methane, the majority component of natural gas, is cheap and plentiful. Ideally, it could be converted into rarer and far more valuable chemicals like methanol, ethane or ethylene, all of which have dozens of uses, many involving the creation of plastics and polymers.

Easier said than done.

This research falls under the umbrella of catalysis, which uses one material to initiate or speed up a chemical reaction that changes other substances. "For more than 30 years, people have tried to do this chemistry," said Grabow, an assistant professor of chemical and biomolecular engineering. "It's the 'Holy Grail' of catalysis…If you could invent a catalyst that selectively converts methane into ethylene, you'd be a billionaire right there."

In addition to the economic value of such a discovery, Grabow said, "Holy Grail" status is conferred by the methane molecule's strong carbon-hydrogen bonds and its unique shape. It is perfectly symmetrical, consisting of one carbon atom surrounded by four hydrogen atoms.

This symmetry means there's no obvious way to split a single hydrogen atom from methane, the first step in converting the gas into a new chemical. In fact, this split can only be carried out at very high temperatures. At these temperatures, the remaining methyl radical (one carbon with three hydrogens) detaches from the surface of the catalyst and simply burns off.

The key to solving this problem, Grabow believes, is finding the oxidizing agent – a molecule that can accept electrons from another molecule – that is the most effective at reacting with and separating hydrogen atoms from methane molecules.

"We want to understand what role the oxidizing agent plays in this process, and if we do that, then we want to use that knowledge to design a catalyst that can break the carbon-hydrogen bond at lower temperatures," he said.

Researcher Wins Grant for Optimizing Catalysts

Jeff Rimer, Ernest J. and Barbara M. Henley Assistant Professor of chemical and biomolecular engineering, has won a $150,000 grant from the United States-Israel Binational Science Foundation to develop a new method for tailoring a class of catalysts known as zeolites.

Zeolites are widely used by the chemical and petrochemical sector as catalysts, which initiate or speed up chemical reactions. A material will diffuse through pores in a zeolite crystal, react with specific sites in the crystal interior, and then exit, transformed into a more useful chemical. Rimer is attempting to control how zeolites grow in order to make them more efficient catalysts for commercial reactions.

Through this latest grant, he and his collaborator, Galia Maayan from the Technion - Israel Institute of Technology (often called Israel's MIT), will develop a class of molecules called peptoids designed to alter zeolite growth.

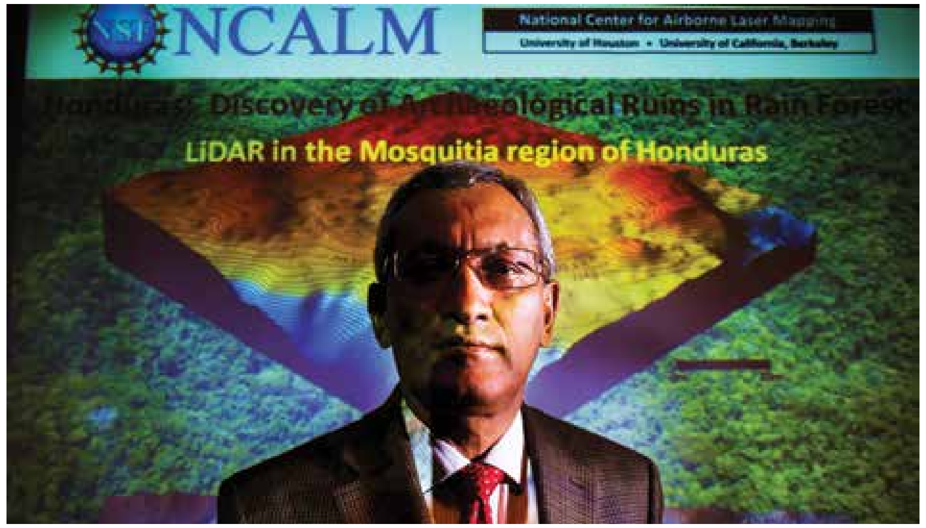
Like all crystals, these zeolites grow when new molecules of the crystal material attach to specific locations (known as growth sites) on the zeolite surface. Rimer and Maayan are developing peptoids that bind to the zeolite surfaces at these sites. A segment of the peptoid will then physically block the growth sites, thus frustrating the attachment of additional molecules to the crystal.

By blocking these sites, he aims to change the shape of these zeolites from cylinders to flat platelets. This will significantly improve the lifetime of catalysts by reducing coke formation in various reactions. As a result, companies should be able to carry out these processes more efficiently and for less money than before.

"This is something that could be integrated into an existing process very easily, without requiring equipment upgrades or dramatic changes in operating conditions," Rimer explained. "So from an economic perspective, this could be very attractive for industry."

ENVIRONMENT

NCALM Researchers Mapping Tahoe National Forest



Ramesh Shrestha discusses LiDAR at the UH Center for Airborne Laser Mapping.

Cullen College researchers are creating a 3,553 square kilometers (nearly 1,400 square miles) map of the Tahoe National Forest in California. Possibly the largest map of its kind, it will chart every square meter of the area, record the tree canopy height down to fractions of a meter and even identify the exact types of plant life in some places.

The group creating it is UH's National Center for Airborne Laser Mapping (NCALM), led by **Ramesh Shrestha**, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of civil and environmental engineering. The group will generate the bulk of the map using LiDAR, or light detection and ranging.

The basics of LiDAR are simple: Fly over the area to be mapped with a system that shoots hundreds of thousands of laser pulses at the ground per second. How quickly those pulses hit the ground and bounce back to their source can be used to calculate the exact distance between the plane and the ground. Repeat that process several billion times, and you've got a map.

The project in Tahoe is funded through a grant from the United States Forest Service to the University of California at Berkeley. The lead investigator is Berkeley's John Battles, professor of forest ecology and chairman of the ecosystems sciences division.

According to Battles, the map will give Forest Service officials a one-of-a-kind baseline for understanding the forest and managing its resources and road networks.

It will be a huge benefit to ecological researchers. In typical forest studies, Battles said, a dense study plots just 1 percent of the ground. With LiDAR, essentially 100 percent of the area is charted, allowing researchers to conduct otherwise impossible research. Possible projects include analyzing the effectiveness of land treatments designed to prevent major forest fires and identifying habitats of rare or endangered species and analyzing how they relate to roads and trails.

Glacier Study Explores Sea Levels, Water Resources

Hyongki Lee, an assistant professor of civil and environmental engineering, is part of an international team studying shrinking mountain glaciers and ice caps using satellite remote sensing measurements.

Researchers at Ohio State University lead the project, which recently won a three-year, roughly $600,000 grant from NASA.

Understanding the ice loss of glaciers, said Lee, can provide researchers worldwide with a better understanding of the contributors to climate change-based sea level rises. This effort is also important because of the role glaciers plays in ecosystems. Himalayan Mountain glaciers, for example, are the source of the continent's 19 major rivers, which supply water to 3 billion people.

The research team will use three types of satellite data taken during the past 21 years to measure the mass of ice that has melted from these glaciers. These include satellite images, satellite-generated gravity maps of the region, and satellite radar altimeter, which measures height based on how radio waves scatter when they bounce off objects. Lee's role in the grant is developing methods to process the altimeter data that is specific to uneven glacier surfaces.

In addition, Lee is developing a technique to measure height changes along the entire path of each satellite, instead of just spots where two satellite paths intersect, as is common. "Satellite paths intersect approximately every 100 to 300 kilometers. With this new method, we'll have measurements about every 350 meters," he said.

The team can then combine these altimeter readings with the satellite images and gravity map data, enabling them to calculate the mass of the ice lost at different points over the past 20-plus years.

They will then match up these different levels of ice loss with sea level changes during the same points in time, providing scientists with a greater understanding of the contributors to sea level rise.

Professor Making Plastics From Plants Through NSF CAREER Award

Megan Robertson, assistant professor of chemical and biomolecular engineering, received a $500,000 grant from the National Science Foundation's CAREER Award Program to develop plant-based plastics and rubbers.

With the funds, Robertson will use vegetable oils like soybean oil, palm kernel oil and linseed oil to develop new polymers. Polymers are long, chain-like molecules made up of repeating units and are the key component of rubbers and plastics encountered in everyday life.

Today, most polymers are made from petroleum. This can present some issues, said Robertson, such as fluctuations in pricing and undesired environmental impacts related to processing the petroleum oils. Another issue, and one that is possibly most serious in the long term, is the limited nature of fossil fuels.

"Are we going to run out of petroleum today? No, but we need to start thinking about this now, because it could take a long time to develop the same diversity in materials from plant-derived polymers that we currently have in petroleum-derived polymers," said Robertson.

One of the challenges in developing good vegetable oil polymers is their chemical structure. Polymers that have desirable mechanical properties tend to contain individual molecules that are intertwined, similar to noodles in a bowl of spaghetti. This entanglement gives them many of their best characteristics, like high strength.

The polymers that Robertson is developing from vegetable oils, though, have long strands of carbon coming off the side of each repeat unit in the polymer chain. These strands limit how much the individual polymer chains intertwine with one another. As a result, the polymers from vegetable oils are typically weaker than their petroleum counterparts. Robertson, then, will explore ways to create vegetable oil polymers that are more fully entangled, and therefore have better mechanical properties. Ultimately, Robertson is aiming to create new materials that have properties that are even better than commercially available petroleum-derived materials.

HEALTH

Imaging Expert Researching Submarine Escapes, Heart Development

A researcher with the UH Cullen College of Engineering is a co-investigator on grants which will explore how to survive a submarine escape and the basic mechanisms of embryonic heart development.

While the two projects have little in common at first glance, they both rely on technologies and devices developed by **Kirill Larin**, associate professor of biomedical engineering and director of the college's Biomedical Optics Laboratory.

The first project, which focuses on submarine escapes, is a collaboration with Marlowe Eldridge and Aleksey Sobakin, both from the University of Wisconsin. The team received a three-year, $1.1 million grant from the U.S. Navy's NAVSEA program to develop protocols for avoiding decompression sickness during a submarine escape.

Decompression sickness, also known as the bends, occurs in people who go from an environment with high air pressure to one with lower pressure too quickly. This change causes nitrogen that was dissolved in the blood to form gas bubbles.

"Decompression sickness can be very serious depending on where the bubbles form," said Larin. "It can cause brain damage, paralysis and even death."

The investigators in Wisconsin will test different protocols for depressurizing using animal models. Larin's contribution to the project is the development of a laser-based tool that can image the blood vessels that feed the brain, where bubbles can cause the most severe damage. With this tool, researchers will be able to detect whether and how many nitrogen bubbles form in these vessels under different depressurization conditions.

Based on their findings, the team will develop principles that will enable a safer rapid ascent.

Larin is also a collaborator on two grants aimed at imaging how the cardiovascular system develops in animal model embryos. One project, led by Irina Larina from Baylor College of Medicine (BCM), is supported by a five-year, $1.95 million grant from the National Institutes of Health (NIH). In this effort, Larin's optical imaging technology is being used to examine one key aspect of embryonic heart development: whether a developing heart actively sucks blood in prior to pumping it out or whether the blood is simply squeezed into the heart by the motion of the heart wall.

The other project, led by BCM's Monica Justice, is funded by a three-year, $25.55 million NIH grant. This effort is aimed at understanding fetal development and disease development on a very broad scale. Larin's responsibility will be to examine animal model cardiovascular systems after random genetic mutations.

Both rely on an optical imaging tool developed by Larin that shoots photons into the embryonic tissue. Based on the reflectivity of that tissue and how long it takes the photons to bounce back to their source, Larin is able to create an image of the developing cardiovascular systems.

Each project, said Larin, will provide researchers with a much deeper understanding of how the cardiovascular system is formed. "If we know more about how the heart forms and how it operates in terms of dynamics and structure and function, the more we'll be able to predict and treat congenital diseases," he said.

Diagnosing Diseases With Smart Phones

Smart phones are capable of giving us directions when we're lost, sending photos and videos to our friends in mere seconds, and even helping us find the best burger joint in a three-mile radius. But thanks to two Cullen College researchers, smart phones may soon be boasting another very important function: diagnosing diseases in real time.

The researchers are developing a disease diagnostic system that offers results that could be read using only a smart phone and a $20 lens attachment.

The system is the brainchild of **Jiming Bao**, assistant professor of electrical and computer engineering, and **Richard Willson**, Huffington-Woestemeyer Endowed Chair and John and Rebecca Moores Professor of chemical and biomolecular engineering. It was created through grants from the National Institutes of Health and The Welch Foundation and was recently featured in ACS Photonics.

This new device, like most diagnostic tools, relies on specific chemical interactions that form between something that causes a disease – a virus or bacteria, for example – and a molecule that bonds with that one thing only, like a disease-fighting antibody. The trick is finding a way to detect these chemical interactions quickly, cheaply and easily. The solution proposed by these professors involves a simple glass slide and a thin film of gold with thousands of holes poked in it.

This task starts with Bao, who takes a standard glass slide that is covered in a light-sensitive material known as a photoresist. He uses lasers to create a fishnet pattern on the photoresist, which is then developed and washed away. The spots surrounded by intersecting laser lines – the 'holes' in the fishnet – remain covered, basically forming pillars of photoresist.

Next, he exposes the slide to evaporated gold, which attaches to photoresist and the surrounding clean glass surface. Bao then performs a procedure called lift-off, which essentially washes away the photoresist pillars and the gold film attached to them.

The end result is a glass slide covered by a film of gold with ordered rows and columns of transparent holes where light can pass through.

Willson and Bao's device diagnoses an illness by blocking light with a disease-antibody bond – plus a few additional ingredients.

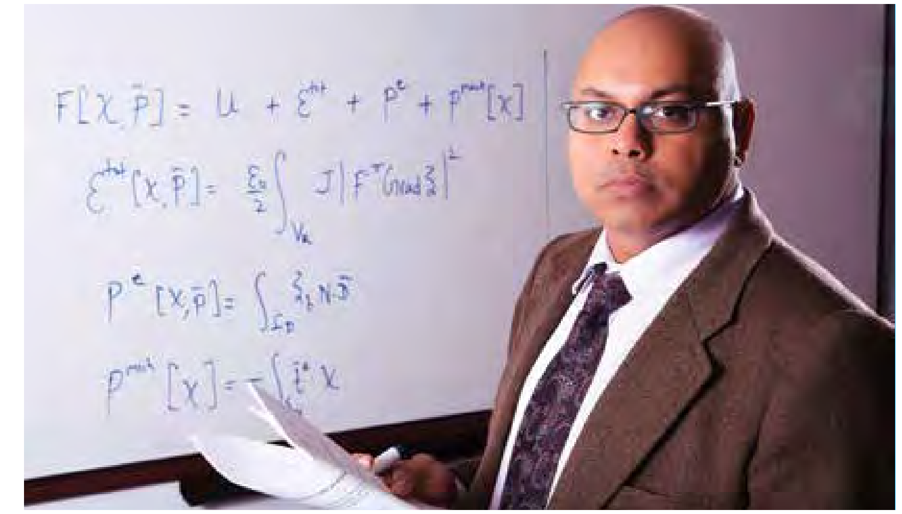
Willson tackles this part of the project by attaching disease antibodies to the holes' surface, then flowing a biological sample over the slide. If the sample contains the bacteria or virus being sought out, it will bond with the antibody in the holes. This bond alone, though, isn't big enough to block the light. Willson then flows a second round of antibodies that bond with the bacteria over the slide. Attached to these antibodies are enzymes that produce silver particles when exposed to certain chemicals. With this second set of antibodies now attached to any bacteria that are in the holes, Willson exposes the entire system to the chemicals that encourage silver production. He then rinses off the slide. Thanks to the chemical properties of the gold, the silver particles in the holes will remain in place, completely blocking light from getting through.

One of the advantages of this system is that its results can be read with very simple tools, like a basic microscope used in elementary school classrooms. With a few small tweaks, a similar reading could almost certainly be made with a smart phone's camera, flash and an attachable lens.

This technique, then, promises an affordable system with readouts that are easy to interpret. "Some of the more advanced diagnostic systems need $200,000 worth of instrumentation to read the results," said Willson. "With this, you can add $20 to a phone you already have and you're done."

ME Chair Wins $1M to Develop Electricity-Generating Soft Materials

M.D Anderson Chair Professor and mechanical engineering (ME) department chairman **Pradeep Sharma** has won a $1 million grant from the Qatar National Research Fund to develop soft materials that combine mechanical strain and nanoscale effects to generate large amounts of electricity.



Pradeep Sharma at the UH Cullen College of Engineering.

Many researchers are working to develop soft materials with the same ability to convert mechanical energy to electricity, Sharma said. Such materials could be used in stretchable electronics or could be placed in shoes to power wearable electronics or equipment used by soldiers in the field.

The material Sharma is developing starts with thin layers of soft polymers. Between the layers, he places pockets of air measuring just a few billionths of a meter. He then exposes the polymer to an electric field, which causes the air in these voids to break down and deposit electrical charges on the wall of the polymer.

"Normally, if you have embedded charges in a material, they leak out," said Sharma. "But these embedded charges are surprisingly stable for long durations. The charges become trapped in the polymer wall."

These trapped charges then interact with a property of the polymers known as the flexoelectricity. Similar to piezoelectricity, the flexoelectric effect converts the mechanical energy of bending or stressing a material into electricity. While the amount of energy produced by flexoelectricity is normally much lower than piezoelectricity, combining it with the charges can change that dramatically, Sharma said.

"We believe that by embedding charges in these polymers, they will interact with the flexoelectric phenomenon and cause a multiplicative effect. Basically, much more of the mechanical energy will be converted into electricity. If it works, the mechanical to electrical conversion will be 20 times more efficient."

Atomic-Scale Patterning Wins $150K NSF Grant

Researchers with the University of Houston Cullen College of Engineering are developing technology to knock single atoms off a silicon wafer without disturbing atoms of other materials nearby.

Chemical and biomolecular engineering professor **Vince Donnelly** and **Demetre Economou**, Hugh Roy and Lillie Cranz Cullen Distinguished University Chair with that same department, are supported in this project by an 18-month, $150,000 grant from the National Science Foundation.

Their effort focuses on silicon wafer plasma etching, where ions are shot at the material to create extremely atomic-scale patterns and features. Such an advance could be used to create radically smaller and more powerful integrated circuits, which are at the heart of practically all computing and electronic devices.

To create these extremely fine and precise features, researchers use a mask – essentially a stencil – that has the desired patterns already formed on it. The masked substrate is then placed in a plasma. There, some of the plasma's ions pass through the mask's patterned holes and etch away the layer just beneath it, creating a perfect copy.

The big challenge to this approach, though, is controlling the kinetic energy – the energy of movement – of the ions that pass through the mask.

As the ions strike the silicon wafer, the wafer becomes electrically charged. This charge ends up slightly repelling the positively charged ions, thereby lowering their kinetic energy. As a result, the beam becomes too weak to etch away the underlying material.

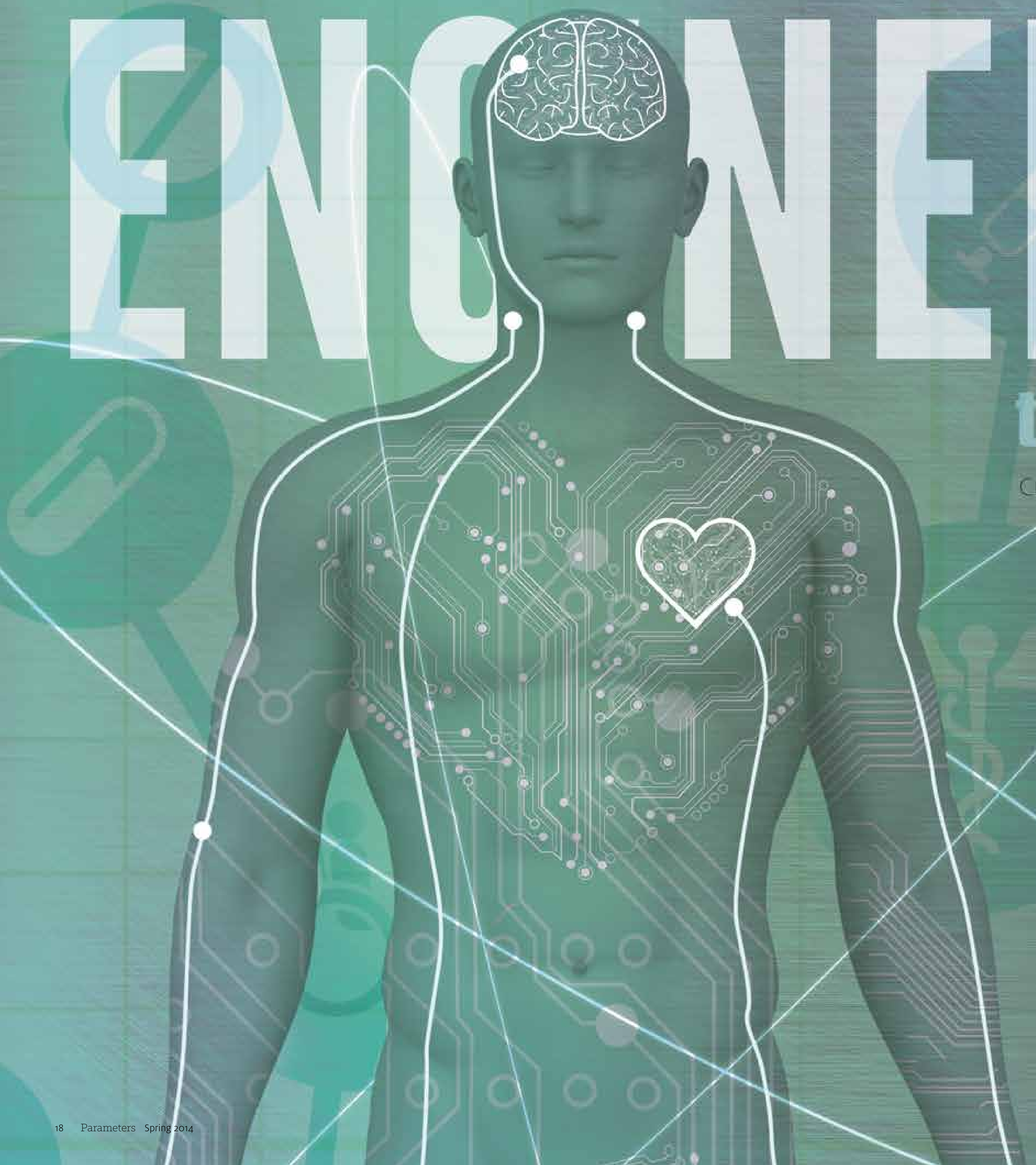
Donnelly and Economou, though, believe they can overcome this problem by applying small, quick bursts of positive voltage to the silicon wafer that should neutralize its charge.

"Atomic-scale etching should contribute to the creation of the most advanced integrated circuits ever built. If we can control the kinetic energy of the ions, we can pattern the silicon wafer with that high level of precision," said Donnelly.

For more news, visit: http://www.egr.uh.edu/news

ENGINEERING the Future of Healthcare:

Cullen College Research Improving Patient Care and Outcomes

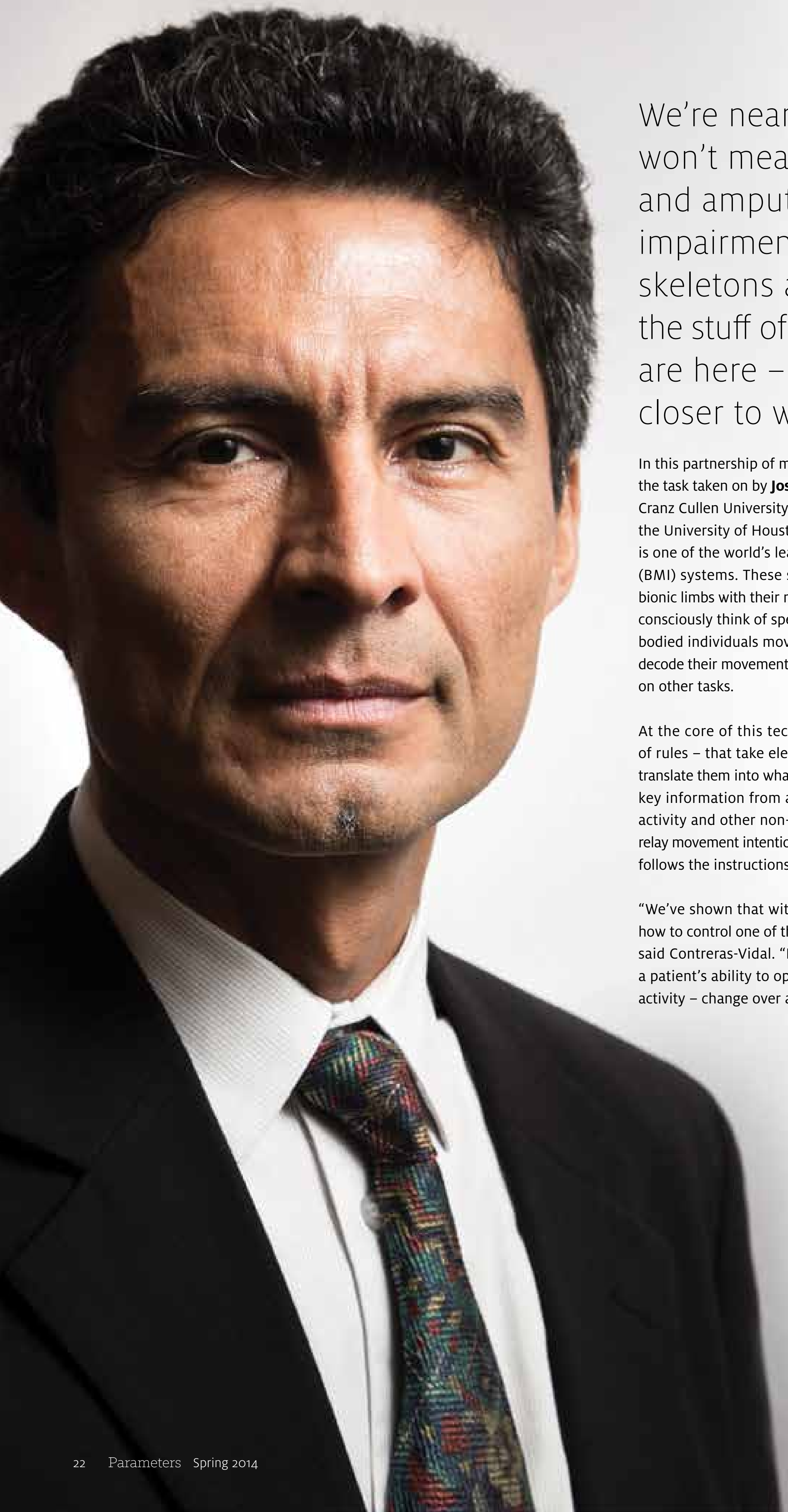


by Toby Weber

Professors from all across the University of Houston Cullen College of Engineering are conducting groundbreaking medical research, developing treatments and tools that will improve patient care and outcomes. Much of this work has already moved outside of the lab and is now being used in the clinic, helping patients at this very moment. What follows is a collection of patient-centered clinical research at the Cullen College that is benefiting everyone from cancer patients to people dealing with paralysis and amputation to individuals who have undergone brain surgery. Their work shows the important roles that engineers play in advancing medicine and patient care.

The EVOLUTION of MAN (and Machine)

Connecting humans with thought-controlled robots to end movement disabilities



We're near an era when paralysis won't mean life in a wheelchair and amputation won't be a major impairment. Powered robotic exo-skeletons and bionic limbs, once the stuff of science fiction movies, are here – and they're moving closer to widespread use.

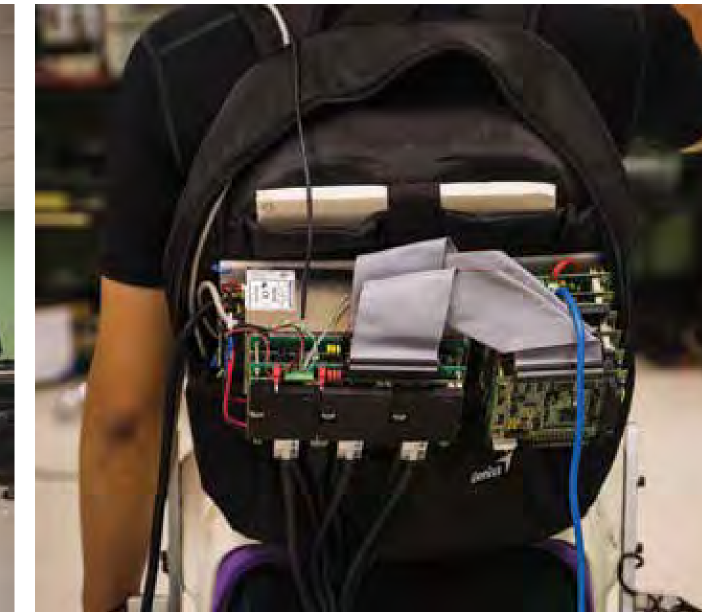
In this partnership of man and machine, the two must be connected. That's the task taken on by **Jose Luis "Pepe" Contreras-Vidal**, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering at the University of Houston's Cullen College of Engineering. Contreras-Vidal is one of the world's leading figures in the field of brain-machine interface (BMI) systems. These systems allow people to control exoskeletons and bionic limbs with their minds. Once perfected, BMIs won't require the user to consciously think of specific commands like "walk" or "stop." Just like able-bodied individuals move without focusing on every step, the interface will decode their movement intentions, leaving their conscious mind free to focus on other tasks.

At the core of this technology are algorithms – or step-by-step sets of rules – that take electrical signals recorded directly from the brain and translate them into what the user actually wants to do. After picking out the key information from all the other "noise" that comes from normal brain activity and other non-physiological activity, Contreras-Vidal's algorithms relay movement intentions to the exoskeletons or wearable prosthetics, which follows the instructions to walk, turn, grasp, et cetera.

"We've shown that with just a few minutes of practice, people can learn how to control one of these powered exoskeletons with their brain activity," said Contreras-Vidal. "Now, we're doing a longitudinal study, testing how a patient's ability to operate an exoskeleton – and their patterns of brain activity – change over a long period of time."

Pictured:
Left: Jose Luis "Pepe" Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering at the University of Houston's Cullen College of Engineering.

Top: (Left) Graduate Students test a robotic exoskeleton in Contreras-Vidal's laboratory at the Cullen College of Engineering. (Right) Close-up detail of the exoskeleton.



This is a major milestone in BMI research. To the best of Contreras-Vidal's knowledge, no other group in the world has allowed a patient with lower-limb paralysis to walk over-ground (instead of on a treadmill) with a robotic exoskeleton controlled only by their thoughts and using completely non-invasive technology.

Note the qualifier "non-invasive." One of the biggest questions in the BMI field is how to reliably record brain activity. Surgical procedures that place the electrodes near or even inside the brain can pick up a significant amount of brain activity. These invasive technologies, though, present a number of challenges and risks, including biocompatibility, unproven long-term reliability and infections. Contreras-Vidal's BMI technology relies on electroencephalogram (EEG), which records the brain's electrical activity through a simple fabric cap embedded with electrodes and worn on the scalp. This eliminates the health risks presented by invasive technologies and makes potential patients more likely to use the technology.

Contreras-Vidal's partner in much of this work is Robert G. Grossman, M.D., who serves as a professor of neurosurgery at Houston Methodist Hospital and a full/founding member of The Houston Methodist Research Institute. Methodist serves as the coordinating center for the North American Clinical Trials Network for the Treatment of Spinal Cord Injury, sponsored by the Christopher Reeve Foundation and supported by the Department of Defense and Mission Connect (a project of the TIRR Foundation).

Grossman and his team at Methodist are evaluating the clinical responses of paralyzed individuals who use REX, an exoskeleton made by New Zealand-based Rex Bionics. The exoskeleton used at The Methodist Hospital was purchased with funds from a generous grant from the TIRR Foundation.

In addition to providing much-improved mobility, the researchers believe such an exoskeleton could have a great number of physiological and psychological benefits.

"Individuals who use the robot say that they have a better sense of well being and their bladder and bowel functions improve. They interact better socially by being at the same eye level as other people. But we want to measure quantitative improvements in blood pressure control, breathing capacity [inhalation and exhalation] and muscle strength," said Grossman.

For Steve Holbert, such improvements would literally be life changing. Holbert, 54, was paralyzed from the chest down in a dirt bike accident almost four years ago, leaving him with control of his head and arms, but not his legs.

Shortly after Contreras-Vidal's arrival at the Cullen College in December 2011, Holbert volunteered as a test subject for his research with the REX exoskeleton. Through this project, he's become one of the few people in the world who've controlled such a machine with only their thoughts. "Sometimes it's been real exciting. I've been strapped into it and thought 'go' and, boom, it goes. That feels really, really cool when it happens."

As should be expected in a research project, though, not every test goes so smoothly from the start. Just like the science connecting man and machine is still being developed, the person being connected must learn how to control the system, Holbert said.

"I mentally have tried many different things to make it go, like trying to will it to go, or trying to think 'move one leg at a time,' 'lift the leg,' or 'lean forward.' I haven't figured out the thought process that does make it go. It's as much about figuring out how my own brain makes it operate as it is the software and hardware."

Such a learning curve is not surprising, Contreras-Vidal said. BMI systems require a co-adaptation process, one that involves teaching the algorithms how to properly interpret the individual's brain signals as well as teaching the individual how to control the machine. At this stage in the research, he said, such training must be carefully guided by physicians and researchers, and must account for factors such as fatigue, stress, speech and other tasks that are known to affect brain waves.

At this point, said Holbert, BMI technology needs to advance significantly before it can be widely deployed – an assertion no one contests. In the meantime, he continues to monitor other research initiatives that could help him regain his lost mobility.

"I've seen a number of projects that pop up now and then," he said. "I hope some of these universities will be able to collaborate together and speed things along."

Spreading the Word

If it's real, tangible results Holbert wants, he's working with the right man. While Contreras-Vidal's research has established him as a leading expert in BMI systems, he's also a leader in the BMI research community. He's using that status to overcome one of the biggest challenges to the deployment of any new technology: the Valley of Death.

For people waiting for a medical breakthrough, that's as bad as it sounds.

Many if not most new technologies – particularly those created in an academic setting – are developed with funds from federal agencies like the National Science Foundation (NSF), the National Institutes of Health (NIH) and the Defense Advanced Research Projects Agency (DARPA). But there's often a gap of time between these agencies' support of such research and when a private investor will step in. That dip in funding – the Valley of Death – is where many good technologies have died.

According to Kip Ludwig, a program director at NIH's National Institute for Neurological Disorders and Stroke, Contreras-Vidal is "one of the few researchers trying to chart a path out of the Valley, both for himself and others."

"Manufacturing, FDA approval, Medicaid reimbursement, market sizes, venture capital – these are all considerations," said Ludwig. "For any of this work to have an impact on a subject's everyday life, it needs to get to a marketable product. I think Pepe's one of the few that are very well aware of that, so he's trying very hard to learn the process for himself and then communicate it to the rest of the community as he learns it."

Indeed, last year Contreras-Vidal organized a gathering of the leading figures in the BMI community from around the country and even the world. The "2013 International Workshop on Clinical BMI Systems" included not just researchers, but investors, entrepreneurs, executives with major medical device manufacturers, regulators, funding agency representatives and patients who would benefit from BMI-enabled technologies like a robotic exoskeleton.

The gathering was dedicated to creating a roadmap for bringing BMI systems of all types from the lab to clinical settings. While such a map was far too complicated to make over a three-day conference, attendees formed working-groups that are now figuring out how to bring these systems to patients as quickly as possible. A smaller, more focused follow-up, "Translational Working Group Meeting on Clinical BCI Systems," was held last February with representatives from the U.S. Food and Drug Administration, the White House's Office of Science and Technology Policy and other stakeholders. Within the next several months Contreras-Vidal and members of this working group hope to publish a draft regulatory roadmap that will facilitate innovation and investment in device development and the translation of neurotechnology from the lab to the clinic, where it can actually help patients in need.

"This is a huge undertaking," Ludwig said. "The roadmap has to address a lot of different conditions – there's stroke, spinal cord injury, amputation. There are also different ways you can connect the brain with a machine or computer. So what we create must cover all these systems from a technology standpoint, and also things like regulation and public versus private funding."

▲ ▶

Pictured: Above: (Top) Ph.D. student, Kevin Nathan (MSEE), the first recipient of the joint UH/HMRI Graduate Fellowship in Clinical Translation, works closely with UH electrical and computer engineering professor Jose Luis Contreras-Vidal and Robert Grossman, M.D., professor of neurological surgery at Houston Methodist.
(Bottom) Jose Luis Conteraras-Vidal works with graduate students to create prosthetics. Right: A patient receives a prosthetic limb for testing.

A Complete Portfolio

While the entire BMI research community will be helped by the creation of this roadmap, Contreras-Vidal will certainly be among the biggest beneficiaries, for one simple reason: He's undertaken multiple projects involving different robotic systems targeting different patient populations.

These include:

- **DEVELOPING** BMI systems for studying brain plasticity (basically, the brain's ability to re-wire itself after injury) and the use of virtual avatars for rehabilitation of gait, which is supported by a $1.2 million grant from the National Institutes of Health.
- **CREATING** 3-D printed exoskeletons for use by pediatric patients, including those suffering from cerebral palsy.
- A **$1.2 MILLION** collaborative grant funded by the National Science Foundation to develop a BMI system that allows users with below-elbow amputation to control a prosthetic robotic hand with a non-invasive interface.
- A **$1 MILLION** collaborative National Robotics Initiative (NRI) grant funded by the National Institute of Neurological Disease and Stroke for clinical validation of BMI-control of a therapeutic exoskeleton by stroke patients.
- **CLINICAL TRIALS** of a BMI control of an exoskeleton for rehabilitation purposes, focused on helping people with spinal cord injury and other forms of paraplegia re-learn how to walk. In addition to the generous support from TIRR, this effort has also received a $450,000 grant from the Cullen Foundation.
- **A NEW EFFORT** carried out in collaboration with NASA to use the agency's X1 exoskeleton, first developed as an exercise tool in outer space environments, as a rehabilitation device for people recovering from brain injury or stroke. Importantly, the device will be endowed with diagnostic capabilities to harness information about the user's physical and neurophysiological states in order to tailor their rehabilitation.
- **ANOTHER NEW PROJECT**, carried out in collaboration with Jose Pons with Spain's Consejo Superior de Investigaciones Científicas, targeting stroke rehabilitation. This project combines EEG and neuromuscular signals to control the H2 robotic exoskeleton, built by Pons.

One of Contreras-Vidal's most recent awards has added a new patient group to those that can benefit from his work. This summer, the National Science Foundation awarded Contreras-Vidal and a collaborator $1.2 million to develop neural control for advanced bionic legs for amputees.

His partner on this effort is Helen Huang, an associate professor in the biomedical engineering department jointly operated by North Carolina State University and the University of North Carolina at Chapel Hill.

According to Huang, their collaboration began when she approached Contreras-Vidal at a conference to discuss a paper he'd published on decoding the neural signals for walking in able-bodied individuals. "Nobody's doing what he's doing," she said. "I would say he pioneered using non-invasive technologies to decode the lower limbs. So at the workshop, I approached him and said I wanted to talk about his paper on walking intentions."

Contreras-Vidal, likewise, was impressed with Huang's work on neural control of prosthetics based on the electrical signals generated by muscle activity. During their conversation, they realized that their efforts could be combined to create a technology that could change the lives of amputees.

In many ways, developing a brain-controlled prosthetic is more complicated than exoskeleton research, said Contreras-Vidal. Exoskeletons essentially replace both legs. This allows complex tasks such as maintaining balance to be built into the machine.

But an advanced leg prosthetic requires greater coordination with the patient's body. A prosthetic that attaches at the knee, for instance, must work in close cooperation with the muscles in the patient's thigh and with his intact leg, as well as with his brain.

The system, then, will have to interpret and integrate these muscles' electrical signals (called myoelectric signals), with readings from EEG signals along with information provided by the prosthetic, which will offer data on joint position and mechanical impedance from pressure sensors.

"The EEG is going to provide the higher-order control – tasks, intentions, very high level – and the low-level myoelectric control is going to provide continuous adjustments for the prosthetic legs. If you need to adjust to steps or deal with uneven terrain and slips, the myoelectric will help with that," said Contreras-Vidal.

One of the main tasks of the research, he added, will be figuring out which type of signal should do the heavy lifting in different scenarios and then building that knowledge into the system. Should an unnoticed dip in the sidewalk, for example, be managed primarily by the prosthetic, by the myoelectric signals, or by the EEG signals?

Whatever the answer, the addition of research into prosthetic legs rounds out Contreras-Vidal's investigations. His lab now covers research benefitting those dealing with paralysis, amputation, stroke and spinal cord injury. Few researchers can claim such a complete portfolio of projects – both in terms of patient population and research funding, he said.

"We have a multi-million concerted effort across agencies, institutions and foundations to address the challenge of movement disability," said Contreras-Vidal. "UH is now one of the leading places worldwide for development of non-invasive BMI systems for restoration and rehabilitation of upper and lower limb function."

FIGHTING CANCER, One Cell at a Time

The statistics tell the story. According to the American Cancer Society, about 1.67 million people in the United States will receive a cancer diagnosis in 2014. Nearly 16,000 of them will be children and adolescents. All told, the disease will claim almost 586,000 lives throughout the year.

There are a lot of causes that contribute to cancer's high toll.

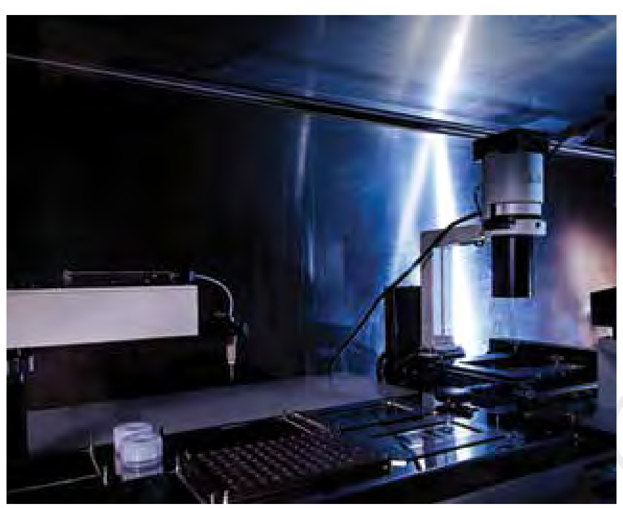
One big factor: In many cases, the body simply doesn't attack the disease. Many cancers suppress the immune system, preventing it from producing cancer-fighting cells and limiting the number of cells that recognize a tumor.

That's why immunotherapy, an emerging field of medicine, holds such promise. Instead of killing cancer cells with chemicals or radiation, immunotherapy researchers alter the body's own immune cells so they'll recognize and fight cancer. Though this treatment approach is in its early stages, it has shown great promise.

One of the world's leading centers for immunotherapy research and care is the University of Texas MD Anderson Cancer Center. And a growing number of researchers there rely on a University of Houston Cullen College of Engineering researcher to make their laboratory and clinical experiments as effective as possible.

That researcher is **Navin Varadarajan**, assistant professor of chemical and biomolecular engineering. Varadarajan brings to the table the nanowell array, a system that addresses one of the biggest obstacles in biological research.

Given the huge disparity in their sizes, it's impossible to study an individual cell using a standard slide, said Varadarajan. Researchers conducting work with cells, then, are forced to study entire groups, or populations, and essentially come up with an average for their behavior and their properties.



Pictured above: (Top) Navin Varadarajan works in his lab with the help of graduate students. (Bottom) Image of Navin Varadarajan's lab space.

The nanowell array overcomes this problem. It features a specialized slide with hundreds of thousands of individual chambers carved into it. Each chamber measures about 60 pitoliters in volume, just the right size to hold and study individual cells, Varadarajan said. "What the nanowell array does is shrink the container so that its dimensions are similar to those of a single cell. That lets us achieve single-cell resolution."

Creating a special slide is only part of Varadarajan's solution, though. While other research groups can build such a slide, the nanowell array is an entire microscopy platform that has been refined over several years. This includes the high-performance computing needed to analyze the hundreds of thousands of isolated cells in a short amount of time, as well as the capability to determine the precise location of specific cells of interest and remove them from the array for further study, among other features.

One key feature of the nanowell array platform suite is FARSIGHT, a histopathology tool developed by Badri Roysam, chairman of the Cullen College's electrical and computer engineering department. FARSIGHT automatically tracks and analyzes the movement of cells within the nanowell array, allowing the researchers to single out those exhibiting the most promising behavior. (For more on FARSIGHT's use as a clinical tool, see page 40.)

Varadarajan is currently working with several different immunotherapy researchers at MD Anderson. Three include Laszlo Radvanyi, a professor in the Department of Melanoma Medical Oncology - Research; Dean Lee, an assistant professor of pediatrics; and Laurence Cooper, an M.D./Ph.D. and professor in the Division of Pediatrics. Combined, these efforts are supported by more than $3.6 million in grants from the Melanoma Research Alliance, the Cancer Prevention and Research Institute of Texas and the National Institutes of Health.

The research effort with Cooper focuses on genetically modifying T cells, a class of immune cells that recognize and attack disease cells. By introducing artificial DNA, Cooper reprograms these cells to specifically recognize and kill cells that give rise to leukemias and lymphomas.

> "Immunotherapy, an emerging field of medicine, holds such promise. Instead of killing cancer cells … researchers alter the body's own immune cells so they'll recognize and fight cancer."

Not all altered T cells are equal, though. Some may only kill one cancer cell before dying themselves, while others may kill dozens. Some may start attacking a tumor within seconds of infusion; others may hold back, saving themselves (and their offspring) for a prolonged fight or even a recurrence years later.

Without the nanowell array, said Cooper, these differences could only be averaged out, as if there were only one type of behavior in a modified T cell population. "One of the beauties of the array is being able to learn not just the average biological response – you can actually make a statement now about multiple individual cells in an infusion product," he said.

The process for determining these individual characteristics starts with Cooper drawing blood from a patient, and then isolating and altering his or her T cells. He then infuses some of these engineered immune cells into the patient and sends others to Varadarajan for study.

Varadarajan places the cells he receives on the nanowell slide, where they naturally fall into individual chambers. Next, he exposes the same slide to cells of the targeted cancer. Using the entire nanowell microscopy platform, they are able to identify particular T cells of interest and pull them out of the array for a more detailed analysis.

This knowledge is vital to the success of using immunotherapy as a cancer treatment. By letting researchers study individual engineered T cells, the nanowell array gives these scientists a much better understanding of what works and what doesn't in immunotherapy. As a result, future experiments and clinical treatments become more targeted and more precise.

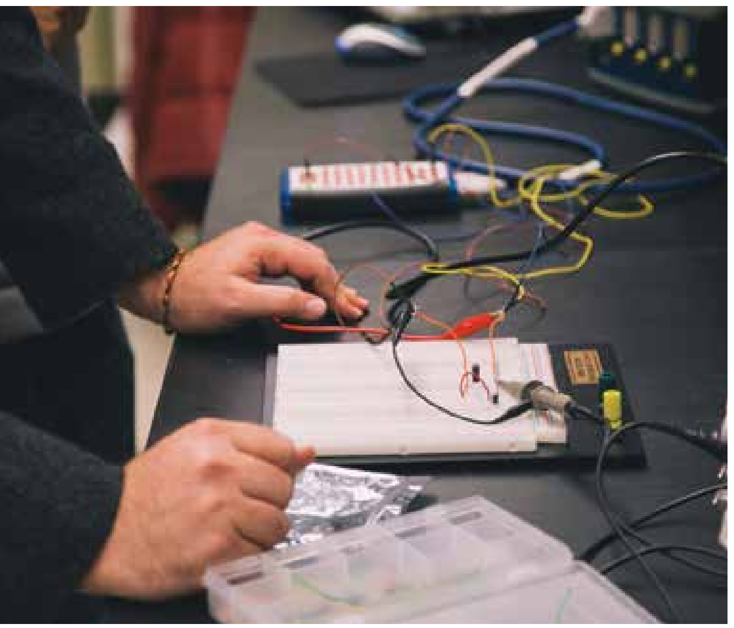
"The MD Anderson/UH partnership lets us use the infrastructure at UH to build a better mousetrap, to build a better set of T cells so we can pilot experiments in the nanochip before we go into the human," said Cooper. "It provides us a level of inquiry we never had before."

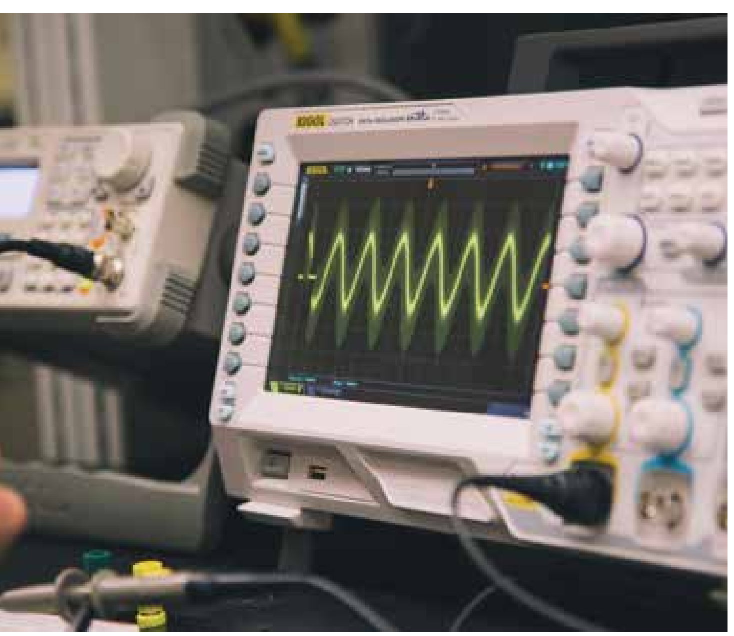
For more on this story and others, please visit: http://www.egr.uh.edu/news

READING THE SIGNALS For Better BRAIN Surgery

Let's start with the obvious:
Brain surgery is incredibly delicate and precise work. Many of the areas targeted in these operations measure just a few millimeters, and a slip of the scalpel can have disastrous consequences.

"We can shorten surgeries and recovery times and improve the quality of life for patients dealing with all sorts of neurological conditions."





Pictured above: Images of Nuri Ince's laboratory at the University of Houston's Cullen College of Engineering.

At the same time, there's an element of uncertainty in many of these procedures. Subtle differences in the shape of a patient's head or the location of specific areas of the brain force neurosurgeons performing the procedure to make educated guesses – but guesses still – about how to proceed.

That guesswork is what **Nuri Ince** is trying to remove from the equation. In doing so, he hopes to shorten patient recovery times and improve outcomes and quality of life.

Ince is an assistant professor of biomedical engineering with the University of Houston's Cullen College of Engineering. Using readings of the brain's electrical activity, he works with neurosurgeons in the operating room to identify the exact location of specific areas deep within the brain. While his approach can be applied to procedures for a number of neurological conditions – Tourette's syndrome, essential tremor, epilepsy – Ince is currently focusing on surgery for severe cases of Parkinson's disease.

This procedure is known as deep brain stimulation surgery, or DBS. The target of the surgery – the part of the brain doctors want to stimulate – is the subthalamic nucleus (STN), a small, football-shaped section of the brain that helps control movement. In Parkinson's patients, the STN is misfiring, causing symptoms like tremors and labored movement. While most patients' symptoms can be managed by medication, some simply don't respond to drugs. If their symptoms become severe enough, they may opt for surgery.

During this procedure, a surgeon inserts a probe targeting the STN into the brain. This probe contains a series of electrical contacts that can be attached to a battery pack and deliver a small jolt of electricity to stimulate a misfiring STN.

One of the major challenges in DBS surgery is getting the electrode to just the right spot, Ince said. "The STN is located in the deep brain and is very, very tiny – just 6 millimeters by 4 millimeters. Finding and hitting it with the probe is extremely difficult."

To locate the STN, surgeons typically insert three microelectrodes just a few millimeters into the brain directly above the area where they suspect the STN lies. The electrical activity recorded by these three probes can provide surgeons with a good idea of where to insert the larger deep brain probe.

There are some shortcomings to this approach, though. First, it is very difficult for neurosurgeons to interpret this activity, especially during a surgery when the patient's life is in their hands.

Pictured above: Nuri Ince works with graduate students to develop signal-processing techniques to interpret the brain's electrical activity.

Ince sits in the operating room during DBS surgeries, interprets the electrical activity recorded by the microelectrodes and guides the neurosurgeon's placement of the final probe used for stimulation.

He takes the data recorded during these surgeries and develops signal-processing techniques that can automatically interpret the electrical activity recorded by the probe. These techniques will provide feedback to neurosurgeons about the location of the STN in real-time, helping them to guide the placement of the probe accordingly. This will allow an entire DBS surgery to be performed faster and more accurately than ever before.

"We first record the electrical activity of the brain, and then by doing signal processing, we are trying to understand if we're at the right location," he said. "The activity we record from the micro and macro probes actually gives us clues."

Ince's support of these patients doesn't end with the surgery. The typical probe used to stimulate the STN has four pairs of electrical contacts. A few months after the surgery, after the patient has recovered from the procedure, he or she meets with a neurologist to determine the best protocol for activating these contacts. This includes finding which ones to fire, at what frequency they should fire and how much current they should carry.

Currently, this is an empirical process, said Ince. The neurologist activates a pair of contacts on the probe and sees how the patient responds. If the tremors stop, that's a good sign. Bad signs include involuntary body movements, the loss of ability to speak or even impaired cognitive function, which is especially troubling because it may not be noticed right away.

The contacts on this probe can not only stimulate, but also record the brain activity. Ince, then, is taking readings from the deep brain probe just before programming and using them to determine which sets of contacts should be used to stimulate the STN. "Basically, we want the brain to tell us which contacts to use," said Ince.

This effort has already proven effective. In a 2010 pilot study, Ince used his data processing techniques on four DBS patients ready to have their stimulation protocol set up. On all four patients, his algorithms correctly predicted which contacts on the probe should be used to stimulate the brain.

But determining which contacts to use is just the beginning. Ince envisions a time when far more sophisticated algorithms can be built into the battery pack used to power the probe.

These algorithms would constantly interpret brain activity provided by the probe and recognize when this activity starts to move outside of a set range – signaling oncoming tremors in a Parkinson's patient or a seizure in an individual with epilepsy. The algorithms would then send the exact amount of electricity to the exact contacts in the exact order needed to keep the brain's electrical activity within a safe set of parameters. In effect, the symptoms of these conditions would almost disappear from the patient's day-to-day life.

"Being able to interpret and respond to electrical activity in the brain in real time is at the heart of this research," said Ince. "If we can do that, we can shorten surgeries and recovery times and improve the quality of life for patients dealing with all sorts of neurological conditions."

Hitting the TARGET:

Optimizing Radiation Treatments for Cancer

Proton beam therapy is one of the most advanced cancer treatments in the world. But what makes it so effective can, for some patients, be one of its greatest shortcomings.

These shortcomings are what **Gino Lim** is working to overcome. Lim, who serves as Hari and Anjali Agrawal Faculty Fellow, associate professor and chairman of the industrial engineering department at the University of Houston Cullen College of Engineering, works with the University of Texas MD Anderson Cancer Center to create treatment protocols for "pencil beam scanning" proton therapy. These protocols are customized to each individual patient, ensuring that the treatment is as safe and effective as possible.

To understand the benefits and challenges presented by proton therapy, it's best to start with what makes it different. Currently, most cancer patients undergoing radiation therapy aren't getting protons. Instead, they're often getting photon beam therapy. These beams are made up of X-rays or gamma rays that enter the human body, passing through healthy tissue until they strike their target. However, this passing through can be a problem.

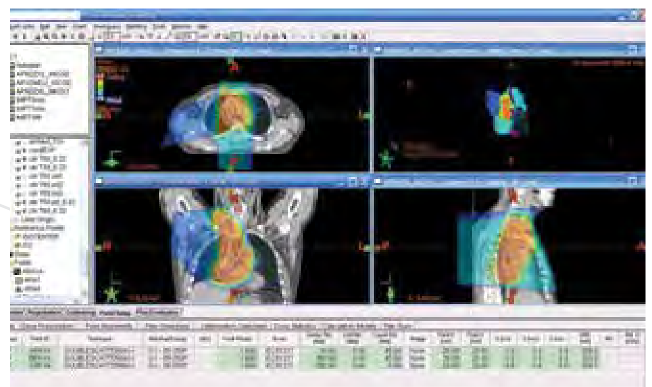
The nature of photon beams means that tissues they come in contact with absorb a significant amount of energy; even tissue that lies beyond the tumor becomes irradiated. As a result, a lot of healthy cells – often cells of vital organs – can be damaged or killed during photon-based radiation therapy.

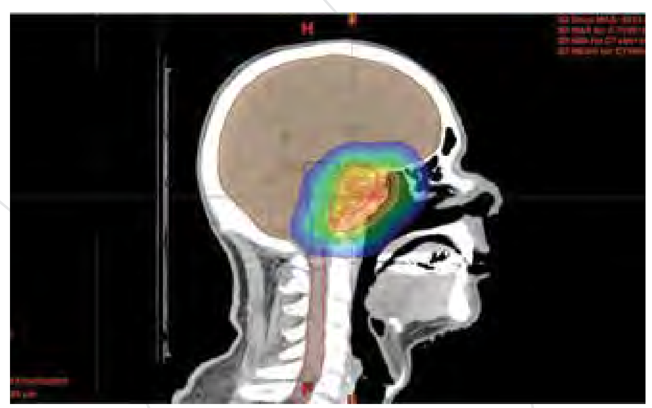
Proton beams don't present this problem. The individual proton particles are far heavier than photon particles, making it easier for healthcare providers to control exactly where they go. Based on MRI or CT images, the treatment planner can program the beam to travel to an exact depth in the body before releasing a burst of energy called the Bragg Peak. As a result, the tumor is targeted nearly perfectly, minimizing nearby healthy tissue's radiation exposure.

Treatment plans that stop there, though, aren't accounting for some important biological facts. Involuntary movements can impact the tumor's position. A lung cancer tumor, for instance, will shift as the patient breathes. In prostate cancer patients, the bladder slowly filling up during treatment can shift the location of the tumor.

"If I am shooting it a little too far, I am completely missing the target," said Lim. "That's the potential danger of using proton therapy. The question is what's the best way to hit the target under such uncertain circumstances."

That's where Lim comes in. An expert in large-scale optimization problems, Lim has developed and is constantly refining algorithms that can quickly devise treatment protocols that take these changes into account. These programs determine the exact angles at which the beam should be pointed at the tumor, the exact spots it should hit within that angle and exactly how long each burst of energy should last.





Pictured:
Above: (Top) Gino Lim works to overcome shortcomings with proton therapy. (Middle and Bottom) Computer imaging of subject's lungs and head.

Right: Gino Lim (middle) works with the University of Texas MD Anderson Cancer Center to create treatment protocols for proton therapy.

"This is an excellent therapy and we should do everything we can to make sure it is as effective as possible."

As a purely academic exercise, coming up with the best protocol for this problem isn't that difficult, said Lim. In fact, it could be solved using the techniques found in optimization textbooks. The problem, though, is time. When approached as an optimization problem, a single tumor case is associated with millions of variables and millions of constraints. Even with high-performance computing, solving a single optimization problem of this size with traditional approaches would take weeks to months. That's obviously not acceptable when dealing with cancer treatments.

"I've never completed one of these problems using the typical approaches," Lim said. "We came up with a much better, faster approach. It's very close to the theoretically best solution, probably 3 percent off, but we can produce a solution in about 10 minutes and we're able to solve much larger problems that optimize the angles and every other treatment parameter within 30 minutes using high-performance computing."

The meat of Lim's approach lies in the use of sophisticated optimization techniques with names like "branch-and-bound," "local neighborhood search," "simulated annealing," "simplex algorithms" and "genetic algorithms." Typical combinatorial optimization techniques would evaluate every beam depth and intensity, every combination of beam angles and more. Lim's optimization process starts with a simple solution. Better performing solutions are then sought out through an iterative process that utilizes multiple CPU cores that are otherwise idle.

"Eventually, when there's no improvement over time, the algorithm stops. This is the perfect approach for a high-performance multi-core computing environment, which has become the trend in the modern computing world. Whatever number of cores I may have, I can utilize them to evaluate multiple solutions at the same time," said Lim.

As mentioned, Lim is constantly refining these algorithms. One of the questions he's paying extra attention to now is how the tumor shrinks. Though that's the entire purpose of the procedure, it is underappreciated in radiation treatment protocols, Lim said. Though imaging procedures are expensive, Lim believes they should be carried out frequently in order to ensure patients receive the best possible care. In fact, he is working on a paper recommending that tumors be imaged every week during proton therapy.

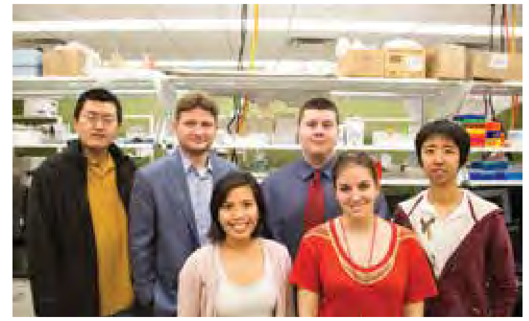
"The beauty of proton therapy is that it's so precise," Lim said. "The radiation exposure is very low at the point where it enters the body, then it hits the tumor with a big burst of energy. This is an excellent therapy and we should do everything we can to make sure it is as effective as possible."

COMING SOON...

In addition to research that directly benefits the patient volunteering for the project, several Cullen College researchers are conducting investigations that could have a significant impact on patient health within just a few years. Here's a selection of a few of these efforts.

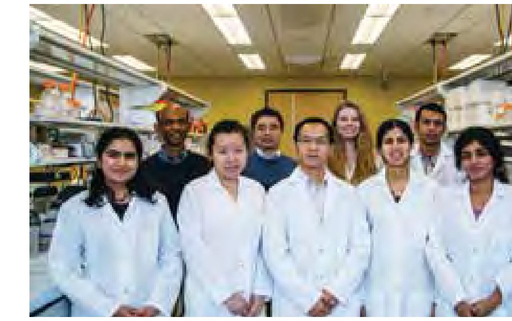
COMING SOON...












Pictured: (Left Page) Images from Sergey Shevkoplyas' lab. (This Page, Bottom Left) Badri Roysam. Remaining Images from Chandra Mohan and Tianfu Wu's lab space.

Making Blood Transfusions Safer

When patients receive a blood transfusion, they get more than healthy, well-preserved red blood cells. They also get a number of materials that are potentially harmful, including the anticoagulant-preservative solution that keeps red blood cells alive throughout storage; cells that have been irreparably damaged by processing the blood after donation and during storage; the remnants of burst cells, including free hemoglobin and microparticles that can contribute to inflammation and the formation of blood clots; and the byproducts of cellular metabolism. The longer blood is in storage, the more these materials build up.

Thanks to an NIH Director's Transformative Research Award, associate professor of biomedical engineering **Sergey Shevkoplyas** is developing a simple device to separate healthy, well-preserved red blood cells from all the other material in the blood bag just before transfusion. The $1.8 million award was originally given in 2012 while Shevkoplyas was at Tulane University and the remaining $1.5 million was recently transferred to UH.

The system Shevkoplyas is developing will consist of two tubes that feed into a plastic device just a few inches in size. One tube will send blood into the device while another will send saline solution. In the first step, the saline will literally wash harmful particles and the storage solution off the healthy red blood cells.

Next, the entire mixture will be sent through an array of precisely designed microfluidic channels. There the shape, size and flexibility of healthy red blood cells will allow them to be separated from the particles, damaged cells and storage solution. At that point, the healthy red blood cells, along with saline acting as a transport medium, can be safely transfused into the patient.

None of this will be easy, said Shevkoplyas. Most microfluidic research (where fluids flow through channels measuring less than a millimeter) involves devices that can handle just a few drops per hour. With its series of interconnected channels, Shevkoplyas' device aims to scale these microfluidic interactions "up by a factor of 1,000."

"That's the big challenge. Adapting our understanding of microfluidics to a high-throughput device turns out to be not very simple, though we do have some good data to show we can do it," he said.

Tailoring Treatments for Cancer Patients

Badri Roysam, professor and chairman of electrical and computer engineering, is working with researchers at the University of Pennsylvania to determine why certain cancer drugs are effective on some people and not on others.

Roysam and **Bill Lee**, associate professor of medicine (hematology-oncology) at the University of Pennsylvania Abramson Cancer Center, are studying the effects of Avastin on patients with clear cell renal cell carcinoma (CCRCC), a particularly deadly form of kidney cancer.

As an anti-angiogenic medicine, Avastin is designed to slow or prevent tumors from growing new blood vessels. Without these vessels to supply a tumor with nutrients and oxygen, its growth can be slowed, halted or even reversed.

While Avastin has worked well for many patients in clinical trials, in others it has had little to no effect.

Lee theorizes that these different patient responses are due to differences in tumor endothelial cells, the cells that form blood vessels. To find out if he's right, he's accessing existing tumor samples of patients who took Avastin in a clinical trial and studying their endothelial cell populations.

This is where Roysam comes in. Roysam has developed a software suite, FARSIGHT, that can single out the endothelial cells in a tumor and can categorize those cells according to their biomarkers, such as molecules that reside inside the cells or on their surface. These biomarkers may play an important role in endothelial cells' susceptibility to anti-angiogenic medications.

This project just wouldn't be possible without FARSIGHT, Lee and Roysam said. Given the size of the study, it would be too time consuming for even a highly skilled pathologist to identify and categorize endothelial cells in the tumor samples.

The information gathered by FARSIGHT will then be sent to Dan Heitjan, a biostatistician at the University of Pennsylvania who has access to the actual results of the Avastin clinical trial. He will match up these results with the FARSIGHT data to see if there's any correlation between a particular endothelial cell biomarker and patients' response to the drug – whether good or bad.

Their findings could determine whether specific anti-angiogenic therapies will be effective for future patients, Lee said.

"It could be a positive predictor or a negative predictor, but either way we would be able to introduce some rationality and be able to guide patients to the most appropriate therapy for them."

Better Treatments for Lupus-based Kidney Disease

Next to an outright cure, having the knowledge and tools to monitor a disease and keep it in check on a daily basis is probably the best-case scenario for patients. That's exactly what **Chandra Mohan** and **Tianfu Wu** with the department of biomedical engineering are working toward for patients with lupus nephritis.

Caused by the autoimmune disease lupus, lupus nephritis is a kidney disease that each year causes hundreds of deaths and tens of thousands of hospitalizations in the United States alone.

While many signs of the condition are obvious – high blood pressure, foamy urine, swelling in the legs, feet, or ankles – physicians don't fully understand what's happening inside the patient's body at the molecular level that sets the disease in motion and causes it to progress. Monitoring the disease on a day-to-day basis, then, is next to impossible, simply because doctors don't know what molecules, proteins and other biomarkers their tests should look for.

Working with the support of a grant from the National Institutes of Health, Mohan and Wu are studying blood and urine samples from lupus and lupus nephritis patients, looking for the biomarkers that show up as the disease develops and progresses.

The researchers, said Mohan, have very little sense of what proteins will show up at different stages of the disease. As a result, they're screening for thousands of different biomarkers at a time and then matching their findings with the patients' conditions, whether stable or changing.

These biomarkers, Mohan said, could end up being the targets of simple blood or urine testing systems. In fact, Mohan and Wu are simultaneously working to develop such tools. Much like diabetics monitoring their insulin levels, these systems would allow lupus nephritis patients to independently track the state of the disease and seek a therapeutic intervention when needed.

What's more, learning which proteins show up as lupus nephritis develops could help researchers break the chain reaction that causes the disease.

"The best biomarkers are tied to the root cause," said Mohan. "Very often the biomarker tends to be a good therapeutic target."

ECE Department Publishes on Small Satellite Research Investment

Students conduct small satellite research at the Cullen College of Engineering.

Small satellite research has taken flight in the Cullen College's electrical and computer engineering (ECE) department, providing students and faculty unprecedented access to space education and research.

Small satellites (or "CubeSats") are generally classified as small, cube-shaped satellites that weigh less than 3 kilograms. Compared to standard-sized satellites – which typically cost hundreds of millions of dollars to develop and launch – CubeSats can be developed for about $5,000 and launched for under $100,000.

Last year, ECE faculty members **Ji Chen** and **David Jackson** received seed funding from the Cullen College to launch a research program aimed at developing improved antennas for small satellites. Shortly thereafter, NASA offered Jackson and Chen up to $200,000 over two years to continue their research within the Small Satellite Research Laboratory.

While the return on investment for the Small Satellite Research Laboratory was great news for college, the real winners, in this case, are the students who now have the opportunity to conduct cutting-edge, NASA-sponsored research within the small satellite lab. Undergraduate and graduate students involved in research within the Small Satellite Research Laboratory work side-by-side with NASA experts in researching, developing and testing new technologies for CubeSats with the very high probability that their work will be deployed into space by the end of the year.

Now, ECE chairman **Badri Roysam**, along with Chen, Jackson and NASA collaborators Steve Provence and Steven Huning, have published an article in the January 2014 issue of "ECE Source" which details the benefits of investing in small satellite research at the college-level for both undergraduate- and graduate-level ECE students.

The article, titled "Elevating the ECE Capstone Design Experience with CubeSats," was the featured article from this issue of "ECE Source," the newsletter of the Electrical and Computer Engineering Department Heads Association.

Cullen College Launches Future Faculty Program

The UH Cullen College of Engineering has launched the first Future Faculty Program to prepare top-performing Ph.D. students for a successful career in academia.

The first-of-its-kind program was spearheaded by mechanical engineering department chair and M.D. Anderson Chair Professor **Pradeep Sharma**, along with associate professor **JR Rao**. Together, the two hope to prepare leading graduate students to become successful educators and researchers at top engineering schools around the world.

To achieve this goal, Sharma and Rao stress to students involved in the program that simply completing a great Ph.D. dissertation is not enough. Students in the Future Faculty Program who want to become successful engineering educators and researchers are exposed to the challenges of a faculty search in today's world and are taught how to set goals and expectations at each stage in their academic career.

Currently, only a few other programs like this exist in the country. Sharma and Rao foresee the Future Faculty Program becoming a mainstay within the college and hope to see it grow into a post-Ph.D. completion program.

College Posts Dozens of Lesson Plans To Engineering Education Site

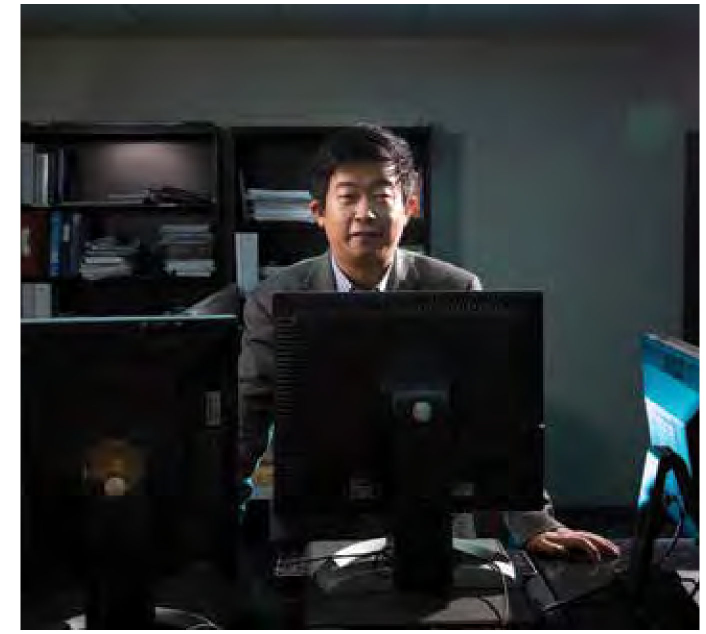
Teachers across the country have access to dozens of new lesson plans and activities thanks to STEM education efforts (science, technology, engineering and mathematics) at the University of Houston Cullen College of Engineering.

These plans, along with hundreds of others, can be found at www.teachengineering.org, a website run by a collection of universities along with the National Science Foundation (NSF) and part of the National Science Digital Library.

The Cullen College-made plans were created by participants in the college's two primary STEM education programs, both funded by the NSF. Through its Research Experience for Teachers (RET) Program, Houston-area high school teachers come to the college during summer breaks to get research experience they can take back to their own classrooms. The GK-12 Program provides the college's graduate students with a stipend to spend time in primary and secondary school classrooms teaching engineering and science. Both efforts are designed to encourage more young people to enter the STEM fields.

According to **Fritz Claydon**, professor of electrical and computer engineering and a principle investigator on the grants supporting these efforts, participants in each program are required to create some sort of peer-reviewed deliverable that allows their work to be transferred to other classrooms. The feedback the Cullen College receives from the NSF on its deliverables has been outstanding, he said. "Because of the efforts we've made and the success we've had, the NSF is saying that the gold standard for deliverables is the UH model."

The support the Cullen College has received for its STEM education efforts bears this out. The college has won multiple grants over the years to operate STEM-related programs; the current awards to run the GK-12 Program and RET Program alone total more than $3.4 million.



Krishnamoorti Named to "Who's Who in Energy" List

Ramanan Krishnamoorti, professor of petroleum engineering and chemical and biomolecular engineering as well as Chief Energy Officer at the University of Houston, was recently named one of the city's top energy professionals by the Houston Business Journal.

Krishnamoorti made the journal's annual "Who's Who in Energy" list, which recognizes the "movers and shakers" in the energy capital of the world.

As UH's chief energy officer, Krishnamoorti oversees the university's strategic plan for all energy-related education, training and research. One of his biggest duties is the development of UH's Energy Research Park (ERP), a 74-acre campus designed to bring academia and industry together to solve the world's most pressing energy-related challenges. The park has received millions of dollars in support from energy firms for the creation of cutting-edge facilities and programs.

On the educational front, Krishnamoorti plays a key role in the highly successful petroleum engineering program (started during his time as chairman of chemical and biomolecular engineering), as well as the recently created energy and sustainability minor. He's also helping to oversee the subsea engineering program's move toward online course offerings.

Most recently, he served as UH's representative in a partnership with Texas A&M University and the University of Texas at Austin to form the Ocean Energy Safety Institute, which will serve as a platform for industry, academia and government to conduct research and communicate on the safest and most efficient methods and technologies for retrieving offshore resources.

"UH is already home to outstanding energy research and educational programs. As we expand these efforts and build new industry partnerships through the Energy Research Park, we will clearly show that UH is one of the top universities for energy in world," Krishnamoorti said.

ECE Professor Named IEEE Fellow

Zhu Han, associate professor of electrical and computer engineering, has been named a fellow of the Institute for Electrical and Electronics Engineers (IEEE). The honor is the IEEE's highest grade of membership and is reserved for those with "an outstanding record of accomplishments" in an IEEE field. No more than one-tenth of 1 percent of IEEE's voting members can be named fellows in a given year.

In naming Han to the 2014 Class of Fellows, the IEEE cited his contributions to resource allocation and security in wireless communications.

Indeed, Han is recognized around the world as an expert in these fields. His work on these topics has resulted in dozens of peer-reviewed papers and co-authorship of five books, all published by Cambridge University Press.

Zhu Han has been named a fellow of the Institute for Electrical and Electronics Engineers.

Rifai Named Environmental Professional of the Year

Civil and environmental engineering professor **Hanadi Rifai** has been named the 2013 Environmental Professional of the Year by the Texas Association of Environmental Professionals (TAEP).

Rifai, who also serves as the Cullen College's associate dean for research and facilities and the director of the environmental engineering graduate program, was honored at TAEP's annual Environmental Challenges and Innovations Conference, held in Houston last October.

TAEP has a long association with the Cullen College's environmental engineering graduate program, said Rifai, including funding a $1,000 student scholarship in the program every semester for several years.

Rifai is widely respected in the civil and environmental engineering communities. She has identified several major sources of water pollution in the Houston region and the Houston Ship Channel, including one location that was named a Superfund cleanup site by the U.S. Environmental Protection Agency. In 2012, she received a $500,000 grant renewal from the Texas Commission on Environmental Quality to expand her work into open areas of Galveston Bay. In addition, she was named a fellow of the American Society of Civil Engineers in 2012 and has served as editor-in-chief of Bioremediation Journal since 2002.

City Honors STEM Center Director With "Dr. Bonnie Dunbar Day"

December 3, 2013 was officially UH STEM Center/Dr. Bonnie J. Dunbar Day in the City of Houston.

Houston Mayor Annise Parker proclaimed the honor during a ceremony at Houston City Hall.

The proclamation was sponsored by Houston City Council Member Melissa Noriega. It honored the University of Houston center dedicated to improving scientific literacy and encouraging young people to enter the STEM fields (science, technology, engineering, mathematics), as well as the center's leader, former astronaut and current Cullen College of Engineering professor **Bonnie Dunbar**.

Dunbar joined the university last year to lead the UH STEM Center. The center's stated goal is to move the United States' K-12 education system in science and mathematics to a leading position by global standards and to encourage more U.S. citizens to pursue careers in science, technology, engineering and math.

New Endowed Chair Supports Disease Diagnostics

Richard Willson's efforts to develop highly sensitive disease diagnostic systems have made him one of the most accomplished researchers at the University of Houston Cullen College of Engineering. Now Willson, already John and Rebecca Moores Professor of chemical and biomolecular engineering, has been named the first Huffington-Woestemeyer Endowed Chair in biomolecular engineering for these efforts.

The endowed chair was recently established thanks to generous gifts totaling $2 million from supporters Ronald and Mariette Woestemeyer along with Dr. Ralph Dittman and his wife, Terry Huffington of the Huffington Foundation. The gift is intended to support research that will lead to earlier diagnosis and treatment of diseases and ultimately save lives.

Willson's work clearly applies. Much of his work centers on using biomolecular recognition to diagnose cancer and infectious diseases.

For example: When an individual becomes ill, their blood often contains pathogenic organisms, or cancer biomarker proteins, in very small amounts. Willson and his collaborators cover micro- and nano-scale particles with specific antibodies that can bind to the pathogen or biomarker, and then build systems that can identify if even a single particle has bonded. With this approach, they are able to detect the smallest signals of the presence of a disease, which allows them to diagnose diseases in their earliest stages. He is applying this approach to a number of diseases including Norwalk and Dengue virus infections, and several types of cancer for which promising biomarkers have been identified.

"I'm honored to be named the first Huffington-Woestemeyer Endowed Chair in biomolecular engineering," said Willson. "Early detection and treatment can make a huge difference in patient outcomes. This appointment will help me continue to work with my collaborators to develop systems that can diagnose diseases, hopefully at a point when treatment can be most effective."

SPE Publishes Fourth Book by Petroleum Faculty Member

John Lee, Professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair in the Cullen College of Engineering's petroleum engineering program, is unquestionably one of the giants of the petroleum engineering field. Among his many accomplishments are three best-selling textbooks published by the Society of Petroleum Engineers.

In December, the SPE added to its catalog a fourth book by Lee, written with senior author John Spivey.

"Applied Well Test Interpretation" focuses on using tests of petroleum wells to determine the important properties affecting flow in a reservoir.

The book primarily focuses on the pressure transient response test. To take this measurement, well operators change the amount of petroleum a well produces (often shutting it down to zero) and then measure how the pressure at the bottom of the well changes over time. "If the pressure changes rapidly to a final, stabilized value, that means the reservoir is able to transmit fluids very rapidly. That's good. If it changes very slowly to that final pressure, then the reservoir is not capable of transmitting signals rapidly and that's bad," said Lee.

In addition to covering the application of pressure transient response, the book also presents the theories behind rate transient testing, which uses the amount of petroleum produced by a well over a period of time to determine the reservoir's important properties.

Since pressure in unconventional wells builds up too slowly to conduct pressure transient response tests, rate transient testing is an important tool for forecasting unconventional reservoirs, Lee said. Applied rate transient testing will be covered in a future book, he added.

This is the first of Lee's textbooks in which he serves as a secondary author. The lead author, Spivey, is a petroleum engineering consultant based in College Station, Texas, who earned his Ph.D. under Lee.

Professor Creates Guide to Nuclear Plant Infrastructure

Thanks to the efforts of a University of Houston Cullen College of Engineering professor, designers and operators of nuclear power plant facilities now have the most up-to-date guidelines on nuclear plant infrastructure available in one book.

"Infrastructure Systems for Nuclear Energy," published by John Wiley & Sons this month, is edited by **Thomas Hsu**, John and Rebecca Moores Professor with the department of civil and environmental engineering, along with Chiun-Lin Wu and Jui-Liang Lin, both with the National Center for Research on Earthquake Engineering in Taiwan.

The book includes 31 peer-reviewed chapters that cover the design and analysis of everything in a nuclear power plant save the reactor and its piping.

These chapters fall into four main sections:

- An overview of nuclear plant infrastructure;
- Containment structures;
- Computer software for containment structures;
- Nuclear waste storage facilities.

The book grew out of a conference organized and chaired by Hsu in 2010. The International Workshop on Infrastructure Systems for Nuclear Energy was held in Taipei, Taiwan in December of that year. From the outset, Hsu and his collaborators planned to use the conference presentations as the basis for a book on nuclear infrastructure.

Initially, he said, they expected to have the book published by the spring of 2012. Publication, though, was delayed significantly by the March 2011 earthquake and tsunami off the coast of Japan, which caused massive damage and large radiation leaks at the Fukushima Nuclear Power Plant. Almost every entry in the book was changed due to what was learned at Fukushima.

The end product, Hsu said, should serve as a central resource for students learning how to design and analyze these plants; as a comprehensive reference for the plant designers; as a resource that will help existing operators to improve their facilities; and as a guiding document for academics to recognize the direction of future research.

Professor Honored by Home Country for Artificial Heart Research

Ravi Birla, associate professor of biomedical engineering, has been honored by his home country of Trinidad and Tobago for his work to create bioartificial hearts and heart components.

The country's National Institute of Higher Education, Research, Science and Technology (NIHERST) presented Birla with The Emmanuel Ciprian Amoroso Award for Medical Sciences at a ceremony held on Nov. 23. The honor is part of NIHERST's Awards for Excellence in Science & Technology program, which is designed to recognize the nation's most accomplished scientific researchers.

"I've very happy and a bit taken aback by it, actually," said Birla. "I'm from there and grew up there so to be recognized at the highest level by your home country is definitely an honor; it doesn't compare to anything else."

Birla's research includes developing artificial heart muscle and parts of hearts, like ventricles and biological pumps. The star of his research portfolio, however, is the whole heart project, which is focused on developing full bioartificial hearts.

This research, he said, has three main components: bioartificial heart muscle; "scaffolding" that will offer the physical shape and form of a heart for the artificial muscle to pump; and bioreactors, devices Birla is developing that train bioartificial heart tissue to behave like natural tissue.

With this approach, Birla has developed full, functioning bioartificial hearts using animal models. Much work must be done, however, before the technology can be transferred to humans.

"You can look at an artificial heart as the Holy Grail. That's 20 years out, but it's not the only solution a patient can benefit from," he said. "Heart disease is progressive. We want to replace current treatments with biological alternatives that are grown in the lab. That alone could save many, many lives."

Civil Engineering, Biology Partner to Offer MOOC

Two University of Houston faculty members – **Steve Pennings**, professor of biology and biochemistry, and **Kyle Strom**, assistant professor of civil and environmental engineering – are collaborating with other faculty around the country to offer a massive open online course (MOOC) for graduate students that links biology and geomorphology.

The interdisciplinary course, "Linking Biology and Geomorphology in Coastal Wetlands (and Other Habitats)," is being offered for credit at nine universities. More than 140 people are participating, including graduate students and faculty members at over 30 academic institutions, and staff at nine National Estuarine Research Reserves and two federal agencies.

The course provides background on biological, geological and hydrological processes in wetlands, and considers how these processes interact to affect wetland structure and function. Lectures are being delivered online by 15 scientists from around the country.

"We're very happy about the high level of interest in the course." Pennings said. "It would be difficult for a single university to offer a specialized graduate course like this one that allows students to interact with so many experts in a field."

Two Faculty Named to National Academy of Inventors

Dmitri Litvinov and **Venkat Selvamanickam** were both named 2013 fellows of the National Academy of Inventors.

To be eligible for fellow status, an individual must be a named inventor on at least one patent and must be affiliated with a university, nonprofit research institute or other academic entity. According to the NAI website, fellow status is awarded to "inventors who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development and the welfare of society."

Litvinov is dean of the UH Graduate School and John and Rebecca Moores Professor in the department of electrical and computer engineering. His recognition is an outgrowth of work he started at Seagate Technology, where he championed the development of perpendicular magnetic recording technology now used in nearly all computer hard drives. He holds 26 U.S. patents and two pending patents.

Since arriving at UH in 2003, in addition to leading research on nanoscale materials and devices for information technology and medical diagnostics, Litvinov has focused on innovating teaching and cutting-edge academic programs.

Selvamanickam is M.D. Anderson Chair Professor of mechanical engineering and director of the Texas Center for Superconductivity's Applied Research Hub. In 2000, Selvamanickam co-founded SuperPower, which produces superconducting electrical wire. At SuperPower, he led the development of technologies to convert a brittle ceramic superconductor into a flexible wire that has 300 times the current-carrying capacity of a comparably sized copper wire.

His team was the first to manufacture thin film superconductor wire, which was used in 2008 to power 25,000 households in Albany, N.Y., and now is used by more than 200 institutions around the world.

Selvamanickam brought the research division of SuperPower with him when he returned to UH in 2008. He holds 39 U.S. patents and 13 pending patents.

Passings

Michael Economides, Adjunct Professor, Chemical & Biomolecular Engineering

Michael Economides, an internationally known authority on petroleum engineering and adjunct professor at the University of Houston's Cullen College of Engineering, died in November.

Economides' research focused on techniques to increase production, from reservoir stimulation theory and advanced reservoir exploitation strategies to offshore technology development. But he also took geopolitical considerations into account, realizing that technical considerations alone could not determine the success of hydrocarbon development.

"He was a globally recognized expert in hydraulic fracturing, in production techniques, generally," said Tom Holley, director of the petroleum engineering program at UH, where Economides taught a master's-level class.

After 15 years on the faculty in the Cullen College's department of chemical and biomolecular engineering, Economides had become an adjunct faculty member, usually teaching one master's class a semester and devoting much of his time to serving as an adviser for companies globally, as well as writing and research. Economides also served as managing partner of a petroleum engineering consulting firm, and was well known as a leading energy analyst and consultant.

Economides was also a prolific writer, with hundreds of journal articles to his credit, and was the author or co-author of 15 books, including the well-known "The Color of Oil." He was the founder and editor-in-chief of Energy Tribune, an online publication, and offered commentary on global energy politics for FuelFix, the energy website at the Houston Chronicle.

Yin-Ho Michael Pao, Distinguished Research Professor, Mechanical Engineering

Yin-Ho Michael Pao, distinguished research professor of mechanical engineering with the UH Cullen College of Engineering and a member of the prestigious National Academy of Engineering, died last September.

Pao, who received a Ph.D. in fluid mechanics from Johns Hopkins University in 1962, had a long association with the college's mechanical engineering department and an incredibly successful career as an entrepreneur and businessman.

He founded and led six technology companies in his career, and took three public on the NASDAQ stock exchange. One of these, Flow International Corp., was named the third-best performing initial public offering in the nation in 1983 by the financial publication Barron's. That firm developed and commercialized the use of ultra-high pressure water-jet and abrasive-jet technology for industrial cutting, drilling, and milling, and is credited with creating the water-jet machining industry.

His other publicly traded companies were FlowMole Corp., which developed and commercialized horizontal directional jet-drilling technology for the trenchless installation of underground cables and pipes; and FloWind Corp., which developed in collaboration with Sandia National Laboratory and then commercialized vertical-axis wind turbine technology for electricity generation.

His most recent venture was Floating Windfarms Corp., which he founded in 2005. True to its name, that firm specializes in the development of offshore wind farms that utilize vertical axis turbines.

Pao's efforts earned him membership in the National Academy of Engineering. The official citation for his induction recognized his "research, development, and commercialization of water-jet technology for machining, trenchless boring, and surface preparation."

Thomas Whitaker, Former Chairman and Professor, Electrical & Computer Engineering

Thomas Whitaker, former chairman of the Cullen College's department of electrical and computer engineering (ECE), died on December 6 at the age of 92.

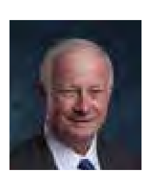
Whitaker earned his bachelor's degree from Rice University (then Rice Institute) in 1942. After graduating, he served in the U.S. Navy during World War II, where he conducted radar research and taught fellow sailors how to use the then-new technology. After the war, he earned a master's from Rice in 1950, followed by his Ph.D. from the University of Texas at Austin in 1963.

Whitaker actually began teaching at the Cullen College in the 1950s, and eventually served as one of the first ECE department chairs. In this post, he led the department through a period of rapid growth, said professor Stuart Long, who worked with Whitaker for several years.

As a professor, Whitaker focused primarily on teaching, Long said. In fact, after his retirement in 1985, Whitaker taught classes for the ECE department for several years. "He was always a good teacher, always loved teaching and being with the students," said Long. "It's a trite phrase, but he was a real gentleman. Everyone liked him."

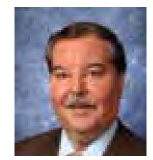
Retirements

Jerry Rogers, Ph.D., P.E.
Department of Civil and Environmental Engineering



Rogers joined the Cullen College as an associate professor in 1970. Since then, he has led an illustrious career in the practice and teaching of civil engineering, particularly environmental and water resources engineering. Over the decades, Rogers has amassed a long list of designations and awards, in addition to co-authoring dozens of papers and giving dozens more research and seminar presentations. In 2011, Rogers was presented with the Lifetime Achievement Award from the Environmental and Water Resources Institute of the American Society of Civil Engineers (ASCE).

Stanley Kleis, Ph.D.
Department of Mechanical Engineering



Kleis joined the Cullen College as a visiting assistant professor in 1973. He then became an assistant professor in 1975, and was named associate professor in 1981. During his UH career, Kleis advised over 30 graduate students, published 57 papers, and even found the time to invent new products – one of which won him the Public Service Medal, NASA's highest civilian award. Kleis has been a recipient of every major award for teaching presented by the college and the university, as well as several "Professor of the Year" awards from the UH American Society of Mechanical Engineers student chapter.

Lewis Wheeler, Ph.D., P.E.
Department of Mechanical Engineering

Wheeler joined the Cullen College as an assistant professor in 1968. During his time at UH, Wheeler supervised the research of over 20 graduate students, served a two-year appointment as interim chair of the mechanical engineering department and a 10-year term as the chief editor of the Journal of Applied Mechanics. Wheeler was awarded the 2002 Dean Claude L. Wilson Award for lifetime achievement as an outstanding engineering educator.

Cullen College Students Competing in **First Shell Eco-Marathon**

A team of UH Cullen College of Engineering students will be the first to compete in the Shell Eco-marathon this April. The event challenges teams from universities around the country to develop ultra energy-efficient vehicles and see which ones can travel the furthest using the least amount of energy. The most recent winning vehicle achieved the equivalent of 3,587 miles per gallon, according to Shell.

The UH Team, dubbed Team Primer, is made up of 10 mechanical engineering undergraduates. Team Primer will enter their vehicle, "EcoPrimer," under the marathon's "prototype" class, which focuses on maximizing the car's efficiency rather than the driver's comfort. The team members' tireless work on EcoPrimer will double as their senior Capstone Design projects, the penultimate project for all graduating seniors at the Cullen College.

Team Primer is currently sponsored by the department of mechanical engineering at the UH Cullen College of Engineering, the UH Engineering Alumni Association, Zoltek, the American Bureau of Shipping, Subsea Systems Inc. and the United States Business Council for Sustainable Development (USBCSD).

Co-op Provides Real-World Lessons for Industrial Engineering Student

For many students, taking a full-time course load of classes like differential equations and thermodynamics is enough to deal with in one semester. For **Antonio Cabrales Juan**, a sophomore pursuing his B.S. in industrial engineering at the UH Cullen College of Engineering, it wasn't enough.

Last fall, Cabrales began a cooperative education program with Risknology Inc., a risk assessment and process safety firm near the Memorial City neighborhood. Recently, his co-op was extended through the spring 2014 semester.

Co-op programs are a type of internship program that enable college students to receive hands-on career training with pay, according to the Cullen College's Engineering Career Center website. For Cabrales, the biggest benefit he's received is the understanding of how classroom theories play into real world engineering.

"You get that responsibility of knowing that as small as a number may be, it may make a big difference. It can save a life. It makes you take everything with a great deal of responsibility," Cabrales said.

Cabrales' boss and Risknology president Andrew Wolford explained that the company examines the three pillars of risk analysis: anticipating what could go wrong, estimating the chances of those things going wrong, and finally, assessing how bad the damage could be if those things do indeed go wrong. After the BP Deepwater Horizon well blowout in 2010, Risknology served as a consultant to the British oil giant on how to safely and effectively cap the leak.

Now, Wolford says the risk assessment industry is growing in conjunction with what he calls a "real resurgence back to basics." He says new builds and older plants alike need front end consultations as they're going through design (or re-design) processes.

Wolford describes their line of work as "keeping hydrocarbons where they belong," like in contained wells or pipelines, but the real nature of the industry is saving lives. Algorithms and analysis determine the risk of disaster, but 'disaster' doesn't just mean lost money or time. Just like in the Deepwater Horizon disaster, where 11 workers were killed by the blast, the impact of risk analysis can mean the difference between life and death for those working on or around projects. "It's what motivates us to go to work every day, to have that noble purpose, to know that what we do really matters," Wolford said.

That fact isn't lost on Cabrales, either. He said that his co-op with Risknology has helped him to apply the engineering theories he's learning in college to the real world. In his end-of-the-semester summary paper – a requirement of the co-op – Cabrales stressed that before his work experience, he never fully grasped the gravity of some of the decisions engineers make. Now that he's had first-hand experience with the consequences of poor decision-making, he more completely understands what is at stake: human life.

He also said, thanks to his co-op, he's now better equipped to take lessons taught in class and relate them to how and where they will fit into his career once he's working full-time. "I try to see how [the lessons] might be helpful. For example, in the user guide for the program we use here [at Risknology], all you see is differential equations. At the beginning of the semester I couldn't understand anything. Now, after the differential equations class, I try to apply what's being taught and it actually makes much more sense."

Undergrad Raises $7K on Kickstarter for Programmable Capacitor

Rakshak Talwar holding his "Programmable Capacitor" at UH Engineering.

Rakshak Talwar, an electrical and computer engineering undergrad at the Cullen College, raised $7,445 on the crowd-funding website Kickstarter for his "Programmable Capacitor." This figure is more than double his original goal of $3,000 and was raised in just 15 days.

Traditional capacitors are so ubiquitous that it's difficult to find an electronic product that doesn't use one. However, one big drawback to these energy-storing components is that one-size-does-not-fit-all; different devices need different types of capacitors. But Talwar's Programmable Capacitor is adjustable to over four billion value combinations, making it compatible with virtually every circuit imaginable – and it only costs $25.

He originally planned to produce an initial batch of 100-200 capacitors, but with the extra money he ended up filling 233 orders.

A tinkerer from birth and an inventor by nature, Talwar had been creating circuits for only a few short months before he came up with the idea for his capacitor. His one-size-fits-all capacitor saves time for inventors, who would otherwise have to search through a pile of loose parts for the capacitor that fits their specific need. With the Programmable Capacitor, one compact board can be used for all circuits.

Perhaps more fascinating, however, is Talwar's devotion to open sourcing his inventions. Instead of racing to patent his capacitor, he secured a creative commons license. Once his initial 233 capacitors are shipped this year, his design files will be available online – for free. Anyone who wants to build upon his idea must keep their design files public as well, thanks to his creative commons license.

Talwar believes his massive Kickstarter success is "empirical evidence" that he can eventually make money off his inventions without patenting them. The idea of never earning large profits doesn't seem to bother him, though. "[Steve Jobs] is my biggest idol. He said – and I completely agree with him – 'I don't want to be the richest guy in the graveyard when I die. I want to go home every night and say I did something wonderful.'"

Undergrads Take a Ride on NASA's 'Vomit Comet'

A team of Cullen College undergrads got the ride of their lives last November, taking a trip aboard NASA's "Vomit Comet" aircraft to conduct experiments in near-zero gravity. The UH "Cougarnauts" team was chosen as part of an elite group to participate in NASA's Reduced Gravity Education Flight Program, where they performed an assigned experiment during 25-second bouts of weightlessness in NASA's reduced gravity aircraft, known as the "Vomit Comet."

During their mission, the plane flies over the Gulf of Mexico and performs nine freefalls, which creates a sensation as close to zero-gravity as possible on Earth. "It was amazing. Time went by fast, it was so much fun. We learned so much," said Aashini Patel, a biomedical engineering student at the Cullen College. The "Cougarnauts" studied the effects of freezing water in zero-gravity conditions.

NASA expects that these experiments could play into the design and implementation of its next generation spaceships. The Reduced Gravity Education Flight Program is intended to increase minority student interest in math and sciences fields.

Students Form Subsea Engineering Society

A group of students from the UH Cullen College Of Engineering have started the Subsea Engineering Society (SES), the first organization for engineers, geotechnicians, technologists and other individuals who specialize in underwater petroleum exploration and production.

SES was founded by Nebolisa Egbunike, a recent mechanical engineering graduate who last spring began pursuing a master's degree in the college's subsea engineering program, the first such program of its kind in the country.

Since its inception last May, SES rapidly gained members and supporters. All students studying in subsea-related fields, including technology students and those in the sciences, are welcome to join the group, Egbunike said.

Several companies in the sector have stepped up to support SES, offering funding, guidance, access to facilities for tours, and manpower in the form of seminar speakers and mock interviewers.

Phaneendra Kondapi, KBR Adjunct Professor in the subsea engineering program and an engineering manager with FMC Technologies, is serving as SES's founding faculty advisor. As a brand new organization, SES will have a great impact on both students and industry, he said, with students in particular benefitting from the increased industry exposure. Companies, meanwhile, are enthusiastic about the group because it helps them establish relationships with young engineers entering a field where talent is in high demand.

Professional engineers from many different disciplines are also interested in getting involved, Kondapi added – a key ingredient to the group's success. Not only do they enjoy mentoring students, they also see SES as an organization that can support their own careers. As SES grows, Kondapi said, it will likely add an arm for professionals that will help working engineers expand their own networks and stay on top of advances in the subsea field.

Engineering Grad Student Wins TcSUH Scholarship

Dhivya Ketharnath conducts research at the Cullen College of Engineering.

When **Dhivya Ketharnath** was in high school, she knew she wanted to be an engineer, but she never would have predicted she would be conducting nanoparticle research for cancer therapy applications inside some of the finest biomedical laboratories the City of Houston's medical center has to offer.

Now, thanks to a grant from The Texas Center for Superconductivity at the University of Houston (TcSUH), along with UH's College of Natural Sciences and Mathematics and the Cullen College of Engineering, Dhivya will continue pursuing her Ph.D. in electrical engineering with a $2,500 stipend to continue her research within the TcSUH laboratories.

The Houston Electrical League (HEL) Scholarship is awarded each year to two outstanding undergraduate or graduate students with fantastic accomplishments both in academics and research. The merit-based scholarship is given to students currently conducting research within TcSUH's multidisciplinary laboratories. The mission of these scholarships is to encourage interdisciplinary research with a focus on finding applications in biomedical sciences and engineering.

Under the guidance of faculty advisor Jarek Wosik, a research professor with the Cullen College's department of electrical and computer engineering and TcSUH, Dhivya is conducting research on manipulating nanoparticles using radio frequencies and AC magnetic fields for cancer therapy applications. Through the HEL scholarship and TcSUH, Dhivya enjoys unique access to the Houston Methodist Research Institute (HMRI), where she conducts in-vitro cell studies at their laboratory facilities. In addition, Dhivya said HMRI doctors provide her with mentorship and guidance with her research.

At the Cullen College in general and the TcSUH in particular, a high premium is placed on providing funding for students and faculty members who take on ambitious, multidisciplinary research efforts. By investing in research and students such as Dhivya, the center has established award-winning research programs in medical imaging and nanomedicine and created lasting partnerships with a variety of collaborators at the Texas Medical Center.

ECE Student, Researcher Honored at Mission Connect Symposium

A researcher and a graduate student with the department of electrical and computer engineering (ECE) at the UH Cullen College of Engineering both won best poster awards at the 2013 Mission Connect Annual Scientific Symposium held in Houston in December 2013.

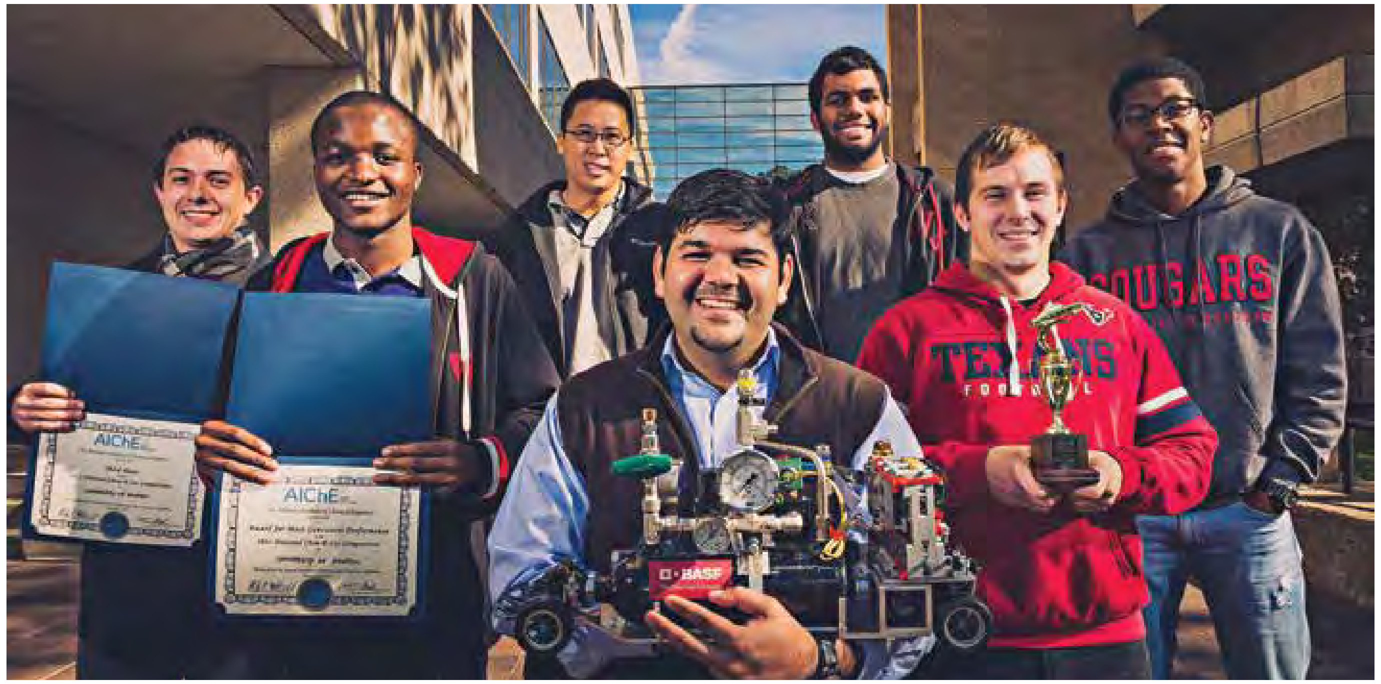
ECE researcher **Atilla Kilicarslan** received the overall best spinal cord injury poster award for his project titled "Neurorex – A Thought Controlled Robotic Exoskeleton for Gait Restoration." Kilicarslan delivered a three-minute elevator pitch for his poster to a panel of judges, who chose his poster presentation as the best among the 15 other presentations.

Kilicarslan works closely with ECE professor Jose Luis Contreras-Vidal, a leading expert on brain-machine interface systems. Contreras-Vidal and his research team (of which Kilicarslan is a member) focus on the development of noninvasive methods to interface the human brain with machines in order to help patients with mobility issues – such as paraplegics, stroke patients or amputees – regain their ability to walk and utilize their limbs using only the power of their thoughts.

ECE graduate student Kedar Grama received first place in the traumatic brain injury student category for his poster titled "Comprehensive detection and quantitative profiling of brain cytoarchitectural alterations caused by pathophysiological conditions using multiplex imaging and computational analysis."

Grama's research focuses on the widespread brain alterations that can take place after a traumatic brain injury occurs – even in portions of the brain quite distant from the original injury or damage site. Current imaging methods often miss critical changes in certain brain regions that can eventually manifest into additional clinical conditions down the road. Using a machine-learning algorithm to analyze images of rat brains, Grama was able to produce a much richer set of quantitative measurements to detect changes in cell structure throughout the brain, as well as identify the type and state of each cell.

UH Takes Third at Chem-E Car Nationals



The Cullen College of Engineering's Chem-E-Car team clinched third place overall at the national Chem-E-Car competition last fall, the highest rank UH has reached in 15 years.

The Chem-E-Car competition is sponsored annually by the American Institute of Chemical Engineers. Teams must construct a car powered solely through chemical reactions that can haul a certain load several meters. The specific load and distance are not known until the competition day. For last year's competition, cars hauled 250 milliliters of water over a distance of 17 meters. Teams were given two opportunities to come as close as possible to the finish line. The UH team's winning run landed 13 centimeters from the finish line.

The UH Chem-E-Car team is composed of team lead Rishabh Mahajan and team members Abraham Aboiralor, Paul Abraham, An Dinh, Ed McDowell and Yen Nhi Nguyen.

The team was also named "Most Consistent" by the judging panel. While other teams had vastly differing runs – the 1st place team came within 3 centimeters on their first run, but overshot the finish line by so much on their second run that their car hit the wall – the UH team came within centimeters of the finish line on both runs.

The UH team's Chem-E-Car runs off of the pressure produced by the catalyzed decomposition of hydrogen peroxide when introduced to manganese dioxide. The decomposition produces water and oxygen; when the oxygen builds up in the tank, the pressure starts the engine. An iodine clock reaction measured by an LED light and LDR sensor stops the car.

Third place came with a $500 prize, which will go toward helping the team expand, including purchasing new tools and materials to be used for the next competition car.

MAES Hosts STEM Outreach Event

NASA, the U.S. Navy, Chevron, ExxonMobil, Fluor, ConocoPhillips and the U.S. Marines all came together at the University of Houston Cullen College of Engineering last fall to encourage young people to study STEM fields in college (science, technology, engineering, mathematics).

The event, called the "Science Extravaganza," was organized by the University of Houston chapter of MAES, a society for Latinos in science and engineering. It brought nearly 500 students from nine Houston-area schools – primarily from communities that are underrepresented in STEM – to the university to learn about their educational options.

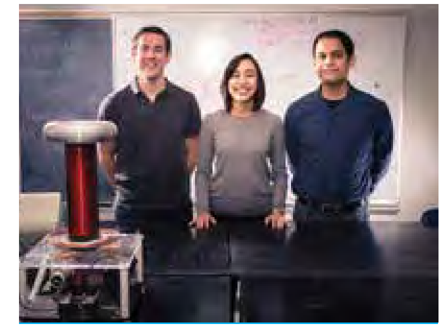
"A lot of these students don't know what STEM is and how to get into STEM," said Lilian Rodriguez, a junior at UH and vice president of outreach for MAES-UH. "The reason we hold this event it is to expose students to STEM and hopefully inspire them not necessarily to pursue a STEM degree, but just to go to college. A lot of these kids don't know what to do to get into college or how to apply."

In keeping with that mission, students attended a talk explaining how to apply for college, what type of financial support may be available to them, and how to navigate the financial aid and scholarship processes.

The event also featured a series of hands-on activities run by volunteers from government, industry and the military, as well from the college's various student organizations. Designed to give students a taste of science and engineering, one workshop, for example, had attendees assemble a circuit board, while another asked them to use a methodical, engineering-based approach to solve some simple problems.

"Outreach is important, especially when professionals and college students work together," said Rodriguez. "We show them what it's like in the work world and as a student. So it says a lot when you give up work or study time to help high school students who probably have never set foot on a university campus before."

Undergrads Top Ph.D.s in Paper Competition



Undergraduate student work at the UH Cullen College of Engineering won the overall Best Paper Award at the recent IEEE International Conference on Wireless for Space and Extreme Environments, topping papers presented by industry, government and academic researchers.

The paper, "Transparent Microstrip Antennas for CubeSat Applications," grew out of a senior design project taken on last spring by electrical and computer engineering students at the college.

Small, cube-shaped satellites that weigh less than 3 kilograms are used for many applications. Once these satellites are launched into space, they communicate through wire whip antennas, which rely on mechanical systems to deploy – systems that often fail. NASA researchers approached the college seeking a better solution.

The student team consisting of Nicole Neveu, Joseph Casana, Richie Dettloff and Mauricio Garcia ended up taking on the project for their senior design course. Their advisors on the project were ECE faculty members Ji Chen, David Jackson and Jack Wolfe.

To avoid relying on any mechanical deployment systems, they knew they had to develop an antenna that is attached to or printed on one side of the satellite itself. This presented a problem: All six sides of CubeSats are covered in solar panels, which generate the energy that powers the satellite's electronics. Covering too much of a solar cell would cut the power it needs to perform.

The solution they devised was a silver mesh antenna on a quartz surface. When placed on a CubeSat solar cell, the cell's power output only dropped by 15 percent. In addition, the new antenna was designed to send and receive signals in a single direction – a desirable property in CubeSats, which rely heavily on satellite-to-satellite communication. As a result, this new antenna has a longer communication range and uses less power than the old whip antennas.

While the design is still being refined, it may be used in satellites launched into space later this year.

Cullen College Names Outstanding Student Award Winners

The Cullen College of Engineering faculty members have made their final decisions on the 2013-2014 Outstanding Junior and Senior Award recipients. The winners are Connor Fernandez, chemical engineering junior, and Ryan Hannemann, mechanical engineering senior.

In addition, faculty chose outstanding juniors and seniors in each undergraduate engineering program. The award winners were recognized at the EAA Engineers Week 2014 Reception and Program on February 18.

Outstanding Junior – Connor Fernandez

Fernandez transferred to the UH Cullen College of Engineering as a sophomore and immediately got involved with the PROMES Program, or the Program for Mastery in Engineering Studies. Fernandez now serves as an engineering workshop facilitator with the program. "Mr. Matthews was the first one that I really met from the department, and he was the one saying PROMES is the best bet to doing real well – and it has been. I joined PROMES right when I transferred, I took their classes, I took all their workshops I could possibly take, and then I applied to be a facilitator," he said.

Although he's still over a year away from graduation, Fernandez has big plans for the future. This summer, he'll begin a process engineering internship with Styrolution, the global leader in styrene monomer, polystyrene and styrenic specialties. He wants to explore the possibilities of getting his MBA after college, and sees himself going into process engineering as a career.

In the meantime, Fernandez said he is thrilled with his choice to pursue his education at the Cullen College of Engineering. "[I like] the fact that we're so close to industry professionals – go 20 minutes down the road and you hit a bunch of plants. All the connections that you get from all the organizations here are so close to the industry professionals, so you can get a really good idea of what you need to focus on when you're taking classes or what you need to brush up on when you finish. That way you can really compete with the best of them. That's one of the best things UH has to offer by far."

Outstanding Senior – Ryan Hannemann

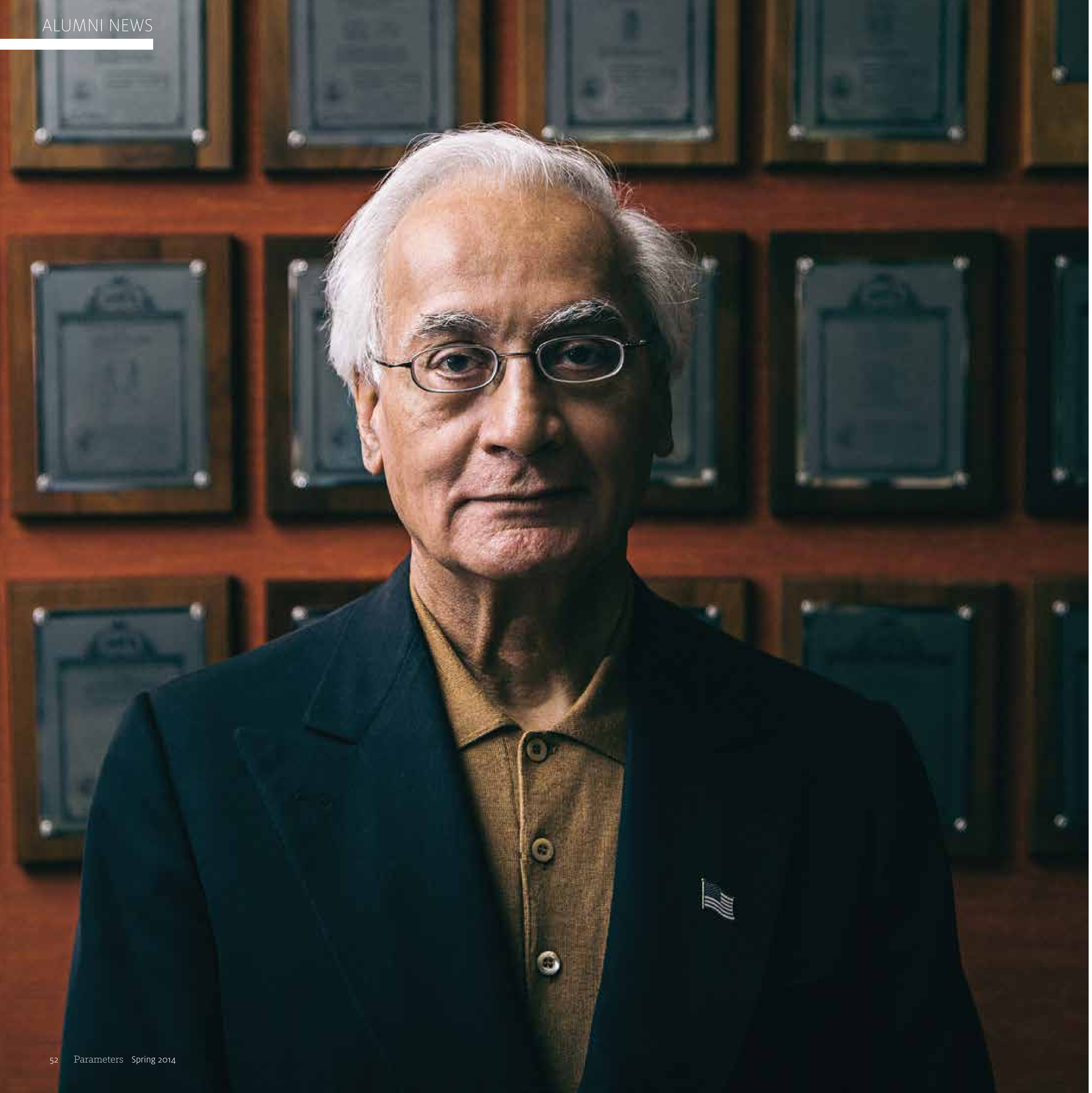
Ryan Hannemann didn't think there was a chance he'd win the Outstanding Senior award. After all, he was honored with the Outstanding Junior award just last year. "No one gets it twice," he said. However, Hannemann's tremendous academic achievements pushed him ahead of the pack once again in the 2013-2014 year.

Instead of moving straight from high school to college, Hannemann joined the army a year after he graduated. He spent six years in the service, including a combined 33 months on deployments to Iraq. On his deployments, he took some community college classes remotely. "I was doing good, and I was trying to find my way, and I did engineering in the army and I thought it would be perfect to continue that on in the civilian world." Hannemann says he is the first in his family to graduate college, but he comes from a long line of builders and creators. "It's a genetic thing, I guess. We do alright at it, we're interested in it, so [engineering] was kind of a natural choice."

Now, after several years at UH, Hannemann says he thinks the most important advice he's received has been to go to the Cullen College of Engineering career fairs. "If you're interested in industry, you need to get internships early. The market is going to continue to get more and more competitive… so there's not going to be the security we have now. You've got to be aggressive about getting internships, because that's what companies want to see." He also stresses the importance of maintaining a high G.P.A. "I've heard, 'grades don't matter, just get the degree and you'll get a job.' But they do matter; it makes a world of difference."

Hannemann took full advantage of the resources at the Cullen College, working three internships with DuPont and then securing an internship with Marathon Oil in the summer of 2013. After he graduates summa cum laude in May, he'll sign on to work there full-time. Not long after, he and his wife Vanessa will welcome their first child.

Other outstanding student award recipients:
Biomedical: Tony Roshan, Cameron Shoraka
Chemical: Michael Achierno
Civil: Francisco Carrillo, Ryan Byrd
Computer: Brian Bojorquez
Electrical: Ankur Lad, James Annis
Industry: Maria Nacinovich, Rosie Ortiz
Mechanical: Navin Krishnasing
Petroleum: Sergey Busygin, Brandon Englert



Alumni Spotlight: Kalsi Engineering Celebrates 35th Anniversary

“My burning desire was to start my own consulting business,” said M.S. Kalsi (MSME ’70, PhD ME ’75), founding owner of Kalsi Engineering and alumnus of the UH Cullen College of Engineering. **In 1978, that’s exactly what he did.**

Three years after obtaining his Ph.D. in mechanical engineering from UH, Kalsi took a leap of faith, leaving a stable, full-time position as R&D Manager at WKM Valves – a major valve manufacturer that is now a part of Cameron – to build his own business from the ground up.

The company Kalsi envisioned wasn’t just an engineering consulting firm – it was also a research and development firm which produced patented products in valve and sealing technologies, conducting design, analysis and equipment testing under real-world conditions for its clients. Today, Kalsi Engineering boasts over 45 patents in seals and valves; 35 of these pertain to rotary seals that are widely used in demanding applications in the oil field drilling and mining industries.

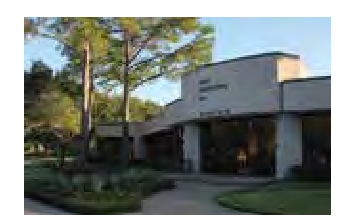
In fact, a Google search of commercial nuclear power plant reactors in the U.S. shows that all 104 of the nation’s nuclear power plants are clients of Kalsi Engineering, using their services and proprietary software to predict performance and improve reliability of valves in safety critical applications.

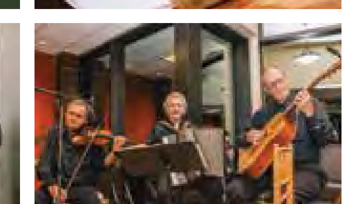
The idea to start his own business came to Kalsi as a graduate student at the Cullen College, where he did intensive research on rotary shaft seals. “The University [of Houston] gave me a head start,” Kalsi explained. “If I didn’t have that head start, I wouldn’t be as successful, and our company would not have made the world-wide impact that it has in these industries today.”

That head start is a common thread among University of Houston students. Over 3,500 UH alumni own or run a business, with many (nearly six out of 10) staying in Houston after graduation. Students in the Cullen College remain faithful to this trend, and like Kalsi, many are entrepreneurial self-starters and go-getters who work full-time to support themselves while pursuing their engineering degrees. The Cullen College takes special care to ensure engineering courses and curriculums are set up so that full-time students may also work full-time jobs to support themselves.

Kalsi’s advice to current Cullen College students looking to start their own engineering firms is simple: “First of all, they must strive for technical excellence and work hard,” he said. Kalsi also stressed the importance of staying on top of developments in your specialized field, but developing strong communication skills, he explained, is just as important as learning the technical side of engineering.

Kalsi Engineering throws a party every five years to celebrate the company’s anniversaries and milestones. Last October, they invited their clients, staff and all of their families to the Kalsi Engineering facilities to celebrate 35 years in business – not only as engineering consultants, but as researchers, manufacturers and inventors. Check out the photos from Kalsi Engineering’s 35th anniversary party below.





Young Alumna Awards $1K Scholarship to Entrepreneurial Student

Nwamaka Nzeocha, an electrical engineering graduate of the Cullen College, awarded a $1,000 scholarship to a current engineering student through her "Dare to be Different" scholarship contest.

"I wanted to make the scholarship something that I'm very passionate about, which is thinking outside the box, but not in a cliché way," Nzeocha said. "Not every engineer that graduates has to be a factory-type, run-of-the-mill engineer. I want to encourage people. If you have an idea that may be a little bit different, it may not be something you saw in a textbook or something you were trained to do, but you've been groomed with all that engineering knowledge and you can use those skills to do something that can really impact somebody's life, really change things for the better."

Nzeocha found a way to use her electrical engineering education both inside and outside of the oil and gas industry. During the day, Nzeocha works as an electrical engineer at Chevron, but when the work day is through, she works on what she calls her "baby": EasyWeave.com, an online sales platform for hair extensions.

To participate, scholarship applicants submitted a short video explaining their unique entrepreneurial ideas. The winner was Joe Udoh, an industrial engineering major at the college who runs Program Lords, a web based system that allows students to schedule tutoring sessions with their more senior peers. Program Lords, Udoh said, has allowed him to learn many of the basics of running a business, including scheduling, hiring and firing, business validation and market research. Udoh now wants to franchise Program Lords to give other students the same valuable experiences.

"This has made me a better business savvy individual," Udoh said in his video. "I would like to take this idea and create a platform out of it, a way for other individuals like myself, who dare to be different, to be able to learn how to run a business."

Four Young UH Alums Honored During EWeek

In cooperation with the Houston Engineers Week Committee, engineering professional organizations and societies in and around the Houston area recognized their outstanding young members with a Young Engineer of the Year Award. Last February, four alums of the UH Cullen College of Engineering received the honor.

Morena Arredondo

Associate and Project Engineer, Klotz Associates

B.S. in civil engineering, '07

Named 2014 Young Engineer of the Year by the Society of Hispanic Professional Engineers Houston Chapter

Clayton Black

Land Development Division Manager and Partner, Jones & Carter

B.S. in civil engineering, '05

Named 2014 Young Engineer of the Year by the American Council of Engineering Companies (ACEC)

Katherine Leskin

Process Engineer, Fluor

B.S. in chemical engineering, '01

Named 2014 Young Engineer of the Year by the South Texas Local Section of the American Institute of Chemical Engineers

Megan Siercks

Senior Associate, Walter P. Moore

M.S. in civil engineering, '11

Named 2014 Young Engineering of the Year by the Texas Institute of Transportation Engineers' Greater Houston Chapter

Alumnus and Professor Featured in Subsea Drilling Brochure

Cullen College alumnus and adjunct professor of mechanical engineering **Benton Baugh** is featured in the 2013-2014 National Academy of Inventors brochure for inventing a current-secured drilling device called the "Drilling Riser Centralizer System."

Baugh, a member of the National Academy of Engineering and a charter fellow of the National Academy of Inventors, serves as president of Baugh Consulting Engineers, Inc., which provides oilfield-related consulting, patent licensing and expert witness work.

One of the most vulnerable parts of a subsea drilling operation is the drilling riser, which is a conduit that provides a temporary extension of a subsea oil well to the surface drilling facility (or floating drilling rig). In strong winds and currents, the drilling riser becomes unstable and drilling operation must be halted until better weather conditions prevail.

With Baugh's Drilling Riser Centralizer System, the riser can remain stable in ocean currents up to 2.88 miles per hour. This not only reduces the risk to the riser and rig, but can significantly reduce the number of lost drilling days due to bad weather conditions.

Engineering Alumni Association Awards $61K to Students During EWeek

The University of Houston Engineering Alumni Association (EAA) hosted its 10th annual EWeek Reception and Program last February, handing out approximately $61,000 in scholarships and awards to UH engineering students and organizations. UH EAA EWeek has now awarded nearly $329,000 during the past 10 years, said Cynthia Oliver Coleman, the event's founder and chair.

About 260 people attended this year's gathering. Two groups tied for the event's top sponsor: Ryder Scott Company Friends of UHPE, which was represented by Dean Rietz, and the UH Petroleum Engineering Advisory Board, represented by Ron Harrell.

A number of companies and individuals contributed to the scholarship and award fund. These included, AADE Houston Chapter, AECOM, Aker Solutions, American Society of Indian Engineers, Black Cougar Engineers, BMC Software, BP, Cameron, Civil Engineering Cougars, ConocoPhillips, Cougar Engineers, Cynthia Oliver Coleman/ExxonMobil, ExxonMobil, ExxonMobil Women Cougar Engineers, Fluor Corporation, FMC Technologies, Friends of Cougar Biomedical Engineering, Marathon Oil Corporation, Phillips 66, Ryder Scott Company Friends of UHPE, Schlumberger, Society of Women Engineers Houston Area, UH Petroleum Engineering Advisory Board, UH Petroleum Engineering Alumni, UH PROMES Alumni, and the EAA.

The winner of the Engineering Challenge was also announced during the event. The challenge has different UH engineering alumni donating so their respective student organization will have the chance to win the grand prize. This year's winning organization was the UH chapter of the American Society of Mechanical Engineers. The top individual donor in the Engineering Challenge was Andrew Weaver, BSME '01.

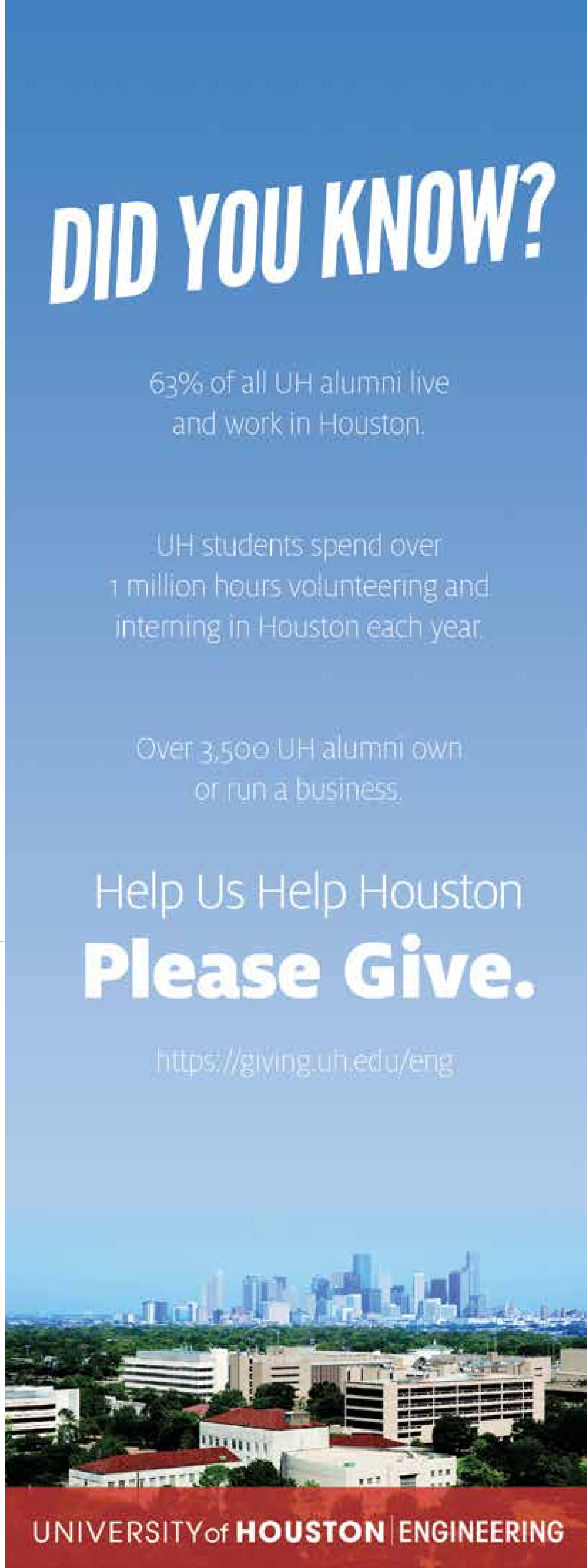
Several awards and honors were handed out during the reception. Among them were awards for the student organization community outreach competition. The UH chapter of the Society of Hispanic Professional Engineers took the grand prize, while the Society of Women Engineers won both the runner-up prize and the early bird prize.

Alumnus Named to University Board of Regents

Cullen College alumnus and advocate **Durga D. Agrawal** has been appointed to the University of Houston System Board of Regents by Gov. Rick Perry.

Agrawal received his master's and doctorate degree in industrial engineering from the Cullen College of Engineering. Since then, he has become one of the most impassioned proponents, donating his time and energy to the college by serving on its Industrial Engineering Advisory Board and Engineering Leadership Board. Recently, Agrawal donated $1 million for the construction of a new engineering research and academic building, the MREB.

Agrawal currently serves as president and CEO of Piping Technology and Products and director of the Agrawal Association of America. He is a member of the national and Texas Societies of Professional Engineers, and the India Cultural Community and Industry Trade Advisory Committee. He is also a past member of the Texas Higher Education Coordinating Board, a member of the board of advisors and past president of the Indo-American Chamber of Commerce of Greater Houston, board member of Friedman Industries, and a member and past president of India House Houston. Agrawal received a bachelor's degree from the University of Delhi College of Engineering in India.



GE Oil & Gas Gives College $100K for Scholarships

GE Oil & Gas will donate $100,000 to the University of Houston Cullen College of Engineering for undergraduate student scholarships.

The gift will support students in the college's mechanical engineering department. For five academic years starting in the fall of 2013, two undergraduates will each receive a one-year scholarship valued at $10,000, along with the title of GE Oil & Gas Scholar. The scholarships can be renewed, provided that the recipients meet specific academic benchmarks.

These students will receive more than financial support, though. As GE Oil & Gas Scholars, they will also get an early look at the world of professional engineering. They will be invited to visit GE Oil & Gas facilities in the Houston area, where they can meet with company executives and members of its engineering team. The winners will also have the opportunity to work with the company on research.

According to Pradeep Sharma, mechanical engineering department chairman, this donation is a boon for the department in more ways than one.

"The relationships we have with the professional engineering world are extremely important to the college. This gift is going to provide support to some truly outstanding students while also strengthening those relationships, giving us deeper insight into the challenges businesses face in terms of employee skills as well as technical and scientific obstacles," Sharma explained. "We're extremely grateful to GE Oil & Gas for this generous donation and the impact it will have on our department."

BP Awards $85K to Student Success Programs

Thanks to an $85,000 grant from BP, the Cullen College's PROMES (Program for Mastery in Engineering Studies) Program has the funds to continue its many outreach and student success activities through the summer of 2014.

According to PROMES Program director Kathy Zerda, PROMES relies on grant funding and corporate support to provide engineering outreach to K-12 students as well as academic enrichment and personal development to undergraduate students in the Cullen College. "We are fortunate to have a number of dedicated alumni and corporate sponsors who believe in this programming and who see firsthand the impact of PROMES, especially as relates to students from groups typically underrepresented in engineering, such as women and minorities."

The grant earmarks $10,000 to support PROMES' "Maximizing Your Power Weekend," an annual orientation for freshman and new transfer students entering into the PROMES community. The two-day event includes inspirational keynote speakers, professional development workshops hosted by industry engineers, and a full-day seminar on the Guaranteed 4.0 Learning System. Over 300 PROMES students and guests attend "Power Weekend" each year. The average cumulative end-of-year G.P.A. of the first-year PROMES students who attended 'Maximize Your Power Weekend' in 2012 was 3.01, compared to 2.66 for those students who did not attend this event.

BP's donation also included $25,000 for the STEP Forward Camp, a week-long engineering camp for rising high school 12th graders. Students who participate in this camp are often from underserved communities in the Houston area.

Many camp participants go on to study engineering, Zerda said. In fact, about 12 to 15 STEP Forward alumni are currently enrolled in the Cullen College, making the camps valuable recruiting tools.

Robotics Team Thrives With Support From Schlumberger

As an electrical engineering manager at Schlumberger, Jim Mayes places a high premium on the ability to hire engineering graduates with real-world, hands-on experience. So, each year since 2006, Schlumberger has been the UH Robotics Teams' number one supporter, providing anywhere between $5,000 and $15,000 to the team annually.

Thanks to the support Schlumberger has provided to the team, UH Robotics has steadily grown larger and more successful each year. The team, which used to only be available to IEEE students, is now open to any students who wish to participate.

"These students are actually building and programming autonomous robots from the ground up," explained John Glover, professor of electrical and computer engineering and advisor to the UH Robotics Team.

Under Glover's mentorship, the robotics team at UH has taken home trophies from many IEEE Region 5 Robotics Competitions since 2002, even winning first place in two of them. And thanks to Schlumberger's support for the team, the cost of materials and travel are covered each year. Glover says this allows him to focus on two larger goals for the UH Robotics Team: expanding and continuing to be successful.

"When the University of Houston team shows up at the IEEE Robotics Competition each year, everyone there knows we're going to do well," Glover said. "That is in no small part due to the incredible support we've received from Schlumberger over the years. It has allowed us to focus our energy on improving our skills as a team each year rather than raising money."

Mayes stressed that Schlumberger's support for the team is in no way a one-way street. "Schlumberger directly benefits from supporting the UH Robotics Team. We love to hire UH graduates – they are very hands-on and ready for work in industry right out of the gate. They are self-starters who have already designed things on their own."

Yokogawa Corp. Donates $5K for Student Scholarships

Headquartered just 20 miles southwest of downtown Houston, Yokogawa Corporation of America has sales offices across the United States. Commitment to their customers is the number one priority, and they back it up with a network of representatives and distributors that reflect this commitment.

The parent company, Yokogawa Electric Corporation, is dedicated to developing the most advanced control and instrumentation products and systems in the world. Today, Yokogawa has a firm hold on its position as a leading manufacturer in the fields of measurement, control and information. As a major global player, the company anticipates the needs of the times, continually tackling new challenges and exploring new markets in order to provide the best solutions possible.

On Sept. 13, 2013, Yokogawa Corporation of America became a corporate partner with the University of Houston Cullen College of Engineering. The college's Director of Advancement Joshua Butler was presented with a check for $5,000 from Sebastien Chambert, Yokogawa's Vice President of Finance and Business Services, to benefit undergraduate scholarship support for a student majoring in chemical or electrical engineering. The scholarship will provide a deserving student with funds to cover expenses such as tuition, books, fees and supplies for the academic semester.

Physiology in 1872

Taken from The Engines of our Ingenuity, Episode #1341

Dr. John Lienhard

I recently picked up a 14-week course in human physiology for high school students written in 1872. It makes a great window into the recent past. The book's engravings give a sane and balanced picture of our bodies' workings – a picture that's dated less by what's said than by what's left unsaid, 126 years ago.

It begins with conventional anatomy: the skeleton, muscles, internal organs. It calls the skeleton the "house we live in," and it goes on about the structural beauty of our bones:

> The hand in its perfection belongs only to man. Its elegance of outline, delicacy of mould, and beauty of color have made it the study of artists; while its exquisite mobility, and adaptation as a perfect instrument, have led philosophers to attribute man's superiority even more to the hand than to the mind.

The author clearly thinks like a structural engineer. He finished his book at the same time engineers were finishing the Statue of Liberty and the St. Louis Bridge. "The heart is the engine which propels the blood," he says. "The skin is a tough close-fitting garment for the protection of the tender flesh." "Putting food into our bodies is like placing a tense spring within a watch."

A book like this, written today, would lay far greater stress on keeping that watch in good repair. The author's health maintenance methods are okay, but he goes little beyond lifestyle and emergency care. Who'd argue with fresh air, exercise and clean living? He also sees the dangers of tobacco more clearly than my generation did. But he wrongly calls alcohol a stimulant, and he recommends it as medicine when our "vital energies" are down.

The huge gulf setting this book apart from today is the lack of any germ theory of disease. His section on False Ideas of Disease explains how healers once thought evil spirits caused sickness, while contemporary science has learned that:

> ... disease is not a thing but a state. When our food is properly assimilated, the waste matter promptly excreted, and all organs work in harmony, we are well. Sickness is discord as health is concord.

But he can offer only cold comfort when that concord breaks down. His cures for illness include purgatives, sweating, compresses, mustard plasters and beef tea.

This was medicine when my grandfather was young. That recently, our world not only had no antibiotic medicines, it also knew nothing of the germs that antibiotics attack. It was a world where anesthetics were still used only now and then for surgery. A world without X-rays or even domestic fever thermometers. A world where we fought pain with camphor, cloves and sometimes opium. Blood transfusions were known, but they lay out on the far fringe of alternative medicine, in 1872. And life was decades shorter.

Do you harbor any doubts that technology serves the human condition? If you do, pick up one of these old books. Find out just how much better we fare than Grandpa did.

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.

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The Program for Mastery in Engineering Studies (PROMES) was established at the University of Houston in 1974 for the recruitment, retention, and academic development of Hispanic, African American, and Native American students in the Cullen College of Engineering. Today PROMES is open to all students in the college, and its mission is to provide a positive learning environment that supports the needs of undergraduate students. PROMES builds a diverse "community of scholars" within the Cullen College of Engineering: PROMES students learn together, study together, socialize together, and encourage each other to be leaders here at UH and in their careers beyond UH.

The PROMES Program will celebrate its 40th anniversary with a BBQ mixer on campus on May 30. Visit www.promes.egr.uh.edu/events/promes-reconnect-mixer to RSVP.

Pictured: 2013 PROMES Awards Banquet