The Neural Network
Reverse-Engineering the Brain
A major milestone has been reached at the University of Houston’s Tier-One Journey. In January, the Carnegie Foundation for the Advancement of Teaching categorized UH as a research university with “very high research activity.” The highest classification given to research universities, the Carnegie ranking places UH in the company of other top-tier research institutions across the country. We have made tremendous progress in a very short amount of time due to the unwavering vision of our leadership and the ongoing diligence of our faculty and students in pursuit of excellence. UH is definitely on the move and will continue making strides toward those strategic initiatives.

At the UH Cullen College of Engineering, we continue to focus on core areas of research growth in addition to expanding academic areas of great national interest. In particular, we have played a significant role in the UH Energy initiative and the developing UH Energy Research Park. Our petroleum program recently moved into the research park, providing more space for the rapid growth of our new undergraduate program and our existing master’s program.

The demand for this program has been incredible. We also continue to experience great interest from the energy industry in the Greater Houston area for other key programs. In response to the workplace development needs of these industries, we’ve launched a subsea engineering certificate program and are working to establish a master’s program in this area. The first and only subsea engineering program in the country, our program will offer specialization in the design and maintenance of equipment, tools and structures utilized in offshore petroleum operations, and therefore fulfilling a greater educational need of this energy-centered region.

In this issue of *Parameters*, we highlight a growing network of neuroscience and engineering education and the profession. For many years, the college has been building expertise across disciplines in the major threat area of biomedical engineering. In 2010, we won a competitive National Science Foundation grant, making us a noted expert in the neuroengineering science, as the founding chair of our new biomedical engineering department. Most recently, we recruited Badri Roysam to lead our electrical and computer engineering department. Featured in this issue, Badri is leading a multi-institutional effort to improve the viability of neural implants for medical applications. These two individuals bring a wealth of expertise in neuroengineering science that further elevates us to prominence within the UH Health initiative and throughout Houston’s burgeoning medical community.

This research excellence provides ongoing scholarship for our academic programs, giving our students a top-tier education in a major metropolitan area. What’s captivating is the fact that our students routinely mirror this excellence in their studies, in student competitions, and in service and other leadership activities and as individuals. We could not be more proud of our Cullen Community for their commitment to UH, engineering education and the profession.

Warm regards,

Joseph W. Tedesco, Ph.D., P.E.
Elizabath D. Rockwell Dean and Professor
Given the undergraduate response to the program, the building will be put to good use. At the end of its first full academic year, 2009-2010, undergraduate enrollment totalled 20 students. Today it stands at nearly 100. The program’s long-term goal is to graduate 50 students with a bachelor’s degree in petroleum engineering each year. This is on top of the 80 students currently pursuing the Cullen College’s existing and highly regarded master’s program in petroleum engineering.

Even with all this momentum, there is still a lot to be done to fully establish the undergraduate petroleum engineering degree program, Holley said. With the program only in its second year, the curriculum and courses for junior- and senior-level students must be fully developed, endowed professorships must be funded and faculty recruited.

“We’ve made a lot of progress in the past year with this program, but there’s still much that has to be done,” said Holley. “Given the incredible support we’ve received from the university and the Houston community as a whole, I’m confident that this will soon develop into a world-class petroleum engineering undergraduate program.”

Petroleum Engineering EXPANDS TO RESEARCH PARK

The University of Houston Cullen College of Engineering’s undergraduate Petroleum Engineering Program is now in full swing with a growing enrollment, a dedicated building and generous ongoing support from the petroleum industry.

The program was launched in the fall of 2009 in response to “the great crew change,” a reference to the many members of the petroleum industry’s workforce who have recently retired or are expected to do so in the coming years. Facing a shortage of skilled workers, several companies in the sector approached the Cullen College about helping them meet their need for new petroleum engineering talent.

“Houston is the center of the petroleum industry for the entire world, so the University of Houston is the ideal place for this type of program,” said Tom Holley, director of the Petroleum Engineering Program.

It should come as no surprise, then, that many companies and organizations in the petroleum sector are generous supporters of petroleum engineering at UH. Major donors include Devon Energy, Marathon Oil, Southwestern Energy, El Paso Corporation and the Society of Petroleum Engineers, Gulf Coast Section, among others. In addition to corporate sponsorship, the program has received substantial donations from individual benefactors, including Beth Madison, founder and president of Madison Benefits Group Inc.

“The University of Houston has been extremely fortunate to have strong support from the petroleum industry,” said Holley. “These very generous gifts are shining examples of leadership and are especially noteworthy in light of the current economic climate.”

Gifts to the program have been used to refurbish and equip the program’s dedicated space at the University of Houston Energy Research Park. The building, which opened to students on January 18 of this year, boasts three classrooms, three undergraduate teaching laboratories, a computer lab, three faculty and graduate research laboratories, faculty and student offices, and a student lounge.

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Holley Establishes SCHOLARSHIP FUND

Tom Holley, director of petroleum engineering at the Cullen College, and his wife Nancy, have made a major gift to the program in support of student scholarships.

This gift, along with anticipated matching funds from Shell Oil Company, where Holley worked for more than 27 years, has allowed for the creation of a $51,000 endowed scholarship fund in honor of Trilochan Padhi, a renowned geophysicist and one of Holley’s mentors at Shell.

The fund will support annual $1,000 scholarships for two petroleum engineering students. Holley said he hopes others who have worked with Padhi and wish to honor him will donate to the fund in order to support additional students.

In addition to supporting student success, Holley noted that this gift shows that individuals can make real, lasting and important contributions to the program. “It’s not always about companies,” he said. “Individuals can do things, too. It is gratifying to Nancy and me to see the impact that a gift to this university has on the lives of students.”
Neal Amundson, Cullen Professor Emeritus of Chemical and Biomolecular Engineering and Professor of Mathematics, passed away in February at the age of 95.

Neal Amundson, 1916-2011

Neal Amundson, Cullen Professor Emeritus of Chemical and Biomolecular Engineering and Professor of Mathematics, passed away in February at the age of 95.

Neal Amundson was regarded as one of the most prominent chemical engineering researchers and educators in the country, and his impact on chemical engineering practice and education. His research contributions to the field included analytical and modeling chemical reactors, separation systems, polymerization and coal combustion. Widely regarded as one of the most prominent chemical engineering researchers and educators in the country. Amundson's efforts led the University of Minnesota's chemical engineering department from relative obscurity to the top-rated program in the country. Amundson held the University of Minnesota's chemical engineering department from relative obscurity to the top-rated program in the country. Amundson was a pioneer of chemical reaction engineering. His research contributions to the field included analytical and modeling chemical reactors, separation systems, polymerization and coal combustion. Amundson took over leadership of the University of Houston as a research university with "very high research activity," the highest classification given to research universities and the equivalent of Tier One status.

"Neal was one of the leading chemical engineering researchers in the country and took on a rather empirical approach to research and introduced new methods of scientific study that were adopted by chemical engineering programs across the nation," said Dan Luss, a Cullen Professor of Chemical Engineering at UH, who earned his Ph.D. from Amundson at the University of Minnesota in 1966.

Amundson's efforts led the University of Minnesota's chemical engineering department from relative obscurity to the top-rated program in the country. Amundson took over leadership of the University of Houston as a research university with "very high research activity," the highest classification given to research universities and the equivalent of Tier One status. "I give the credit to our faculty, our students and our Board of Regents who have been so supportive the last two or three years," said UH President Renu Khator. "But, at the end of the day, great communities build great universities. It is a compliment to the city and the state and to our fabulous delegation members, our legislative leaders who believed this was an important initiative."

UH now becomes the third public university in Texas in the top-tier group, joining The University of Texas at Austin and Texas A&M University. Khator said the Carnegie designation will bring greater visibility to Houston and lead to more economic development for the region and sustained research productivity from UH.

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College Performs Well in Latest NRC Rankings

The UH Cullen College of Engineering studied in the National Research Council's rankings of Ph.D. programs. Using the median for all rankings, the college's chemical engineering doctoral program placed 18th in the nation out of 106 ranked programs in the study's S-ranking, which measures a program against criteria set by members of the discipline. With this ranking the program seated its counterparts at nearby institutions such as Rice University (46th) and Texas A&M University (45th). The University of Texas at Austin was the only school in the region to rank higher.

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The ADULT HUMAN BRAIN has roughly 100 billion neurons connected by anywhere from 100 trillion to 500 trillion synapses. Another 100 billion to 500 billion glial cells exist in the brain to support neural activity.

Such numbers reveal a simple fact: the human brain is more complex than the world’s most advanced supercomputer, than anything humans have ever built, really.

While reverse-engineering the brain was pinpointed as a “grand challenge” in 2008, for years, a network of researchers at the Cullen College have been investigating exactly how the brain works. Today, their efforts include creating neural implants capable of controlling prosthetic limbs, developing the next generation of neural probes and working to understand how the brain processes sensory information. Their efforts will help reveal the guiding principles organizing the billions of cells and trillions of connections that make up the human brain, making one of the world’s most powerful instruments an even more powerful tool for advancing science and improving human lives.
The human brain is staggeringly complex, the source of everything from abstract reasoning to involuntary activities like breathing. With roughly 100 billion neurons, each capable of firing up to 200 times per second, it is far more sophisticated than the most advanced, most powerful supercomputer.

Because of this complexity, overcoming the biggest neuroengineering problems often requires teams of experts all at the top of their fields. Badrinath “Badri” Roysam, chair of the Cullen College’s Department of Electrical and Computer Engineering, is leading one such team. Consisting of researchers from four institutions, they have been charged by the U.S. Department of Defense’s Defense Advanced Research Projects Agency (DARPA) with overcoming one of the most significant obstacles to the use of prosthetic limbs controlled by the user’s mind: the failure of the neural implants that receive signals from the brain and then transmit them to the prosthetic limb.

According to Roysam, these devices, which can also be used to stimulate the brain, sample brain fluids or deliver medication, fail because the brain treats them like an injury.

Once a device is implanted, “the tissue begins remodeling itself right away,” Roysam said. “It’s called a tissue reactive response. Basically active cell types envelop the device to the point where it becomes completely isolated from the rest of the brain. At that point, it’s basically ineffective.” Typically these implants fail within two months, eliminating their value as long-term solutions for individuals who have lost a limb.

While researchers understand the fundamentals of why implants fail, the details of the process are not well known. How, exactly, do different brain cell types react when an implant is introduced? How do the active cell types make their way to the neural implant? And how does an implant’s design affect the brain’s response to it?

These are the questions this research group will seek to answer.

The work will begin at the University of Michigan, where Professors Kristin Bennett and Mark Embrechts will seek to identify the properties of the implants that spur the brain to isolate them, as well as which implant properties seem to hinder this process. Using this information, they will suggest design changes to the researchers from the University of Houston, restarting the whole process.

In addition to making practical decisions on the direction of device design, data from each round of devices will be compiled, Roysam said, in order to determine the principles for developing better neural implants.

The group’s research is supported by a DARPA grant for up to three years and up to $5 million. Given the talent assembled in this group of researchers, Roysam is hopeful that they will make advances in neural implant design that can help these devices last a lifetime.

“This is a dream team,” Roysam said. “We have preeminent leaders in implant design, 3-D multispectral imaging, quantitative histology, and pattern recognition on our team. Ideally, we will be able to make great strides in the understanding of neural implant failure.”
Here’s an interesting visual phenomenon. Take out a video camera — or these days, a smartphone — hit record, and move it back and forth quickly. What you end up with is a blur. Now quickly swing your head up and down or side to side. Practically everything in your field of view stays focused.

The difference, obviously, is the brain. While the lens of the eye and the retina operate much like a camera, registering a three-dimensional scene on a two-dimensional surface, the brain uses a complex process to recognize and bring into focus objects that we barely glance at. Discovering the details of this process, the rules by which the brain lets us see the world clearly, is one of the major research thrusts of Haluk Ogmen, professor of electrical and computer engineering and biomedical engineering, and executive director of the UH Center for Neuroengineering and Cognitive Science.

According to Ogmen, the brain, working with the visual system, is able to keep focus through reference frames, which are essentially coordinate systems quickly formed by the brain. These frames are often based on something physical, such as a stationary object that allows humans to focus and identify a moving one — think of a car driving past a house. Reference frames can also be created out of something abstract. The knowledge of how a person moves, for example, allows us to bring into focus in a split second anyone who walks in our field of vision.

Ogmen’s research is trying to determine the rules for creating these reference frames. How, for example, does the brain register different movements to create reference frames? Are there different reference frames for objects that are close to us versus far away? What are the brain’s rules for creating reference frames for objects of different sizes? And what role do these reference frames play in storing our visual experiences in our memory and retrieving them later?

To answer these questions, Ogmen creates visual stimuli that can fairly be described as optical illusions. “The idea,” he said, “is to take a hypothesis and express it as a visual stimulus that has two opposite perceptual outcomes, one supporting the hypothesis and the second refuting it. By measuring the outcome, I can test my hypothesis about how the brain creates reference frames.”

For example, one typical stimulus created by Ogmen and colleagues entails two images of three dark circles intermingled with white dots placed at different positions. Volunteer test subjects look at a computer screen that is quickly flashing these two images, one after another. They are then asked whether they see one particular dot as moving clockwise or counterclockwise around one of the circles. Their answers provide insight into how the brain allows us to keep moving objects in focus, such as the role of an object’s rough motion, in forming reference frames.

This research currently focuses on simply determining what reference frames the brain uses and the rules for creating them. As it progresses, though, Ogmen plans to explore what parts of the brain are at work in creating reference frames. Using functional magnetic resonance imaging, which reveals brain activity based on blood flow, he will determine the general locations of the brain that are at work in the formation of specific reference frames. Neuroscientists can then use that information to delve into the behavior of particular neurons or neuron groups.

This knowledge about how reference frames are formed, according to Ogmen, could aid in the creation of computer vision systems that can track and recognize more accurately objects in natural scenes, and even contribute to navigation systems developed by robotics experts.

“Computers beat the brain in many tasks, like large number multiplication and database searches,” he said. “But there are other tasks that no computer even comes close to what we can do. In the area of navigation, the most powerful supercomputers cannot even match insects. So what’s missing are the engineering design principles that capture the fundamentals of biological information processing. That’s my goal as an engineer, to reverse-engineer vision, memory, and cognition and see how our brains and minds work.”
Today, Dani and other neuroscientists record brain activity with tiny probes that are about half the thickness of a human hair. Inserted into the brain, these probes detect electrical activity of these neurons.

Such probes are handcrafted by twisting together four fine wires, each with a sensing node at the end. By comparing how strongly an electrical signal registers on each of the nodes, researchers can identify the activity of a specific cell amid the background noise generated by nearby neurons. “These handcrafted tetrodes are the standard for brain studies that are currently used, helping to unlock information on the workings of individual neurons.”

While effective, these probes are far from ideal. If all four nodes are not equally sensitive to electrical activity, the probe will distort the perceived positions of neurons. And while these instruments are built one at a time, they are typically used in batches of 50 or more, making every experiment very labor-intensive. What’s more, there is simply no way for these probes to sense any area other than near the tip of the probe. The next generation of probes, Dani says, must be able to sense multiple areas simultaneously.

At the heart of this team’s new probe concept is a glass fiber substrate with hundreds of ultra-thin conductor lines that carry nerve signals from sensing nodes to signal processing electronics outside the skull.

With this design, the probe can have hundreds of sensing nodes and still be even smaller than a conventional tetrode. In addition, while stiff enough to be inserted into the brain, these probes will be flexible enough to shift with slow brain movements caused by breathing and other activities in free animals or humans. This flexibility is critically important since a stiff probe might cut or tear the brain.

The team is now developing additional features for this probe that turns it from a device that measures brain activity to one that can actually induce it. Combining optical modalities with a light-sensitive molecule introduced into the brain on demand and then studying the electrical response of nearby neurons. For Dani, whose research interests include addiction, the optical probe could be used to simulate the effects of particular drugs on the brain and then explore its electrical response to those effects.

“One of the limitations in neuroscience research is the ability to collect high-resolution data. Data is being lost in the background noise that we don’t want to collect,” he said. “By increasing the precision and accuracy with these new kinds of electrodes, we will be able to collect more data, new kinds of data that could potentially revolutionize the way we look at interactions between elements of the brain.”
Seeing and hearing are so fundamental to our day-to-day lives that most people don’t even think about them. That would be like pondering the water that comes out of the tap, or our cars needing gasoline. Just because we don’t think about our senses doesn’t mean the brain isn’t hard at work when we see and hear. The mechanisms for processing the senses are in fact incredibly complex. They are also not completely understood. Professors Bhavin Sheth and Ben Jansen, both with the Department of Electrical and Computer Engineering, are among those conducting research to gain a better understanding of the brain’s sensory processing mechanisms.

Sheth’s research explores not just sensory processing in typical situations but in suboptimal conditions as well. Some of his work centers on whether and how the brain processes visual and auditory stimuli during sleep.

One of his most recent experiments explores the brain’s response to colors during sleep. “We know that we can adapt when we’re awake. What we now know is that a person can adapt during sleep.”

This result, Sheth readily admits, isn’t extremely surprising. But what it reveals about the workings of the brain and the nature of sleep — a state in which most people spend one-third of their time — is very important. “We know that we can adapt when we’re awake. What we now know is that a person can adapt during sleep. We’ve shown that during sleep, there are changes in brain circuitry and activity in response to external stimulation that are observable later during wakefulness.”

One of Jansen’s longtime research focuses is auditory processing, or how the brain registers and responds to sound. He is working with two groups in ongoing research projects — one of individuals with schizophrenia and one without — to understand the different ways in which they process sound.

Jansen conducts his tests using functional magnetic resonance imaging, or fMRI, an imaging technique that shows the oxygenation level of the blood flowing in the brain. Images that show increased blood oxygenation levels in particular areas indicate what parts of the brain are at work.

During the test, Jansen introduces the subjects to two sounds spaced half a second apart, measuring the responses to each sound. In individuals without schizophrenia, the brain typically exhibits a strong response to the first sound and a weaker response to the second. This is not surprising, he noted, since it is consistent with the ability to block out background noises and focus on a particular sound.

Individuals with schizophrenia, though, show a different response. While the reaction to the second sound was more or less equal for both groups, schizophrenic individuals had a much smaller response to the first sound. In fact, it was essentially equal to their response to the second sound. So instead of schizophrenic individuals having a difficult time blocking out background noise, as some have proposed, this test indicates that they tend to respond poorly to all sounds.

The next step of this research moves beyond observing to actually understanding what’s happening. To that end, Jansen and PhD student Xiaofei Du developed a complex mathematical model of the brain’s auditory processing system. In applying this model, he has used as a starting point the dopamine hypothesis of schizophrenia, which holds that many symptoms of the condition are due to abnormal levels of the neurotransmitter dopamine in individuals suffering from schizophrenia. By both reducing and increasing dopamine levels in the model, “we get results that are indistinguishable from actual schizophrenia patients,” he said. The findings will appear in an upcoming issue of Neural Networks.

While this is not a conclusive proof of the dopamine hypothesis, it does help light possible paths for the treatment of individuals with the condition. “In the end, you want to use your knowledge to treat people,” Jansen said. “If you understand what a disorder is all about you can develop drugs, surgeries or other therapies.”
Assistant Professor of Industrial Engineering

Qianmei (May) Feng

Education
Ph.D. Industrial Engineering, University of Washington, Seattle, 2005

Career Overview
Feng joined the University of Houston Cullen College of Engineering as an assistant professor in 2005 following an appointment as a research assistant at the Pacific Northwest Agricultural Safety and Health Center at the University of Washington in Seattle. Since joining UH, she has received several honors, including a Highly Cited Researcher Award for her publications in the Emerald Literati Network and an Outstanding Teaching Award from the college. In 2010, she was also awarded a Brij and Sunita Agrawal Faculty Fellowship, established to honor promising junior faculty within the Department of Industrial Engineering. She is a member of the Institute of Operations Research and the Management Sciences (INFORMS), the Institute of Industrial Engineers (IIE), American Society for Quality (ASQ) and the Alpha Pi Mu Honor Society. She served on the editorial board for Quality Engineering, the International Journal of Quality Engineering and Technology and the International Journal of Rapid Manufacturing.

Research Interests
Most of Feng’s research involves complex systems modeling, analysis and research related to underground infrastructure construction and maintenance.

New Faculty

Patrick Cirino
Title: Associate Professor, Department of Chemical and Biomolecular Engineering

Previous: Associate Professor, Pennsylvania State University

Education: Ph.D. Chemical Engineering, California Institute of Technology, 2003

Research: Cirino’s research interfaces chemical engineering with the biological sciences. He is interested in developing and applying protein and metallic engineering tools to engineer microbes with improved biocatalytic properties, as well as pursuing fundamental understanding of metabolic and protein biochemistry. Biocatalyst design goals include more efficient microbial utilization of biomass for production of renewable fuels and chemicals, and enhanced biosynthesis of secondary metabolites.

Faculty Accolades

CHEMICAL AND BIOMOLECULAR ENGINEERING
Michael Harpole has been named a M.D. Anderson Professor.

Peter Velkov was named a Fellow of the American Physical Society for his pioneering research on the separation of cryocrystals and crystal growth.

Richard Wilson was named a 2010 fellow of the American Association for the Advancement of Science for his distinguished contributions to biophysical modeling.

CIVIL AND ENVIRONMENTAL ENGINEERING
Jerry Rogers’ paper titled “The New Town of Boulder City: City Planning and Infrastructure Engineering for Hoover Dam Workers” was one of 20 papers selected nationally for inclusion in the proceedings of a special symposium to celebrate the 75th anniversary of the Hoover Dam at the American Society of Civil Engineers annual conference.

Constandos “Vipu” Vipulanandan won the 2011 Most Valuable Professional award from the Underground Construction Technology Association and Underground Construction magazine for his outstanding contributions in education and research related to underground infrastructure construction and maintenance.

Faculty News

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In Print

UH Engineering faculty recently published a couple of textbooks and one edited compilation that are widely used in engineering education. Ernest Henley, professor emeritus of chemical and biomolecular engineering, released the third edition of Separation Process Principles, a co-authored with J.D. Seader and Keith Seader. The book is one of the best-selling texts for chemical and biochemical processes in the United States and is published by Wiley.

Ali Kamrani, associate professor of industrial engineering, also authored a text with Emal Abouel Nasr titled Engineering Design and Rapid Prototyping. Published by Springer, the text outlines methods and techniques for engineering design as it relates to modularity, rapid manufacturing and process planning. Kamrani also edited a book titled Systems Engineering Tools and Methods, a collection of chapters authored by more than 20 industrial and systems engineering faculty across the nation. The book published by CRC Press was edited by Kamrani’s post-doctoral fellow Maryam Amini.
Eliminating tens of thousands of manual lab experiments, two University of Houston professors are working toward a method to cut the development time of new antibiotics. While current practices typically last for more than a decade, a computerized modeling system being developed at UH will speed up this process.

Michael Nikolaou, professor of chemical and biomolecular engineering, and Vincent Tam, associate professor of clinical sciences, are focusing on dosing regimens to reveal which ones are most likely to be effective in combating infection. It is hoped that pharmaceutical companies can then focus their tests on the most promising regimens.

Their findings appeared in the Public Library of Science’s journal, PLoS Computational Biology. The journal aims to further the understanding of living systems—from molecules to humans—through the application of computational methods. This article chronicles the results of a three-year endeavor that was initially funded by a $400,000 grant from the National Science Foundation.

“With microbial resistance to drugs increasing, there is a need to develop new antimicrobial agents rapidly,” Tam said. “Our work proposes a new computational method that will provide quantitative insight to the interaction between certain antibiotics and pathogens. Through pharmacodynamic modeling, which studies the effects of drugs on organisms, our aim is to both help develop new antibiotics and optimize existing medications to curb the prevalence of drug-resistant bacteria.”

The traditional trial-and-error approach to drug development involves a great deal of trial-and-error testing, such as empirically selecting a handful of dosing regimens for clinical investigations among hundreds of possibilities—only time will tell their effectiveness. Tam and Nikolaou, however, are employing computer modeling and simulation to project how bacteria would respond to different exposures of a drug, focusing on how much bacteria would respond to different exposures of a drug, focusing on how much medicine a patient should take, how often it should be taken and for how many days. Subsequent investigations in clinical studies can then target those dosing methods that have the highest probabilities of success.

Tam, an expert on experimental therapeutics, and Nikolaou, with a background in computer-aided systems engineering, forged their collaboration through a seed grant from UH before they attracted external funding.

“While our approach is not intended to replace traditional drug discovery, we see it as an important step toward streamlining the development of new antibiotics,” Nikolaou said. “Some pharmaceutical companies are following our developments closely, and we are in the process of offering a model prototype in the form of a computer program to ultimately be used in a clinical setting.”
ROBO SHASTA

Four UH Cullen College of Engineering undergraduates have shown their Cougar pride by building a “Robo Shasta” for their senior design course.

The robot, designed to look like the head of the University of Houston’s cougar mascot, can move, speak, track objects and perform basic arithmetic.

It was built by electrical and computer engineering students Marlon Belleth, Michael Canuz, Kyle Clifton and Major Jonah, who graduated from the Cullen College in December.

The inspiration for Robo Shasta came nearly two years ago, when Belleth and Canuz were members of the robotics team led by Professor John Glover. At one point, the team watched videos showcasing the work of robotics groups around the world. Seeing those videos convinced Belleth and Canuz that they were getting the skills and education needed to build a sophisticated robot of their own.

The self-directed nature of the project turned out to be a fitting way for the group to go out on their own and find the pride by building a “Robo Shasta” for their senior design class.

“Seeing those videos was really the point of the senior design class,” he said.

Senior Design Yields

ROBO SHASTA

Undergraduate Recognized for Biomedical Research

Biomedical engineering junior Mohamed Mohamed captured first place in the Society of Mexican American Engineers and Scientists (MAES) Symposium 2010 poster competition by showcasing work performed in the Biomedical Optics Laboratory at the UH Cullen College of Engineering.

Mohamed has been working to quantify the permeability rates of lipoproteins, or cholesterol transporters, and other biologically relevant molecules through carotid tissue, the aortic branch supplying blood to the head.

His results verify the diffusion of low-density lipoprotein (LDL) into the inner lining of arteries, which is assumed to be the leading cause of atherosclerotic plaque formation. Atherosclerosis is a condition that develops due to the buildup of fatty substances inside arterial walls.

Utilizing a non-invasive imaging technique known as Optical Coherence Tomography (OCT), Mohamed was able to measure the permeability rates of lipoproteins such as LDL and high-density lipoprotein (HDL) in the tissue.

“What we were able to do here is verify this fact with a non-invasive method,” he said. “In the future, we might be able to figure out how effective certain drugs are in preventing and treating atherosclerosis.”

Graduate Students Win High Honors

Mona Meisami-Azad

The Association for Women in Science has given one of its three predoctoral 2010 Educational Awards to Cullen College graduate student Mona Meisami-Azad.

Meisami-Azad is working toward a Ph.D. in mechanical engineering under the guidance of Professor Karlof Gergen and Matthew Franchuk. Her studies and research focus on controls for complex engineered systems. This work has been applied to fluid engine after-treatment systems with the objective of reducing harmful emissions, as well as wind turbines, where the goal is to increase the energy capture while minimizing structural loads.

“These systems are actively controlled, where the measurements from a number of sensors are used to make a decision on how to manipulate actuating devices to ensure that a set of design objectives are met considering the design constraints,” she said.

Meisami-Azad is on schedule to complete her Ph.D. by the end of 2011. Upon earning her degree, Meisami-Azad hopes to land a research engineering position in the automotive or energy industry. “I’m interested in a position in the research and development department of a large company,” she said. “I’d like to be able to utilize the skills I acquire in my graduate studies and apply them in real-world applications including renewable energy systems.”

Taraka Ravi Shankar Mullapudi

Taraka Ravi Shankar Mullapudi, a Ph.D. candidate in the Cullen College’s Department of Civil and Environmental Engineering, won the Earthquake Engineering Research Institute’s 2011 Student Paper Competition.

The award was presented to Mullapudi during the group’s 63rd Annual Meeting, held in La Jolla, Calif., on February. Mullapudi presented the winning paper, “Seismic Behavior of RC Structures Subjected to Combined Loading Including Torsion,” at the gathering.

The article explores the behavior during earthquakes of reinforced concrete members with eccentric loadings, asymmetrical geometries, and skewed and curved geometries with unequal spans and column heights. In seismic events, these concrete members are subjected to multiple combined loads, including axial, flexure, shear and torsion loads.

Mullapudi has developed an analytical model “to predict the behavior of structures under such loads, as well design them to resist against destructive earthquakes,” he said.

This is just the latest honor Mullapudi has received during his time at the Cullen College. He has received two fellowships from the American Society of Civil Engineers and also won the best paper award for April 2010 from the ASCE’s Texas Section. Mullapudi is pursuing his doctorate under the guidance of Associate Professor Ashraf Ayyub.
Each year in celebration of National Engineers Week, the Cullen College names the outstanding junior and senior students for every department and major. Out of this group of young scholars, the college chooses in overall Outstanding Junior and Outstanding Senior, two students whose work inside the classroom and out is truly exemplary. This year’s honorees are mechanical engineering junior Ethan Pedneau and December 2010 civil engineering graduate Jennifer Ngo.

Mechanical engineering major Ethan Pedneau has been named the Cullen College of Engineering’s Outstanding Junior for the 2010-2011 academic year. Pedneau, who hails from Pasadena, Texas, originally enrolled in the college planning to study chemical engineering. He switched to mechanical engineering as a freshman, however, because it appealed to his strengths. “My best courses in high school were art and mathematics. Mechanically engineering was the best way for me to apply those skills,” he said.

Given his academic performance over the past three years, that was clearly the right choice. Pedneau boasts a grade point average of 3.753, and is an accomplished student researcher. Working with Ralph Meacham and Fadi Hussian, both professors in the Department of Mechanical Engineering, he has explored ways to overcome the problem of inconsistent energy production from wind farms in the Gulf of Mexico. Utilizing wind data gathered by the National Oceanographic and Atmospheric Association, Pedneau’s research team determined that by interconnecting wind farms throughout the Gulf coast, power generation would be “smoothed” to a predictable, dependable level. When one wind farm fails to generate enough power because of poor wind quality, another would generate enough to make up for it, they found. Further, their research indicates that hurricanes do not pose a major threat to offshore wind farms in the Gulf. Wind farms built on water withstood up to a strong Category Three storms have only a 0.1 percent chance of being destroyed by wind each year. That figure, however, does not account for wave forces, a factor Pedneau and his group are currently calculating.

“The threat of hurricanes is very small, especially when compared to mechanical failure, grid failure and all the other things that can go wrong,” Pedneau said.

Given his flair for research, it should come as no surprise that Pedneau is an active member of the Houston Undergraduate Research Network, a UH student organization, and hopes to hold a leadership role within the group during the next academic year. He is also a member of the Student Governing Board of The Honors College at UH, where he creates the artwork and posters advertising student events. Looking ahead, Pedneau plans to pursue a graduate degree in mechanical engineering, most likely at the Cullen College.

The Cullen College of Engineering’s Outstanding Senior for the 2010-2011 academic year is Jennifer Ngo. Ngo, who came to UH on a full academic scholarship, graduated with a B.S. in civil engineering, in December of 2010 with a final grade point average of 3.71.

During her time at UH, Ngo was active in the life of the college. She served as treasurer of the UH chapter of the American Society of Civil Engineers for two years, organizing and/or participating in events like the ACSCE Chili Cook-off, its Habitat for Humanity volunteer efforts, and the group’s annual beach ball game.

Ngo was also a three-time member of the college’s Gamma House team. “I’m really active physically and I like to do outdoorsy stuff, so this was a natural fit for me,” she said. Two of those teams won the regional Gamma House competition and went on to represent UH at nationals.

In addition to her work with student organizations, Ngo went out of her way to build up her resume while still enrolled as a student. She spent a year as a research assistant on a Texas Department of Transportation-funded research project led by Kyle Strom, an assistant professor of civil and environmental engineering. She also completed two internships during her time at the college. The first was with United States Gypsum, a building materials manufacturer. The second internship, which she landed through the Engineering Career Fair, was with Spectra Energy, a natural gas pipeline and infrastructure firm.

After graduating in December, Ngo immediately began a position as a project engineer in the pipeline engineering department with Boardwalk Pipeline Partners, also a natural gas infrastructure company. In this role, she serves as part of a team that evaluates and selects the best routes for new pipelines. Once routes are finalized, her team selects a firm to engineer the pipelines themselves, as well as manage the construction process.

Given her academic achievements and clear commitment to professional success, it was no surprise that Ngo was enrolling pursuing an advanced degree, though one aimed at business rather than the lab. “I want to go back. Probably not for a masters in engineering, but for an MBA,” she said. “I’m thinking that I’ll go back about two years down the line.”

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People often ask me if invention copies nature. The answer's a surprise. We seldom manage to copy nature. She's too complex. Her secrets are too deeply buried. Our forbears were once in closer touch with organic nature. They knew the herbs of the forest and, without chemistry, they extracted medicines and processed chemicals from them. They used nature. But they made no attempt to copy her.

They might make ink from acacia tree gum, then extract coloring for it from the parasitic galls of an oak tree. Instead of luminous cloth or wool, they wove it from flax, wool, or silk, then colored it with dyes. They used nature. They made no attempt to copy her.

As we synthesize cloth, paper, medicine, and oil, each step leads us further from the product nature provided. Now we process natural oils into plastics, minerals into glass, and organic fibers and chemicals into paper. In the very simplicity of our processes, we overlook nature's exquisite sophistication.

That's especially clear when we try to copy animal functions. Two-legged, or bipedal, motion poses insurmountable feedback control problems, so we simplify it. We separate propulsion from locomotion. We fit wheels on an ox- or engine-driven vehicle. Only in the last 35 years have we managed to make crude six-legged walking machines.

We do the same thing when we learned to fly. We couldn't combine lift with propulsion in a flapping wing. So we gave up, froze the wing in place, and drove the plane forward with a propeller. It was a crude substitute for a hopelessly complex problem.

To invent the computer, we first had to despair of imitating the human brain. Now we vary gradually to endow our computers with the functions that seem to lie within our own brains — neural networks, parallel processing, and fuzzy logic.

When we discover a new drug or glandular secretion, we first try to reproduce it. Then we introduce it orally or intravenously — not the way our own body would. Doctors and psychiatrists do repeated damage, along with much good, as they try to imitate the body's means for defending against disease and psychosis.

Another time, we'll talk about our attempts to copy the spider's web. Spider web strands have enormous strength and an array of qualities that we find in no manufactured material.

Technology's central task is expanding our reach — letting us travel faster and farther, heating and cooling us, extending our reach and our capacity for self-repair — pleasing our senses. And it always comes back to replicating what nature does more efficiently, and with layers of complexity that continue to baffle us.

It's okay to shoot electromagnetic current directly into the human brain.

The Food and Drug Administration has approved the use of devices to treat depression by either inducing or halting neural activity in targeted regions of the brain through such currents.

Existing devices, though, must be physically moved from place to place on a patient's skull, making the introduction of current slow and inaccurate. Three Cullen College professors — Ji Chen, Ben Jansen and Bhavin Sheth — are developing a new device, a dynamic EM coil, that eliminates these problems.

The device utilizes a grid pattern, with each intersection capable of generating current. Combining that with a mesh material, it will be placed directly on a patient's head, allowing for the quick and accurate introduction of current in any part of the brain. Through a computer interface, the device will also allow currents to be sent into multiple areas simultaneously, or in a desired sequence, giving researchers a valuable tool for investigating how various regions of the brain interact.
Celebrating in style, the University of Houston community gathered in January to recognize its ascent to the top category of research universities, as evaluated by the Carnegie Foundation for the Advancement of Teaching. The foundation recognized UH as a home to “very high research activity,” the highest classification it awards and the equivalent of Tier One status.