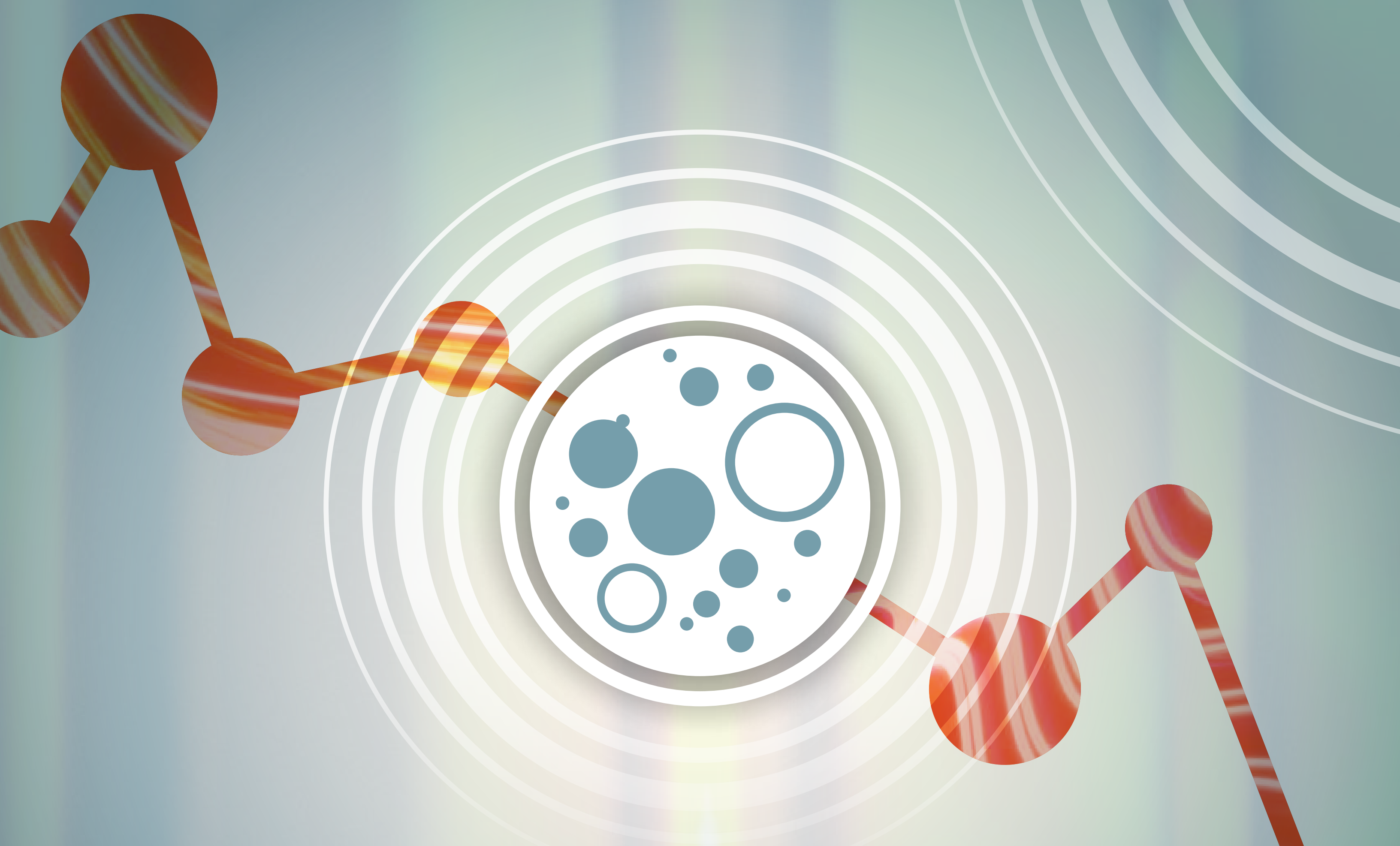
University of Houston Cullen College of Engineering

[ParameTErs]

Spring 2012



LIFE INSIDE *the* CELL

THE NEW TOOLS *– of –* BIOMOLECULAR ENGINEERING

Over the past four years, the University of Houston Cullen College of Engineering has been working strategically toward its vision of becoming a Top 50 program nationwide. We have made significant progress in recruiting top faculty to join the college as part of our efforts to grow more than 30 percent, positioning ourselves to become more nationally competitive.

Part of this growth includes hiring talented assistant professors whose research shows promise in one of the four major research focuses of our college: biomedical engineering, energy, nanomaterials and sustainability. On that note, I am thrilled to announce that five of our assistant professors have won National Science Foundation CAREER Awards this year! Many of these faculty have joined us in recent years and we are so proud of these accomplishments, as well as the achievements of our other junior faculty who continue to pave pathways of success of their own.

At the Cullen College, we are extremely fortunate to have such a vibrant, intelligent faculty to educate our students. In fact, we lost one of these faculty members recently, and our entire college family was deeply saddened by the news. Dr. David Zimmerman, professor of mechanical engineering, passed away in early April. He was an incredible leader, mentoring many junior faculty and students throughout his academic career. Dave served as associate chair of our Department of Mechanical Engineering for almost a decade and spent two years serving as interim chair during an important transition in the department's leadership. We will forever be grateful for his contributions to the college, to our community and to the world of structural dynamics and controls.

In this issue of *Parameters*, we highlight how Cullen College researchers are developing new tools and methods to better understand and leverage cellular activity on the molecular level. In the rapidly emerging area of biomolecular engineering, our researchers are working to gain a fundamental understanding of disease development, determine new approaches for detecting and treating illness, and utilize biomolecular processes to create valuable products for various industries. We hope you enjoy learning about some of the remarkable biomolecular engineering research currently underway at the Cullen College.

Warm regards,

Joseph W. Tedesco

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

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Joseph W. Tedesco

Associate Dean for Administration & Research
Frank J. "Fritz" Claydon

Associate Dean for Graduate Programs & Computing Facilities
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Associate Dean for Undergraduate Programs
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Mechanical Engineering
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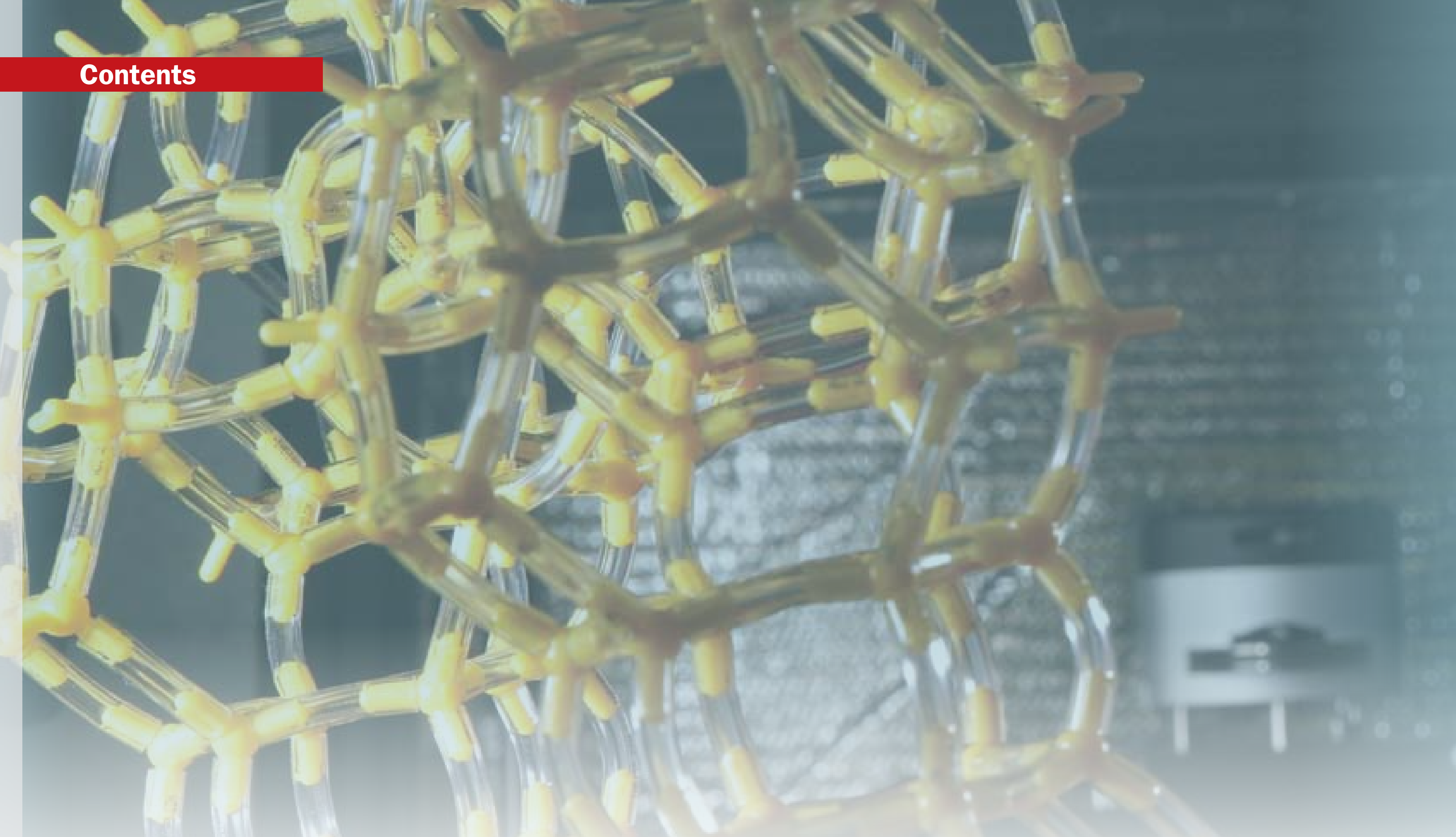

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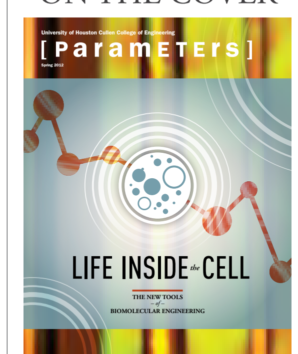
PARAMETERS - SPRING 2012

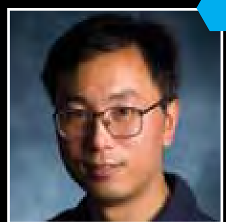
ON THE COVER



Biomolecular Engineering

UH Cullen College of Engineering researchers are developing new tools and methods to solve some of the greatest engineering challenges on the molecular level.

2012 NSF CAREER AWARDS



Jiming Bao
ELECTRICAL AND COMPUTER ENGINEERING
Doped Graphene: A Transformative Paradigm for Plasmonics and Two-Dimensional Nanophotonics
Grant Award: $400,000

Jacinta Conrad
CHEMICAL AND BIOMOLECULAR ENGINEERING
Role of Surface Properties in Motility of Bacteria to Control Biofilms
Grant Award: $400,021

Debora Rodrigues
CIVIL AND ENVIRONMENTAL ENGINEERING
Toxicology of Graphene-Based Nanomaterials: A Molecular Biotechnology Approach
Grant Award: $449,967

Wei-Chuan Shih
ELECTRICAL AND COMPUTER ENGINEERING
Integrated Molecular and Computational Sensing (IMACS) for Label-free Bacteriomics
Grant Award: $400,000

Gila Stein
CHEMICAL AND BIOMOLECULAR ENGINEERING
Controlling the Morphology of Polymer/Fullerene Solar Cells
Grant Award: $500,000

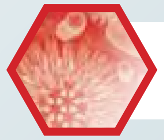
Five UH Cullen College of Engineering assistant professors have each been awarded a prestigious CAREER Award from the National Science Foundation. With a combined value of up to $2.15 million, the grants will help these outstanding researchers launch successful research careers and help further propel the University of Houston into Tier One status.

BACTERIA MOTILITY

JACINTA CONRAD, assistant professor of chemical and biomolecular engineering, received a CAREER Award to develop surfaces that limit bacterial motility, or movement.

How bacteria move, Conrad said, influences the formation of biofilms, colonies of bacteria that are protected by an extracellular matrix made of proteins. Biofilms are extremely difficult to remove and often extremely problematic for industries ranging from healthcare to petroleum to food processing.

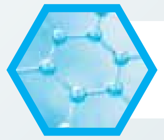
Conrad and her collaborators have published multiple articles revealing methods of bacteria motility. She plans to use this newfound knowledge to design surfaces that can inhibit biofilm formation and change the shapes these biofilms take. Using polymer thin films layered on a glass substrate, Conrad will work to prevent hairlike bacteria appendages called pili from attaching to a surface by altering its chemistry, its elasticity and its topography.



EFFICIENT BACTERIA IDENTIFICATION THROUGH RAMAN MICROSPECTROSCOPY

WEI-CHUAN SHIH, assistant professor of electrical and computer engineering, has won a CAREER Award to develop a new method to rapidly identify, count and profile bacteria with minimal sample preparation. At the heart of the method is Raman microspectroscopy, a technique of "fingerprinting" molecules by shining laser light on them. Exactly how a molecule causes the laser's incident photons to scatter, as evidenced by a change in color, can be used for identification purposes.

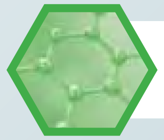
Traditional Raman microspectroscopy is very slow, examining only one small point at a time. Shih is developing a multiple-point Raman microspectroscopy system that can image roughly 100 points at once. He will combine this advance with Surface-Enhanced Raman Spectroscopy, or SERS, which enhances the Raman scattering of molecules near bacteria surfaces in contact with certain nanostructures. This boost will allow Shih to quickly identify possible bacteria among human cells and other environmental particles.



EXPLORING GRAPHENE'S OPTICAL PROPERTIES

JIMING BAO, assistant professor of electrical and computer engineering, has won a CAREER Award to study the optical properties of graphene, single-atom thick sheets of carbon.

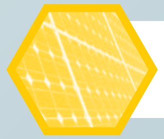
Simulations have shown that graphene has the ability to act as an optical waveguide for surface plasmon, essentially serving as a pathway along which these electromagnetic waves can travel. By creating sheets of graphene and then etching nano-scale features into the material, Bao aims to confirm this property and characterize how well different types of graphene nanoribbons perform this task. If Bao is able to create and observe graphene with good optical waveguide properties, nanoribbons of the material could serve as optical interconnects in electronic devices.



ENVIRONMENTAL IMPACT OF GRAPHENE

Though graphene is one of the most promising nanomaterials in existence, its impact on the environment is unclear. **DEBORA RODRIGUES**, assistant professor of civil and environmental engineering, has won a CAREER Award to study how nano-scale materials that utilize these one-atom-thick sheets of carbon affect the bacteria that are essential to the treatment of wastewater.

In addition to studying the environmental impact of nanomaterials, Rodrigues is developing technologies that utilize graphene and other nanoparticles in applications such as water filtration.



POLYMER SOLAR CELL EFFICIENCY

Though polymer solar cells have several advantages over standard silicon-based cells, they convert sunlight into electricity far less efficiently. **GILA STEIN**, assistant professor of chemical and biomolecular engineering, will work to improve their efficiency by better controlling the interface between the polymer in a cell, which generates electrons when exposed to sunlight, and the material that receives these electrons, often spherical carbon molecules known as fullerene.

Starting with a polymer thin film, Stein will create interconnected nanoscale features on its surface and then coat the film and fill in these features with fullerene. She will then determine how efficiently these new solar cells generate electricity and work to optimize the most promising interfaces.

Subsea Engineering Program Wins World Oil Award

The UH Cullen College of Engineering shared the stage with FMC Technologies last fall as co-winners of a 2011 World Oil Award.

Presented by *World Oil* magazine, the awards recognize "the industry's leading innovators and innovations that represent the best technological achievements or contributions."

The two won the Best Outreach Program honor for the Cullen College's new Subsea Engineering Program. The program was proposed by executives at FMC and subsequently launched by the Cullen College at the beginning of 2011.

The program, which offers two certificates, focuses on the engineering sciences and best industry practices in deepwater oil and gas retrieval. Offering the first and only dedicated subsea curriculum in the United States, the program awarded its first certificate in May 2012.

Accepting the award for the Cullen College were Dean Joseph W. Tedesco and Matt Franchek, professor of mechanical engineering and director of the Subsea Engineering Program.

"Response to the subsea program has been tremendous," said Franchek. "We've gotten dozens of applications from potential students and received significant industry support. This award provides more proof that we're educating engineers with the skills the petroleum industry needs to continue to thrive."

Michael Harold, M.D. Anderson Professor of Chemical and Biomolecular Engineering, presented to a group of 30 representatives from government and industry during the Texas Diesel Testing and Research Center's Fuel Economy Roundtable event.

Diesel Center Hosts Fuel Economy Roundtable

When analyzed from the oil well to wheels on the ground, diesel is the single most efficient liquid transportation fuel. Combine that with rising petroleum prices and concerns about peak oil production, and it is clear that there is a real and growing need to improve efficiency and reduce emissions from diesel-powered vehicles.

Representatives from government, industry and academia gathered earlier this year to discuss these issues at the "Fuel Economy-Enhancing Technologies for Fleets" roundtable, hosted by the UH Cullen College of Engineering's Texas Diesel Testing and Research Center. The center performs research and development of new diesel technologies and offers third-party verification of technologies developed by other groups.

About 30 people attended the event, held at the Diesel Center's facility at the University of Houston's Energy Research Park. Among the attendees were members of the Port of Houston Authority, the city of Houston's Economic Development Division, the Houston Galveston Area Council, and businesses such as Williams Brothers Construction.

The roundtable started with a presentation by Michael Harold, M.D. Anderson Professor of Chemical and Biomolecular Engineering and the center's lead researcher. His talk, "Clean Diesel: Improved Fuel Economy and Cleaner Emissions," provided attendees with an overview of the Diesel Center's work and of technologies that reduce emissions from diesel vehicles while maintaining or improving their fuel economy.

News Briefs

Retired Exxon Mobil CEO Reflects on Energy Industry, Honors Neal Amundson

Professor of Chemical Engineering Dan Luss; Lee R. Raymond, retired chairman and CEO of Exxon Mobil Corp.; Professor of Petroleum Engineering John Lee; and UH Cullen College of Engineering Dean Joseph Tedesco at the Amundson Memorial Tribute Lecture reception.

The late Neal R. Amundson, Cullen Professor of Chemical Engineering, was honored in February with a memorial lecture delivered by Lee R. Raymond, retired chairman and chief executive officer of Exxon Mobil Corp., at the University of Houston.

Raymond spoke before an audience of 200 about his extensive and distinguished career in the energy industry over the last five decades and paid tribute to Amundson, his doctoral advisor and mentor.

Raymond, who led Exxon from 1993 until his retirement in 2005, reflected upon the evolution of the energy industry over the last 50 years and discussed major investments that energy companies should make to secure economic growth in the future: technology, operational excellence and people. The evolution of technology — and its impact on the energy industry over the last half century — he described as "breathtaking," noting that the companies that support technology development "are going to be the ones that will have the strongest pillar in what the future holds."

Sharma Named ME Chair

The UH Cullen College of Engineering has named Pradeep Sharma the new chair of its Department of Mechanical Engineering, an appointment effective Jan. 1, 2012.

Sharma, who has been with the college since 2004, has been named the M.D. Anderson Chair Professor in conjunction with this new role.

As chairman, Sharma said his primary goal is to dramatically improve the department's national ranking through enhanced reputation among students and other engineering colleges. One way to achieve this, he said, will be to emphasize that faculty secure prestigious grants and produce not simply more journal articles, but more articles in highly regarded publications. Teaching will also continue to remain a high priority for the department, he stressed.

He also plans to establish a mentorship program to help graduate students land prestigious jobs in academia. "We will start a pilot program for promising students and train them to be professors," he said. "A typical Ph.D. student does not know how to be a professor. We'll work with them on how to establish research projects and how to present their ideas in a compelling way."

Sharma also said he will increase the standard pay for Ph.D. students, personally oversee graduate student recruitment and institute a plan to aggressively recruit new, high-quality faculty.

ENGINEERING extras

ConocoPhillips Donates $1.125M to UH

» ConocoPhillips is donating $1 million to the University of Houston's growing Energy Research Park (ERP) and $125,000 to a number of engineering, science and business programs at UH. The $1 million gift will support the ConocoPhillips Petroleum Engineering Building, which is located in the ERP and serves undergraduate and graduate students. ConocoPhillips also gave $1 million to UH last year and intends to follow up with an additional proposed gift of $1 million in 2013.

ExxonMobil-NSBE Impact Award

» The National Society of Black Engineers has named the Cullen College's Program for the Mastery of Engineering Studies (PROMES) a winner of a 2012 ExxonMobil – NSBE Engineering Impact Award. The award was given in recognition of the program's success in recruiting and retaining students from underrepresented minority groups and includes a $10,000 grant in support of these efforts.

EWeek

» The UH Engineering Alumni Association hosted its annual EWeek Reception in February in celebration of National Engineers Week. Approximately $44,000 was donated by engineering companies, professional organizations and alumni to provide cash awards for UH engineering students in recognition of their excellence in academics and leadership, bringing the eight-year total raised to more than $200,000.

ExCEED

» The Department of Civil and Environmental Engineering hosted a Mini-ExCEEd Teaching Workshop, presented by American Society of Civil Engineers, for faculty in January. The event was a two-day series of seminars open to all college faculty that focused on innovative ways of conveying engineering concepts to students and being more successful in the classroom.

cullen college news @cullencollege

LIFE INSIDE *the* CELL

THE NEW TOOLS *– of –* BIOMOLECULAR ENGINEERING

Years ago, biomolecular engineering research was a niche pursuit, one taken up by only a handful of investigators in most institutions. They'd do work involving fermentation or E-coli and were generally viewed as far from the cutting edge.

Times have changed.

Today, biomolecular is one of the hottest areas of engineering research. By uncovering and manipulating the exact workings of biologically-derived molecules and proteins, the life inside (and outside) the cell, researchers can make huge advances in fields ranging from drug development and delivery to commercial-scale production of targeted molecules.

The University of Houston Cullen College of Engineering has experts that are taking the lead in all of these areas.

Among them are researchers from the Department of Chemical and Biomolecular Engineering who are working to uncover biomolecular basics. Peter Vekilov is one of the world's leading researchers in the field of nucleation and is using his findings to develop treatments for diseases such as sickle cell anemia, while Manolis Doxastakis has developed a set of sophisticated algorithms for simulating protein activity inside the cellular membrane.

Patrick Cirino and Navin Varadarajan are conducting separate research efforts focused on mutating cells to produce specific proteins and/or molecules and then identifying those cells among millions of others.

An expert in the field of molecular recognition, Richard Willson is using engineered viruses as labels to signal a bonding event involving a disease biomarker, hence providing a disease diagnosis.

And in the field of drug development and delivery, Jeffrey Rimer is part of a team working to develop medications that would stop the aggregation and growth of crystals that form the most common type of kidney stone, while Ramanan Krishnamoorti is working with researchers at other Texas Medical Center institutions to devise new methods of delivering RNA-based medications to the brain and lungs.

With these research projects, Cullen College researchers will provide a framework for individuals and industry to benefit from some of the most basic, most elemental activities of the biological sphere.

by TOBY WEBER
PHOTOS BY TBS PHOTOGRAPHY

Revealing the Secrets of Nucleation

Nucleation, the formation of the first little piece of a new phase during liquefaction, evaporation, solidification, precipitation or any other phase transformation, is one of the great unknowns of the physical sciences.

"In any area of science, if you have a factor of 10 discrepancy between theoretical models and experimental results, that's considered a major problem," said Professor Peter Vekilov. "For nucleation, this discrepancy is 10 factors of 10, which is 10 billion. It's one of the big puzzles of chemistry, physics and materials science."

Vekilov has done as much as any active scientist to uncover the nucleation mysteries. Over the past several years, much of his work in nucleation has revolved around the two-step mechanism, which is followed by substances in solution transitioning into crystals. In 2004, Vekilov formulated this mechanism and then observed its occurrence. He has since made great headway in uncovering the exact physical and chemical actions at its root.

The first step of the two-step method finds proteins or other materials in solution coming together to form clusters just a few hundred nanometers across. It is inside these clusters that the formation of crystals actually occurs.

Vekilov recently found and will soon publish results that show that the clusters in protein solutions undergo Ostwald Ripening, during which they grow through the addition of more proteins. Unlike other materials that undergo Ostwald Ripening, these clusters tend to grow very slowly, over a period of days. As they get bigger, Vekilov said, nucleation is more likely to take place inside of them. "That's why sometimes you have a solution and you don't do anything to it for days and then suddenly nucleation occurs. It's because you've had these clusters sitting there, ripening very slowly."

Vekilov is putting his nucleation expertise to use in many areas, including the study of sickle cell anemia. He and his team have recently gathered data that show sickle cell hemoglobin releases molecules of its subunit heme into red blood cells and the solution. This free heme accelerates the polymerization of the sickle cell hemoglobin, causing red blood cells to harden, the disease's primary and often fatal pathogenic event.

He is now working to gather more information on sickle cell heme and hemoglobin to confirm these findings.

To do so, Vekilov and his collaborators — Elena Petrova, a post-doctoral associate, and Anupam Aich, a chemical engineering Ph.D. student — are putting the finishing touches on a microfluidics device that will allow them to quickly study a broad range of heme and hemoglobin concentrations in near real-world conditions.

The tool is made of polymer and contains a channel just five microns deep and 40 microns wide. Such a small volume will allow Vekilov to adjust the temperature of the solution within 10 to 100 milliseconds. Acting as a heater will be a layer of copper deposited on top of a layer of chromium, which is itself deposited on the glass bottom of the microfluidics device. Running an electrical current through the copper will allow researchers to heat the solution, while measuring electrical resistance will let them know and control the temperature.

Nucleation is one of the great unknowns of the physical sciences.

The primary advantage of this device is speed. Using existing techniques, Vekilov has been able to gather just 30 data points on sickle cell heme and hemoglobin per year. The new microfluidics tool will let him gather that much data in just one week.

Vekilov noted that devising such a tool is no easy task. Thanks to the UH Nanofabrication Facility, though, he's been able to test several different prototypes. What's more, he has called on the expertise of several other Cullen College faculty members, including Gangbing Song and Dong Liu from mechanical engineering and Gila Stein from chemical and biomolecular engineering, to help design the device.

"I'm very happy with the environment we have here," he said. "Without this facility, without these collaborators, we wouldn't be able to approach such a complex topic."

Simulating the Cell Wall

Of the thousands of proteins involved in biochemical processes, about 30 percent reside in cell membranes.

How these proteins behave in the membranes is not well understood, however. Traditional investigative methods simply aren't useful enough for studying proteins in the membranes' lipid-rich environment. Questions such as how the composition of this environment impacts protein association, which is involved in everything from drug delivery to cancer, remain largely unanswered.

What's left, then, are simulations. Assistant Professor Manolis Doxastakis is leading one of the most prolific research groups focused on the simulation of proteins in a lipid environment. His research group dedicates millions of computer processing hours to perform cellular membrane simulations.

So many hours are necessary, Doxastakis noted, because simulating a lipid environment is notoriously difficult.

"The dynamics, how fast things move, are much slower than in water," said Doxastakis. "If you perform a traditional molecular dynamics simulation, following the evolution of molecules over time using a supercomputer, in weeks you'll get only one microsecond's trajectory."

Instead of using such a deterministic technique, Doxastakis has developed complex algorithms that employ stochastic Monte Carlo methods in a distributed approach over hundreds of processors. Starting with an existing positioning of proteins and lipids, the algorithm proposes a new structure, then calculates the probability that this new structure actually forms. If the probability is high enough, it then proposes another structure, then another. The trick lies in building a new structure to be proposed. If this new structure is considerably different from the previous one but has a high probability of being accepted, the method is significantly faster than traditional simulation approaches, opening the door to studying environments that are otherwise inaccessible.

Among Doxastakis' most important findings with this algorithm: the specific constituents of a lipid environment, such as cholesterol concentration, can change not just the structure of the dimers formed by proteins but also the path followed during the association process. This characteristic of cell membranes, he stressed, would have been nearly impossible to find through traditional simulations or lab work.

"With this algorithm we can examine processes that happen over milliseconds or slower," he said. "This allows us to do things other methods don't."

Mutating Cells for Small Molecule Production

By mutating the DNA of bacteria, scientists can create cells that produce any number of different molecules, from fuels to pharmaceutical precursors. The mutagenesis techniques involved in this are fairly well established, so the process itself isn't too complex or difficult.

That doesn't mean deriving molecules from bacteria is easy, though. Owing to the complexities of biological systems, determining exactly which genetic modifications to make is often difficult or impossible. Scientists therefore often turn to an evolutionary approach, whereby many different mutations are introduced into one or more genes in a random or semi-random fashion, and those conferring improved properties are selected from the mutant library. Generating even a handful of bacteria that produce a desired molecule (or more of the molecule) will also result in millions, even billions of mutated cells that don't. Picking out the good from the bad then becomes a great challenge.

"How do you screen your library?" asked Associate Professor Patrick Cirino. "That's a huge bottleneck in the biological design process: being able to develop a high throughput and accurate screening process."

Cirino's solution for sifting through millions of cells? Create millions more.

Cirino is developing biosensors out of regulatory proteins. "Regulatory proteins naturally control gene expression. We have them controlling the expression of fluorescent proteins," he said. "What we're doing is engineering regulatory proteins to respond to different small molecules of interest, and thereby they become sensors for those different small molecules."

This involves using both random and directed mutagenesis of the genes that create the regulator proteins. He creates up to hundreds of millions of different bacteria, each with a unique regulator. Cirino then introduces the targeted small molecule into these bacteria. The few mutated bacteria with regulatory proteins that recognize the targeted molecule then turn fluorescent. They are isolated using flow cytometry, while the vast majority that don't are discarded.

Next, working with the bacteria that turn fluorescent in the presence of the desired molecule, he employs mutagenesis once again. This time, though, he's seeking to improve production of the targeted molecule by the bacteria.

Again relying on fluorescence and flow cytometry, he is able to identify and characterize those cells producing more of the desired molecule. In a recent example Cirino and post-doctoral researcher Shuang-Yan Tang showed that this method allowed them to dramatically improve mutated bacteria's production of triacetic acid lactone (TAL), a molecule used to produce antibiotics, biologically derived resins and other products.

"Using our reporter, we were able to screen a large library of randomly mutated genes encoding an enzyme known to synthesize TAL. That pointed us to hot spots on the enzyme," he said. "Then we did more focused mutagenesis in those locations. Within a couple of rounds, we got a 20-fold improvement in the production of TAL."

Engineering Molecular Biocatalysts

Proteases, enzymes that recognize and clip specific proteins, are involved in a huge number of biological processes, from clipping extracellular matrices to enable cell movement, to degrading mutated proteins, to biological signaling, to name a few.

With so many different purposes, a full two percent of human genes are dedicated to producing different proteases, resulting in the existence of thousands of different types of these enzymes.

Surprisingly, however, only a handful of proteases are used routinely by researchers and industry. Most of the others have characteristics, such as an inability to be easily produced in a lab, that make them impractical for anything other than their natural use.

Assistant Professor Navin Varadarajan is seeking to make more proteases available for use by devising a method to customize synthetic versions of these catalysts.

Rather than starting with one of the thousands of unused proteases, Varadarajan begins with the commonly used, well-characterized proteases. "We take one of these common proteases and modify the DNA sequence to create new custom synthetic catalysts," he said. "So we use the basic scaffold and make changes to it so that you have a new molecule."

Inserted into bacteria, each mutated DNA sequence produces one and only one mutated protease.

With millions of individual bacteria, the next challenge becomes identifying the mutated proteases that cleave the target protein of interest.

First, the protease must be brought to the surface of the cell for identification and, should it perform the desired task, harvesting. To achieve this, Varadarajan is developing proteins that are fused with proteases and, according to preliminary data, have the ability to bring these catalysts to the cell's surface.

Varadarajan will then introduce the bacteria to the peptides he hopes to clip. These peptides have been slightly modified to turn fluorescent when they are clipped.

Using a flow cytometer's ability to identify fluorescence, he will then sort upwards of 10,000 cells per second, separating the bacteria that have clipped the peptide and therefore have produced the targeted protease. These proteases and the mutated DNA sequence that produced them can then be further characterized and modified to produce even more efficient catalysts.

"The ability to clip any desired peptide sequence in a highly selective manner and with high catalytic efficiency would be extremely useful in analytical, biotechnological and even therapeutic applications," he said. "With this approach, we should be able to make proteases a valuable tool for research and industry in all these areas."

Much of Richard Willson's research involves developing new medical diagnostic tools based on biomarker detection, such as an antibody bonding to a bacterial cell.

New Tools for Disease Diagnostics

Richard Willson's office is as close to hallowed grounds as there is in the University of Houston Department of Chemical and Biomolecular Engineering.

Early in Willson's career, this 18-by-10 foot, second-floor space belonged to Abraham Dukler, former dean of the college and a member of the National Academy of Engineering. After Dukler, it housed another NAE member, Neal Amundson, the man widely credited as the father of modern chemical engineering.

"This office," Willson said, "carries a heavy burden of expectations."

These expectations don't seem to bother Willson too much, though. A recognized authority in the field of molecular recognition, he has more than 80 publications to his name. For the past three years he has served as director of diagnostics at the National Institutes of Health's Western Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research. He has been a John and Rebecca Moores Professor at the University of Houston since 2010, and in 2011 was named a fellow of the American Institute for the Advancement of Science.

Much of Willson's research involves developing new medical diagnostic tools based on biomarker detection, such as an antibody bonding to a bacterial cell.

"The question is how can we transduce this molecular recognition event into something that we can see, some sort of label," he said.

Willson's approach typically involves one antibody attached to the surface of a sensor. The antibody then bonds with the biomarker to which it is specific. Another antibody then forms a second bond with the same biomarker. Attached to this second antibody is a label that can be identified, signaling the presence of a disease.

Following this general pattern, Willson has an ongoing research project with Paul Ruchhoeft, associate professor of electrical and computer engineering, that entails using retroreflectors to signal the presence of a given pathogen. A second collaboration with John and Rebecca Moores Professor Dmitri Litvinov, also with the ECE department, centers around the development of a giant magnetoresistive (GMR) sensor array that can detect hundreds or thousands of biomarkers on a single microchip.

A more recent effort involves developing a diagnostic test for lung cancer, which has an overall five-year survival rate of just 14 percent. With this research he hopes to develop an entirely new type of label to signal that molecular bonding has occurred: engineered viruses and nanoparticles attached to antibodies and identified through polymerase chain reaction. A related effort, being conducted in collaboration with Assistant Professor Jacinta Conrad, involves regulating virus fluorescence and then observing whether viruses and biomarkers come together by the shapes they form.

Willson notes that a multidisciplinary team is necessary to develop each of these systems. In addition to molecular recognition, these efforts require expertise in molecular pathology, nanofabrication, particle tracking, image analysis, biochemistry and multiple other fields. In addition to those previously mentioned, Willson's collaborators include Research Assistant Professors Katerina Kourentzi and Uli Strych; Assistant Professor of Electrical and Computer Engineering Jiming Bao; Juan Olano and David Walker from The University of Texas Medical Branch at Galveston; and Robert Atmar from Baylor College of Medicine. His efforts are funded by the Cancer Prevention Research Institute of Texas; the National Institutes of Health; the NIH Western Regional Center of Excellence in Biodefense and Emerging Infectious Diseases Research; the National Science Foundation; the Texas Higher Education Coordinating Board's Norman Hackerman Advanced Research Program; and the Welch Foundation.

Stopping Stone Formation

Assistant Professor Jeffrey Rimer is partnering with researchers from Rensselaer Polytechnic Institute to develop medications for calcium oxalate kidney stones. Affecting millions of individuals in the United States each year, these are the most common type of kidney stones.

Like all stones, calcium oxalate kidney stones form through crystal nucleation, growth and aggregation. Patients suffering from chronic cases take dietary supplements and drink large amounts of water in order to inhibit stone formation and encourage the expulsion of calcium oxalate before it crystallizes or the removal of small crystals before they aggregate. These approaches, however, have found only limited success.

Rimer, an expert in the field of crystal formation and growth, aims to prevent and/or limit crystal growth by creating peptide-based tailored growth inhibitors. These compounds will attach to the surface of calcium oxalate crystals and physically block further addition of calcium oxalate.

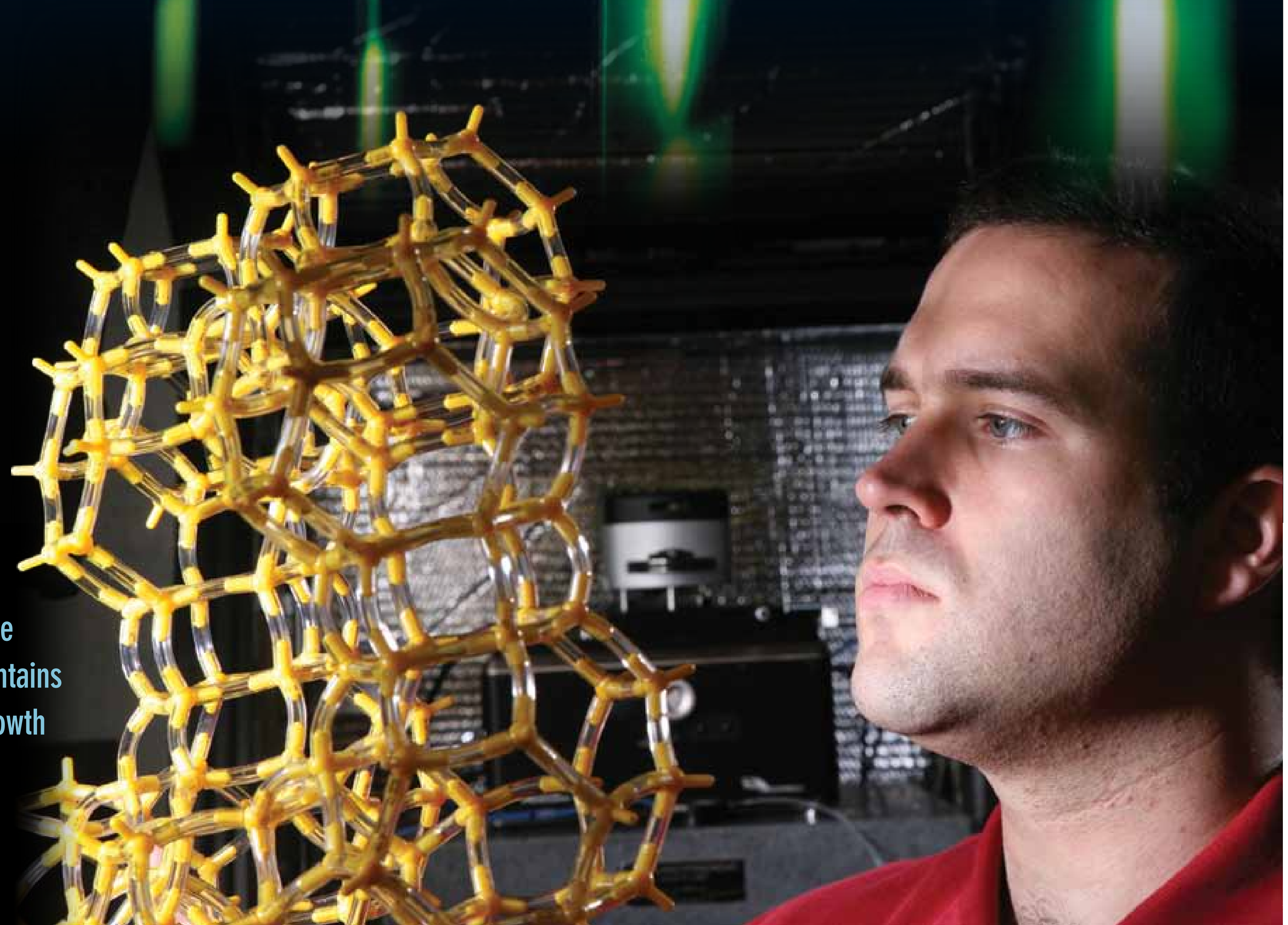
The use of peptides is challenging since they can easily be broken down into amino acids by the digestive system. However, more than 100 peptide-based drugs are currently in clinical trials, he noted, signaling that many researchers are recognizing their potential.

In this case, Rimer and his collaborators chose peptides because they can be readily designed to mimic naturally occurring proteins that inhibit calcium oxalate crystal formation. The idea, he said, is to create an oral medication that contains multiple growth inhibitors in a single pill, each with an affinity for different crystal surfaces, thereby completely capping crystal growth long before it results in a kidney stone.

What's more, by using peptide chains 15 to 20 amino acids long, Rimer and his collaborators should be able to tweak the structure of a potential medication to improve its chances of making it through the stomach and intestines and to the targeted destination, the kidney.

"Usually you want to find the best inhibitor. In this case, we're trying to find multiple inhibitors that are comparable. Once we've found these, further studies will require an iterative process to see which ones work best in vivo and have adequate bioavailability," he said.

This work is supported by a University of Houston GEAR Grant. Rimer's collaborators are Pankaj Karande and Shekhar Garde, both with RPI.



The idea would be to create an oral medication that contains multiple [kidney stone] growth inhibitors in a single pill.

Delivering RNA Therapeutics

RNA-based medications have the potential to successfully treat any number of gene-based diseases, from small cell lung cancer to multiple sclerosis.

To realize this potential, though, researchers must overcome the hurdle of bioavailability. Since RNA is a biological compound, orally administered RNA medications are easily destroyed by the digestive system, while the kidneys destroy the medication if administered through standard intravenous delivery.

"People have developed different RNA therapeutics, but there is no way to deliver them," said Ramanan Krishnamoorti, chair of the Department of Chemical and Biomolecular Engineering. "One idea that we are pursuing is to use nanoparticles made out of a biodegradable polymer as the delivery mechanism."

Krishnamoorti is conducting research projects in partnership with investigators at The University of Texas Health Science Center at Houston focused on developing new methods of successfully delivering RNA-based drugs in various manners.

One of these projects aims to deliver RNA medications to the brain to treat conditions such as ALS or multiple sclerosis.

Delivering any medication to the brain is notoriously difficult due to the blood-brain barrier, the uniquely shaped capillaries that tightly control what does and does not enter the brain through the blood stream. Krishnamoorti aims, in essence, to sneak RNA medications past this barrier.

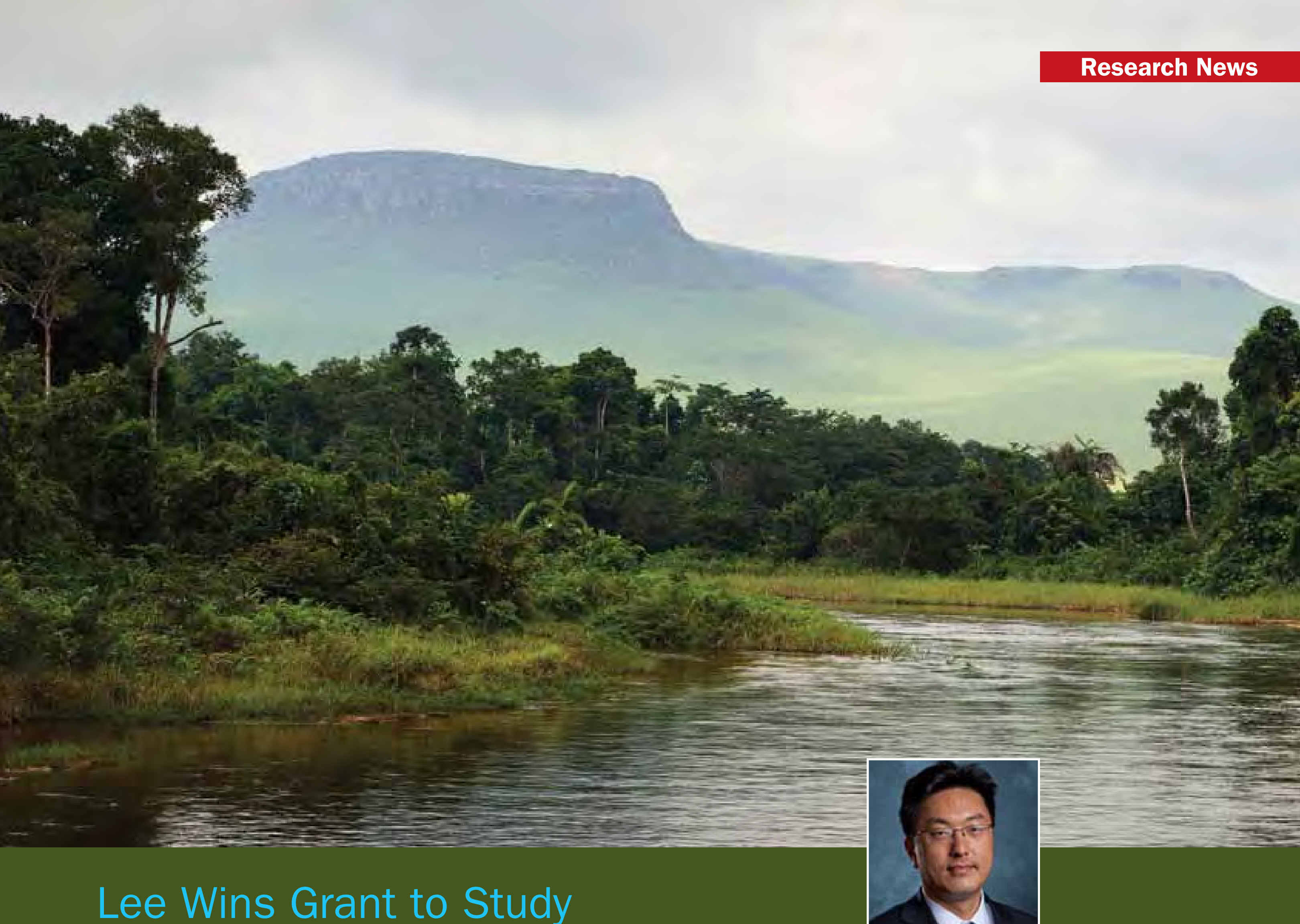
He starts with biocompatible polymer-based particles measuring about 100 nanometers, inside of which is the RNA medication. He then adds two compounds to the surface of the particles, an antibody and a small bit of the RNA drug.

The antibody is the key to slipping the drug into the brain. After the drug is administered through an IV, the mechanisms that police the blood-brain barrier will recognize the antibody and allow it, along with the nanoparticle it is attached to, to enter the brain.

At that point, the RNA drug on the surface of the nanoparticle will attach to the neural cells whose mutated genes are believed to be at the root of these conditions.

The drug will then be delivered through the nanoparticle. Since the nanoparticle is biodegradable, it can be designed to slowly release the RNA medication over time. Depending on the condition being treated, patients may need as few as one IV treatment per month.

"RNA therapies hold a lot of potential," said Krishnamoorti. "We think the use of biodegradable nanoparticles is one of the most promising methods for delivering these drugs."



Hyongki Lee

Assistant Professor of Civil and Environmental Engineering

Lee Wins Grant to Study Congo River Basin

Hyongki Lee, assistant professor of civil and environmental engineering, recently won a $663,000 grant from NASA to conduct research into the Congo River Basin, the second largest river basin in the world, surpassed only by the Amazon.

Compared to the Amazon, though, the Congo basin is a mystery. Its remote location, combined with political instability in the region, have prevented geoscientists from gathering even the most basic information about the basin: How much water exists in its wetlands? Is most of this water from direct precipitation, river flooding or upland runoff? How much of the basin is wetland? According to Lee, answering such questions should give researchers a better understanding of everything from regional climate to greenhouse gas emissions.

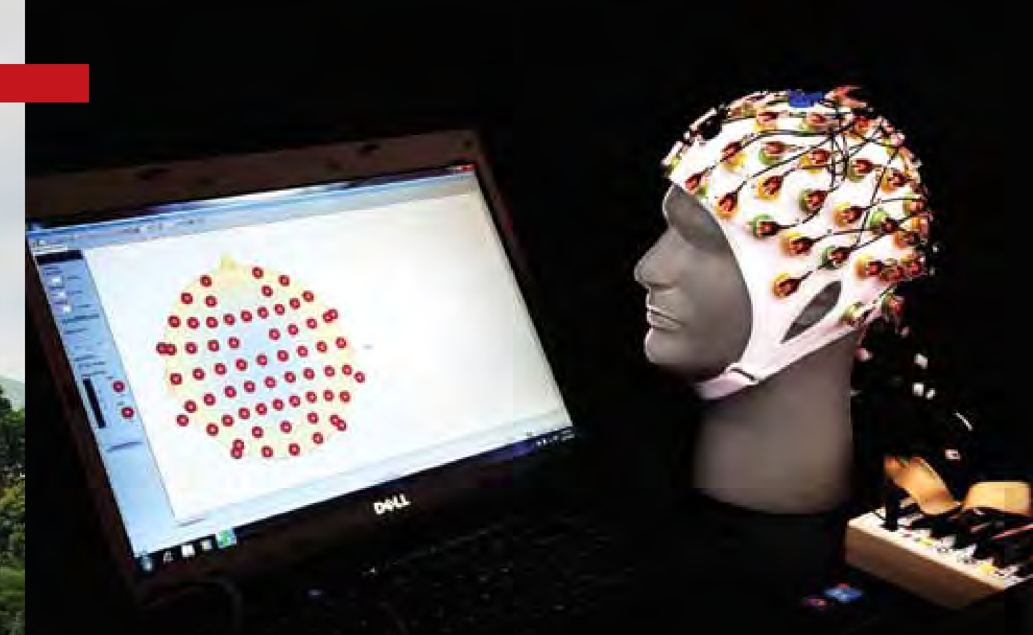
"There is not much data [on the basin] so modeling is very limited," said Lee. "As a consequence, the other important estimates based on the terrestrial dynamics of the Congo basin, such as the methane emissions of its flooded wetlands and its contributions to global methane levels, cannot be well known."

Lee, who joined the college in the fall of 2011, won't be traveling to Africa to conduct this work. Instead, he'll rely on unanalyzed data already collected from satellites operated by the European Space Agency, the Japan Aerospace Exploration Agency and NASA.

These satellites have gathered data through optical sensing of the region, radar topography and the creation of gravity maps, which show areas of the earth with significant mass change due to terrestrial water storage change, such as in tropical rainforests. Lee and his research team will combine and process this data to answer the most basic questions about the Congo wetlands.

Combining multiple types of data from different satellites is basically unheard of in hydrologic research, Lee noted. If successful, this work will provide investigators with an entirely new method for studying areas of the planet that are otherwise inaccessible.

"This is a new combination of technologies for this application," said Lee. "It's a first attempt. That's one of the reasons we proposed it."



Professor Developing Brain-Machine Interface

Jose Luis 'Pepe' Contreras-Vidal, professor of electrical and computer engineering, has been awarded a grant to develop non-invasive methods of interfacing the human brain with machines in order to help those who have suffered severe injuries such as limb amputation, spinal cord injury or stroke.

Individuals confined to a wheelchair could use such an interface to walk with a robotic exoskeleton, for example, while those who have lost a limb could control a multi-functional prosthetic device.

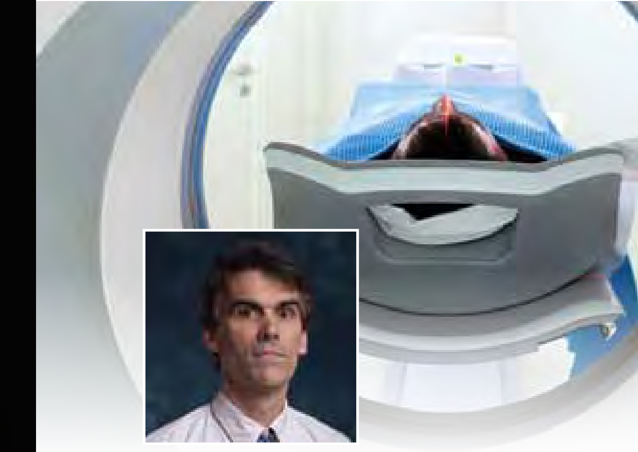
The grant, worth roughly $1.2 million over the next four years, comes from the National Institutes of Health. It was first awarded to Contreras-Vidal when he was a researcher at the University of Maryland and has recently been transferred to the University of Houston.

Under this system, a skullcap equipped with multiple electrodes will pick up the electrical activity generated in the user's brain through electroencephalogram technology. Sophisticated algorithms developed by Contreras-Vidal will translate these thoughts (or intentions) into instructions for the exoskeleton, which will then be wirelessly transmitted to the device.

According to Contreras-Vidal, developing this sort of technology can not only improve the patients' quality of life, but can also lower the cost of caring for these individuals by limiting the medical problems caused by remaining in a seated position for extended periods of time.

The University of Houston is an ideal location to develop such technology, Contreras-Vidal said. "This is a very complex project. It requires the close collaboration of many people in the engineering core, clinical core and the companies that develop these robots. What is unique about the University of Houston is its partnership with the Texas Medical Center and the existing core faculty in engineering and other areas at UH that will make this research possible."

Contreras-Vidal's partners in this project include Rexbionics, an exoskeleton manufacturer; Brain Products, which develops advanced EEG technology; and researchers and clinicians with The Methodist Hospital Research Institute, who offer expertise on potential users of such a system.



Howard Gifford

Associate Professor of Biomedical Engineering

Professor Working to "Replace Clinicians" in Imaging Research

Associate Professor of Biomedical Engineering Howard Gifford has won a $1.2 million grant from the National Institutes of Health to develop a mathematical model to analyze images produced by new PET and SPECT scan technologies, key tools in the early detection of cancer.

Ideally, clinicians would analyze images produced by technologies under development. Few clinicians, though, have the time to participate in research projects. As a result, the development of these technologies is slower and less efficient than it could be.

"What I'm trying to do," said Gifford, "is come up with a mathematical model that could replace clinicians or human observers in detection experiments where researchers are trying to figure out if what they're working on is actually useful for the detection task."

Asking clinicians to look at sets of images, Gifford is using tools to track their eye movements and then determining what qualities in an image (such as particular shapes or levels of contrast) tend to draw their attention. Gifford will then build this information into his mathematical model, enabling it to focus in on the same areas a clinician would.

Ideally, the analysis provided by this model will more closely resemble guidance from a skilled human observer, thereby accelerating the development of new imaging techniques.

Faculty News

Mo Li

Assistant Professor of Civil and Environmental Engineering

Education

Ph.D. Civil Engineering,
University of Michigan, Ann Arbor

Career Overview

Li joined the University of Houston Cullen College of Engineering following the completion of a postdoctoral research fellowship at the Advanced Civil Engineering Materials Research Laboratory and the Laboratory for Intelligent Structural Technology at the University of Michigan, Ann Arbor. Before pursuing her doctorate, she received two M.S. degrees from UM: one in industrial operations engineering and the other in civil engineering. She also holds a B.S. in civil engineering from Tongji University in Shanghai, China.

Li has been honored with many awards, including the American Society for Engineering Education's Outstanding Student Instructor Award, the Helene M. Overly Memorial Fellowship for Women's Transportation Seminar, the Raymond C. Hurt Fellowship in civil engineering, and a National Science Foundation ADVANCE Workshop Fellowship.

Research Interests

Li's research involves creating, assessing and implementing advanced material technology for repairing existing and designing next-generation engineered structural systems, focused on three challenging areas: (1) extending structural service life and durability under combined environmental and mechanical loading conditions, (2) enabling distributed multimodal self-sensing capability for structural health monitoring, and (3) improving system resilience and environmental sustainability. These research interests extend to assessing life cycle economic, environmental and social impacts caused by technological and economic changes at different scales, aiming to provide a knowledge base to support decision-making, and to provide information on the interdependence among critical components that will guide future material development and structural applications.

photo by TBS Photography

Accolades

BIOMEDICAL ENGINEERING

Metin Akay has been invited to become a fellow of the International Academy of Medical and Biological Engineering. He was also selected as an ambassador by the Institute of Electrical and Electronics Engineers.

CHEMICAL AND BIOMOLECULAR ENGINEERING

Michael Harold is now editor-in-chief of the *AIChE Journal,* the most advanced chemical engineering research publication by the American Institute of Chemical Engineering.

CIVIL AND ENVIRONMENTAL ENGINEERING

Jerry Rogers has been named a Distinguished Alumnus of the University of Arkansas College of Engineering.

Thomas Hsu has been named an Honorary Member of the American Concrete Institute, the highest distinction given by the organization.

MECHANICAL ENGINEERING

Gangbing Song is the recipient of the 2012 Outstanding Professional Service Award from the Aerospace Division of the American Society of Civil Engineers. He also received an Excellence in Research and Scholarship Award from UH.

IN MEMORIUM

Professor David Zimmerman in the Department of Mechanical Engineering passed away Tuesday, April 10, 2012.

Zimmerman earned his doctorate, master's and bachelor's degrees in mechanical engineering, all from the State University of New York at Buffalo in 1982, 1984 and 1987, respectively. He then served as a faculty member at the University of Florida before joining the University of Houston Cullen College of Engineering in 1993. Widely respected by his colleagues, Zimmerman held many leadership roles in his department, including associate chairman of mechanical engineering from 2000 to 2009 and interim department chair from 2010 to 2011. Throughout his academic career, he contributed to both the experimental and theoretical aspects of structural dynamics, optimal control, modal analysis, optimization algorithms and signal processing as part of his research program.

New Faculty

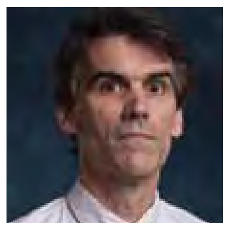
Jose Luis Contreras-Vidal

Professor of Electrical and Computer Engineering

Previously: Associate Professor, University of Maryland School of Public Health

Education: Ph.D. Cognitive and Neural Systems, Boston University

Research: Contreras-Vidal's research interests include neural, cognitive and rehabilitation engineering, computational neuroscience, noninvasive brain neuroimaging, brain-machine interfaces, movement disorders, models of the injured brain and smart neuroprosthetics.



Howard Gifford

Associate Professor of Biomedical Engineering

Previously: Assistant Professor, University of Massachusetts Medical School

Education: Ph.D. Applied Mathematics, University of Arizona

Research: Gifford's research interests involve image formation and reconstruction for medical imaging, objective assessment of imaging systems, visual perception and sources of observer variability in perception studies, image classification and pattern recognition, statistical decision and estimation theory and parallel-computing applications in imaging.

Philippe Masson

Assistant Professor of Mechanical Engineering

Previously: Senior Scientist, Advanced Magnet Lab

Education: Ph.D. Electrical Engineering, University Henri Poincaré, France

Research: Masson's research applies mainly to superconducting power devices and magnets, and turbo-electric propulsion. Specifically, his research interests include design and optimization of superconducting systems, characterization and modeling of superconducting material, multiphysics FEA simulations, and systems dynamics analysis and optimization.

Saurabh Prasad

Research Professor / Assistant Professor of Electrical and Computer Engineering (Fall 2012)

Previously: Assistant Research Professor, Mississippi State University

Education: Ph.D. Electrical and Computer Engineering, Mississippi State University

Research: Prasad's research interests involve statistical learning, pattern classification, adaptive signal processing, hyperspectral image analysis and remote sensing. He will be working with the NSF-funded National Center for Airborne Laser Mapping (NCALM).

Student LEADERSHIP

Cullen College of Engineering students excel in and out of the classroom, paving the way towards a bright future in engineering through leadership, outreach and ingenuity.

"Especially as a freshman, I find corporate engineering intimidating. The build brought everything down to earth."

– CEE major Nabiha Hossain

photo by Thomas Campbell

HEP Students Build Habitat for Humanity Home

UH Honors Engineering Program (HEP) students participated in a Habitat for Humanity build project in northeast Houston, in a joint event with volunteers from KBR.

For Ethan Pedneau, a mechanical engineering senior, the experience was both fun and physically demanding. "My friends and I picked a wall, grabbed a few ladders and started hammering nails in to secure a plywood wall covering," he said. "It was especially nice to get to hang out with my friends while we worked."

Civil engineering major Nabiha Hossain enjoyed the opportunity to network with established engineers, and as a result, feels confident in beginning career pursuits. "Especially as a freshman, I find the corporate engineering world intimidating," said Nabiha. "The build [with KBR] brought everything down to earth. This will give me a little more confidence when I start pursuing interviews for internships with prestigious companies."

The Honors Engineering Program is jointly offered by the Cullen College of Engineering and The Honors College as a program that cultivates community among honors students pursuing an engineering degree.

Engineering Undergrads Represent UH in Energy Innovation Challenge

A team of four mechanical engineering undergraduates have been named semi-finalists for the MIT Clean Energy Prize, an energy innovation competition. Mario Laposse, Eduardo Jasso, Andres Paez and John Vu developed a business plan to solve cost assessment problems in carbon capture, transportation and storage systems by commercializing new methods in carbon sequestration. This is the first time that UH has been represented in the business plan challenge.

UH ACI Student Chapter Recognized

The University of Houston has been named an American Concrete Institute (ACI) Excellent University for 2011. The UH ACI student chapter was recognized for its level of participation in ACI-related activities, an exclusive honor awarded to only 21 other peer organizations.

Engineering Students Among NSF Graduate Research Fellows

Two Cullen College students have received National Science Foundation Graduate Research Fellowships. Biomedical engineering major and Honors College member Darren Seibert is researching the neural computations underlying visual perception. He will begin his graduate studies at MIT in the fall. Audrey Cheong, a graduate student in electrical and computer engineering, is assisting the development of neural implants that will allow users to control prosthetic limbs with their mind.

Environmental Grad Student Receives Support for Water Research

Isis Mejias, an environmental engineering Ph.D. student, received a scholarship from the Rotary Club of Humble Intercontinental that will enable her to conduct research at the University of Sao Paulo on techniques to remove heavy metals from water. Mejias also secured a $50,000 grant for Engineers Without Borders – Central Houston Professional Chapter, which will provide for the installation of a water distribution system in Maseno, a town in western Kenya.

Grad Student Honored for Image Analysis Research

Raghav Padmanabhan, a Ph.D. student in electrical and computer engineering, has received a 2012 Presidential Student Award from the Microscopy Society of America for his paper entitled "Active Machine Learning Method for Identification of Cell Types in Multiplex-Stained Histopathology Specimens Imaged by Multi-Spectral Microscopy." He will present the paper at the 2012 Microscopy & Microanalysis Annual Meeting, set for July 29 to August 2 in Phoenix.

Competition & Community at UH

This year, UH engineering student organizations hosted three regional events:

Regional Steel Bridge Competition

The University of Houston American Society of Civil Engineers student chapter hosted the Texas-Mexico Regional Steel Bridge Competition in January at the Pasadena Convention Center. UH Cullen College of Engineering students Kim Pham (chair), Julio Villalta, Khanh Bui, Kevin Odom, Jonathan Tran, and Kristen Torbett comprised the event committee.

Eleven schools from Texas and Mexico competed in the all-day event, including Southern Methodist University, Texas A&M University, Texas Tech University, Universidad Autonoma del Estado de Mexico, Universidad La Salle Cuernavaca, and The University of Texas at Austin. A panel of 15 judges evaluated the design of steel structures, based on their performance and economy. The UH team came in 9th place overall.

Regional AIChE Conference

The UH student chapter of the American Institute of Chemical Engineers (AIChE) hosted the 2012 Southwest Regional Conference in March on the UH campus. Students and professionals were invited to attend this event, which included workshops, plant tours, and a keynote address by Dr. R. Gerald Bailey, chairman of Bailey Petroleum LLC. The UH Chem-E Car team took second place at the regional competition held during the conference, and will advance to the national Chem-E Car Competition later this year.

SASE Conference

The Society of Asian Scientists and Engineers (SASE) at UH hosted the first-ever South Regional Conference in Houston in March. Science and engineering students were invited to attend and connect with peers in the region during this day-long learning and leadership event. Sponsor companies included Shell, BP, Proctor and Gamble, GE, Dow Chemical, and more.

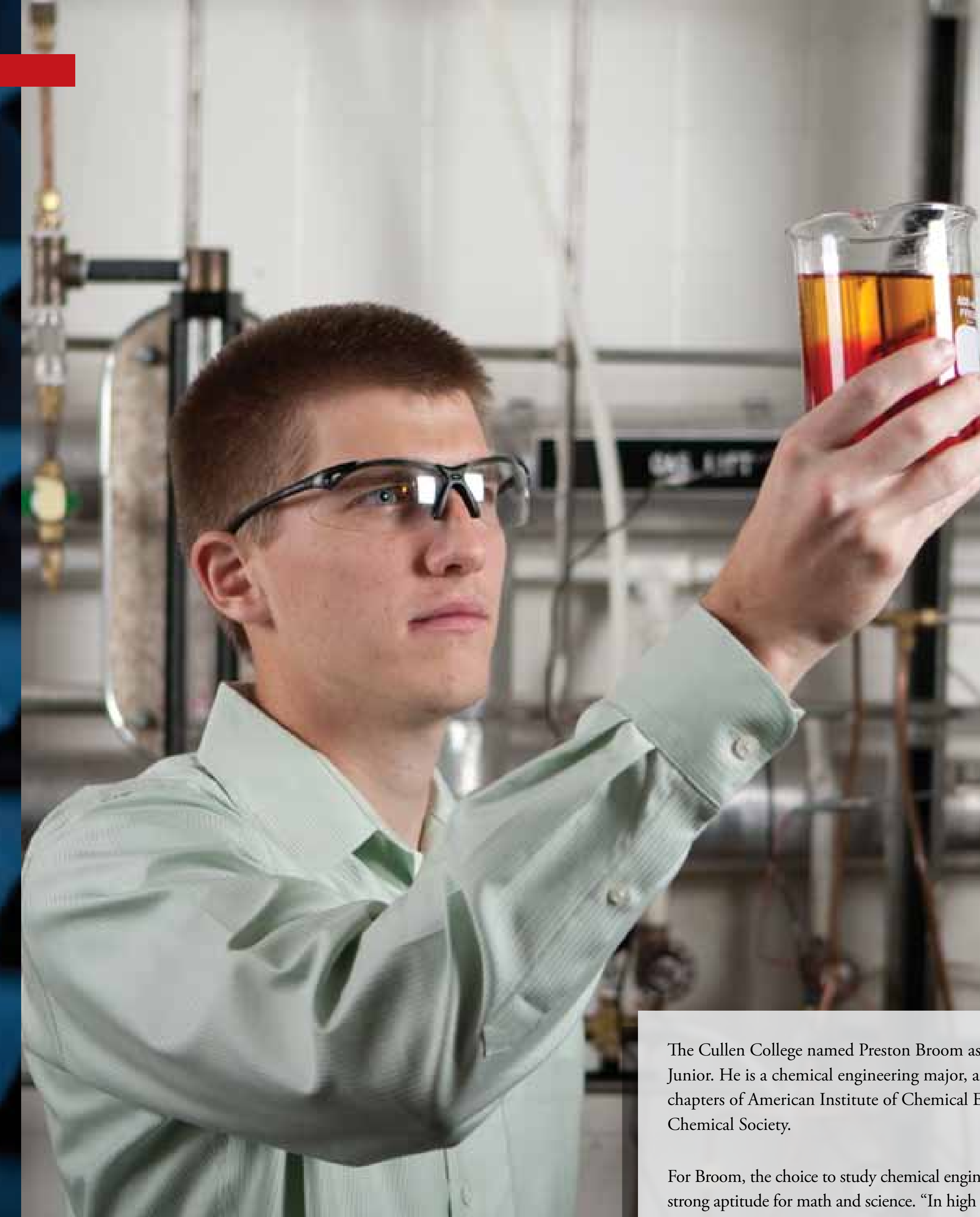
Outstanding Senior: BRIAN CLARK

Brian Clark's dedication to his academic career won him the nomination for Electrical Engineering Outstanding Senior. He is active in several student organizations, including IEEE, Tau Beta Pi Engineering Honor Society and the newly-revived Eta Kappa Nu Electrical Engineering Honor Society, where he is an officer.

"In high school, physics, math and programming were some of my favorite classes, so electrical engineering was a good way to put those interests into practical use," said Clark, who is from Allen, Texas. Engineering also runs in his family. Both of Clark's parents are UH alums — his father received an electrical engineering degree, and his mother's was in chemical engineering. His sister, Rachel Clark, was the Outstanding Senior for UH chemical engineering in 2010.

Clark's interest has a musical complement. "I play French horn in the Moores School of Music Symphonic Winds band," he noted. "I'm one of the few non-music majors, and we had to go through rigorous auditions. It's something I really enjoy doing. It can be hard to balance with school work, but it's worth it."

In addition to balancing course work and extracurricular activities, Clark has built a strong résumé of teaching and research assistantships, and internships. He recently acquired a research position with Professors Stuart Long and David Jackson, working on the design of more efficient antennas for satellites. "Electromagnetics is definitely my favorite subject; I've taken four classes and all of the professors in that area are just outstanding," he said. Clark plans to extend his studies in electrical engineering in graduate school next year.



Outstanding Junior: PRESTON BROOM

The Cullen College named Preston Broom as the 2011-2012 Outstanding Junior. He is a chemical engineering major, and is involved in the student chapters of American Institute of Chemical Engineers and the American Chemical Society.

For Broom, the choice to study chemical engineering was easy. He always had a strong aptitude for math and science. "In high school I knew I was going to be some kind of engineer, so I took some basic engineering courses," he said. Broom's grandfather and uncle are both chemical engineers, and his brother also graduated from UH with a civil engineering degree.

This summer, Broom will hold an internship he gained through the Engineering Career Fair. "The Career Center is really helpful," he said. "I think they do a really good job." Broom will intern with Valero. "I'll be at their Houston refinery, working on each and every piece of equipment — distillation column, catalytic cracker," he said. "I'll be working on a rotation basis every two weeks until the summer is over."

Broom noted that he has gained a solid foundation in engineering concepts through the courses he has taken at the Cullen College. "They really cover a broad range," he said. "Courses are generalized as much as possible, so whatever discipline you go into, you have some sort of background."

When Broom isn't studying, he's at the UH Recreation and Wellness Center playing a number of intramural sports. He plans to work after graduation for a while to gain practical experience; and long-term, he would like to pursue advanced studies.

photos by Thomas Campbell

Know Thyself

Taken from *The Engines of Our Ingenuity*, Episode #1847

Dr. John Lienhard

We all weigh the question, "Who am I," now and then; but the place we hope to find the answer shifts. I long ago despaired of finding a usable answer in autobiographical data. For a while, I thought it might be a matter of self-perception. Then I read Oscar Wilde's wonderful quip, "Only the shallow know themselves."

Maybe objective science will tell me as much as the subjective stuff will. Whatever else we might be, we certainly are great gaggles of cells. So let's see what they have to tell us:

Robert Hooke's book on the compound microscope, *Micrographia,* came out in 1665. In it, he sketched the microstructure of a slice of cork. Then he wrote, "I could ... plainly perceive it to be all perforated and porous, much like a Honey-comb, but ... the pores of it were not regular." Of course he was seeing the walls of dead cells in dead bark. They'd once been filled with fluid, and alive.

Not until 1838 did a German botanist compare notes with a zoologist. They realized the structures they'd been studying in plants and in animals were very similar, and they concluded that all living things are made up of cells.

Twenty years later, it became clear that cells are the home of disease as well as life. But cells remained perplexing because they take on such a dizzying variety of forms. And they execute so many functions. Pines presents a remarkable chart showing the range of things that can be called cells. The largest is a six-inch ostrich egg. A human egg is only a 250th of an inch in diameter. Red blood cells are less than one millionth of an inch.

But they all include nucleic acids, proteins, lipids, carbohydrates, water, and salts. They all include DNA. Uncoil each long molecular helix of DNA in your body, lay them end-to-end, and your DNA will reach all the way to the sun and back.

Electron microscope pictures show human cells girdled by an outer mess of microfilaments to help them crawl. What frightful-looking creatures! Yet there I am — there you are: splatters of organic matter, marvelously efficient, crammed with complex apparatus — mitochondria, ribosomes, lysosomes -- more than we'll ever fully understand.

How right Oscar Wilde was! We would be shallow indeed to think that we truly knew ourselves.

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 2,750 episodes have been broadcast. For more information about the program, visit www.uh.edu/engines.*

Building a Heart *From Scratch*

Organ donation may one day become obsolete. In its place? Organs grown in a lab, possibly from a patient's own cells.

If this possibility becomes a reality, though, it will be due to the work of researchers like Ravi Birla. An associate professor of biomedical engineering at the UH Cullen College of Engineering, Birla specializes in the engineering of cardiac tissue. Working with cardiac stem cells mixed in a gel that encourages growth, he has been able to create patches of tissue that from a biological and molecular standpoint are extremely close to naturally developed heart tissue.

Given that the heart isn't just a patch, but a full organ with chambers, curves and crevasses, Birla uses scaffolds to grow tissue that take a desired shape. He has also been successful at training cells in this tissue to contract, showing the ability to develop tissue that "beats" like the human heart.

Though full lab-grown organs are years to decades away, the efforts of researchers like Birla hint at what the future holds for transplant patients.

photos by TBS Photography

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UH Cullen College of Engineering
Office of Communications
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REACHING OUT, GLOBALLY

The UH Cullen College of Engineering has been reaching out to establish educational partnerships with institutions around the world. The college has recently established or is working to create new agreements with some of the top universities in Sweden, China, Taiwan, India and the Philippines in an effort to promote collaborative research and academic exchange programs for students studying in the U.S. and abroad.

Learn more online at http://www.egr.uh.edu