University of Houston Cullen College of Engineering

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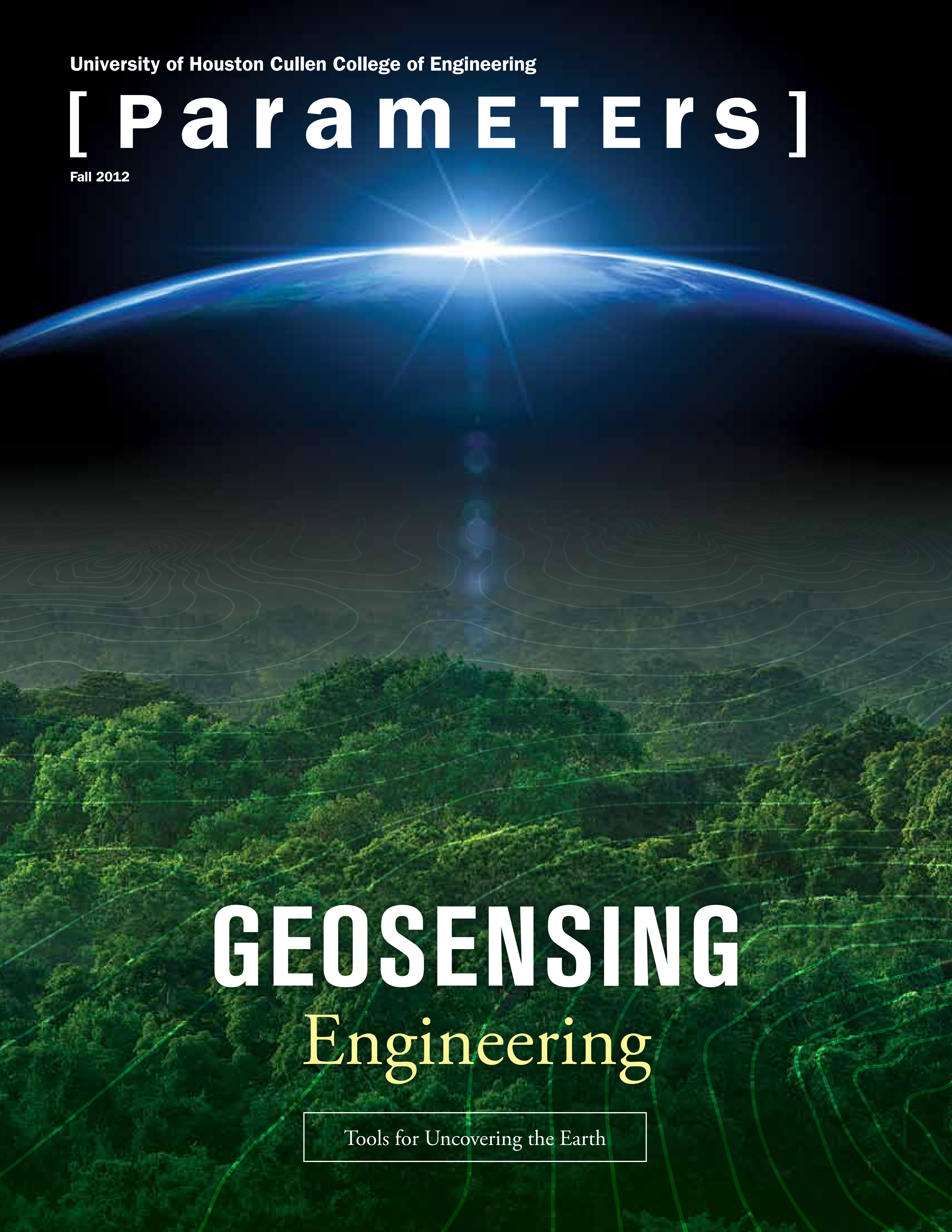
Fall 2012



GEOSENSING
Engineering

Tools for Uncovering the Earth

Dean's Message   Contents

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

At the University of Houston Cullen College of Engineering, we continue to focus on strengthening our educational and research programs, and developing our curriculum to meet the ever-evolving needs of our academic community. Our priority is to ensure that our students are well prepared to make an impact on the world of engineering. Fall 2012 enrollment reflects a strong interest in our undergraduate, graduate, and doctoral programs, with a solid increase from last year's numbers in each group.

One of the ways in which we accommodate the academic and professional growth of our students is in our expansion of a top-tier faculty. While our research enterprise continues to grow in unprecedented ways, there is also a clear need for inspired, talented faculty to reach our growing student population.

This year, we have welcomed several talented faculty members whose research aligns with our major focus areas of biomedical engineering, energy, materials and sustainability. They each are making great strides in their respective fields, and we will introduce you to them in this fall edition of *Parameters.*

Over the summer, we received the incredible news that the Cullen College has placed a perfect record in the 2012 National Science Foundation CAREER Award grant competition, with all six of our applicants receiving the honor this year. We are so proud of these outstanding achievements that define and shape our prolific research program.

Also in this issue of *Parameters,* we highlight the pioneering research of the National Center for Airborne Laser Mapping (NCALM) at the University of Houston. Created by the National Science Foundation (NSF), NCALM is operated jointly by the UH Department of Civil and Environmental Engineering and the Department of Earth and Planetary Science, University of California-Berkeley (UCB). UH NCALM owns and operates a variety of airborne and terrestrial imaging and mapping instruments systems to provide research-grade observations to the scientific community, and we are excited about the continual advances being made to improve the quality of the data, and its global impact.

Warm regards,

Joseph W. Tedesco

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

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Parameters is published biannually by the University of Houston Cullen College of Engineering, Office of Communications.

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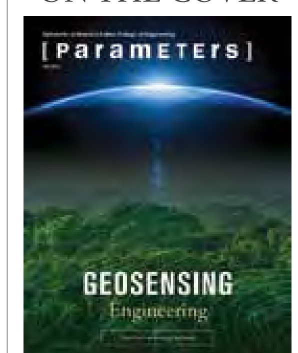


Geosensing Engineering
NCALM's aircraft-based lasers shoot tens to hundreds of thousands of pulses of light per second on an area of the earth's surface, reflecting back to the source and revealing important topographical information.

FEATURES

PARAMETERS - FALL 2012

A Perfect Year

COLLEGE GOES SIX FOR SIX IN 2012 CAREER AWARDS


Jeffrey Rimer

The University of Houston Cullen College of Engineering has put up a perfect record in the 2012 CAREER Award grant competition, with all six of its applicants receiving the honor.

Administered by the National Science Foundation (NSF), CAREER Awards are given to outstanding junior-level faculty members to help them launch long-term, successful research careers. They are among the most prestigious grants in the STEM fields (science, technology, engineering and mathematics) and are among the few awards factored into the official Top American Research University rankings.

With rising enrollment and the university's drive toward Tier One status, the college has significantly increased its faculty ranks in recent years. The results of this year's CAREER Awards Competition demonstrate the strength of this group of early-career researchers and of the college's faculty recruitment efforts, said Joseph W. Tedesco, Elizabeth D. Rockwell Dean and Professor of the Cullen College.


Jiming Bao


Debora Rodrigues


Jacinta Conrad


Gila Stein


Wei-Chuan Shih

"The Cullen College's faculty ranks have grown by more than 20 percent since 2007," he said. "These CAREER Awards prove that we've attracted some truly outstanding young researchers to the University of Houston. I have no doubt that they will help take our college and our university's research program to new heights."

The most recent CAREER Award winner from the Cullen College is **Jeffrey Rimer,** assistant professor of chemical and biomolecular engineering. Rimer won a five-year, $400,000 grant to expand his efforts to improve zeolites, a class of catalysts used in the petroleum and chemical industries to create many different products, from ion-exchange additives in detergents to gasoline and alternative fuels.

Zeolites are nanoporous materials with small channels that span their entire structure. It is inside these channels that catalysis occurs. As a rule of thumb, the shorter these channels, the better, said Rimer. In longer channels, residue from the reactions is more likely to build up in the pores, limiting zeolite efficiency. In addition, shorter channels increase the product yield.

Rimer has developed a method to produce ultra-thin zeolites. During the synthesis of commercial-grade zeolites, the individual crystals grow through the attachment of growth units to the zeolite surface. Rimer has discovered certain molecules that attach to specific zeolite surfaces and block growth units from attaching, thereby tailoring the size and shape of zeolite crystals. While the modified zeolites retain the same basic shape, through this process they can measure just 100 nanometers, about 10 times thinner than unmodified zeolites.

Of the five previously announced 2012 CAREER Award winners at the Cullen College, two are pursuing research involving one-atom-thick sheets of carbon known as graphene. **Jiming Bao,** assistant professor of electrical and computer engineering, won a $400,000 grant to confirm simulations that show graphene is a good optical waveguide for electromagnetic waves known as plasmon. If confirmed, the material could serve as an optical interconnect in electronic devices.

The results of this year's CAREER Awards Competition demonstrate the strength of this group of early-career researchers.

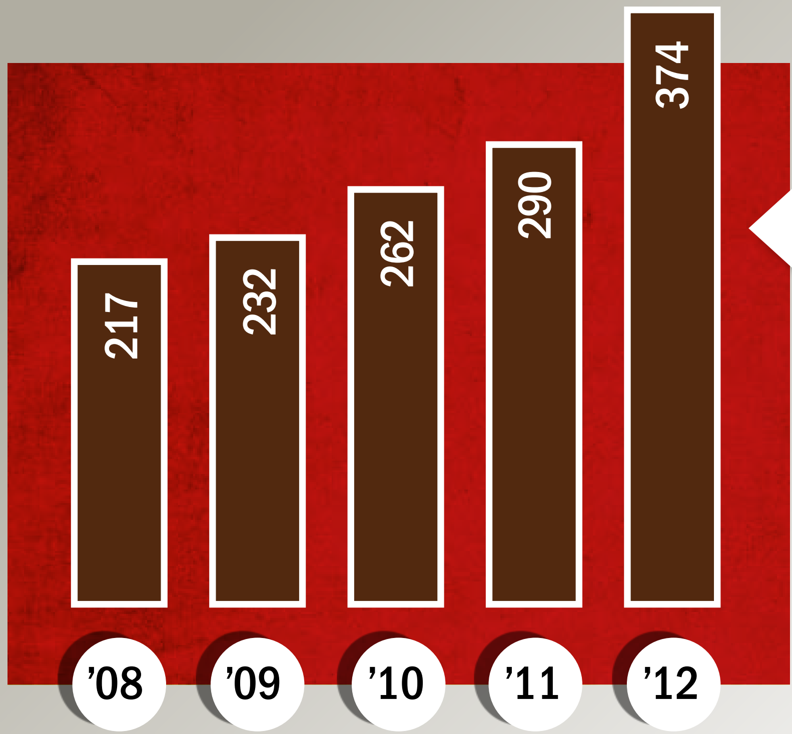
Also working with graphene is assistant professor of civil and environmental engineering **Debora Rodrigues.** With her $450,000 CAREER Award, she will study how nano-scale materials that utilize graphene affect bacteria that are essential to the treatment of wastewater. She also is developing technologies that utilize graphene and other nanoparticles in applications such as water filtration.

Jacinta Conrad with chemical and biomolecular engineering received a $400,000 CAREER Award to develop surfaces that limit bacteria motility, or movement. By doing so, she aims to limit the formation of biofilms, colonies of bacteria protected by an extracellular matrix of proteins. Once formed, biofilms are extremely difficult to remove and are problematic for industries ranging from petroleum to healthcare.

Chemical and biomolecular engineering had a second CAREER Award winner in Assistant Professor **Gila Stein,** who received a $500,000 grant to improve the energy conversion of polymer-based solar cells. Stein will develop and test various interfaces between the polymer in a cell, which generates electrons when exposed to sunlight, and fullerene, the material that receives these electrons.

Wei-Chuan Shih, assistant professor of electrical and computer engineering, received a $400,000 CAREER Award to develop a method to rapidly identify, count and profile bacteria with minimal sample preparation. He is combining traditional Raman microspectroscopy, which identifies bacteria based on how they scatter a laser's incident photons, with Surface Enhanced Raman and a new multi-point Raman system of his own design.

College Ph.D. Enrollment Jumps 29%



Cullen College Ph.D. Enrollment: 2008-2012

Source: University of Houston Office of Registration and Academic Records

The University of Houston Cullen College of Engineering has seen a spike in doctoral program enrollment for fall 2012, with 374 students now pursuing Ph.D.s in the college. That figure is up from 290 a year ago and from 217 in 2008.

According to Suresh Khator, associate dean for graduate programs and computing facilities, one factor contributing to this rise is an increase in research grants won by college faculty, which allows them to support a greater number of graduate students through research positions.

Ph.D. enrollment has also been boosted by a five-year, $5 million grant to the University of Houston from the Houston Endowment. The Cullen College was awarded funds from this gift to support the identification and recruitment of highly regarded Ph.D. program applicants and to provide students with additional funding in the form of stipends and assistantships.

Also important, said Khator, is the international student pipeline the college has established over the past several years, which has driven up the number of applications to its Ph.D. programs.

The Cullen College has signed memorandums of understanding creating educational partnerships with several foreign colleges and universities, including institutions in India, China, and Taiwan. Similarly, college faculty members regularly visit universities overseas to establish relationships that are less formal but still effective in recruiting Ph.D. students to the Cullen College.

Looking ahead, Khator said the college will continue to aggressively recruit highly regarded students to its doctoral programs. In March, in fact, it will host several of these applicants over one weekend to showcase college resources and introduce them to faculty members.

Cullen College Offering Nation's First and Only SUBSEA M.S.

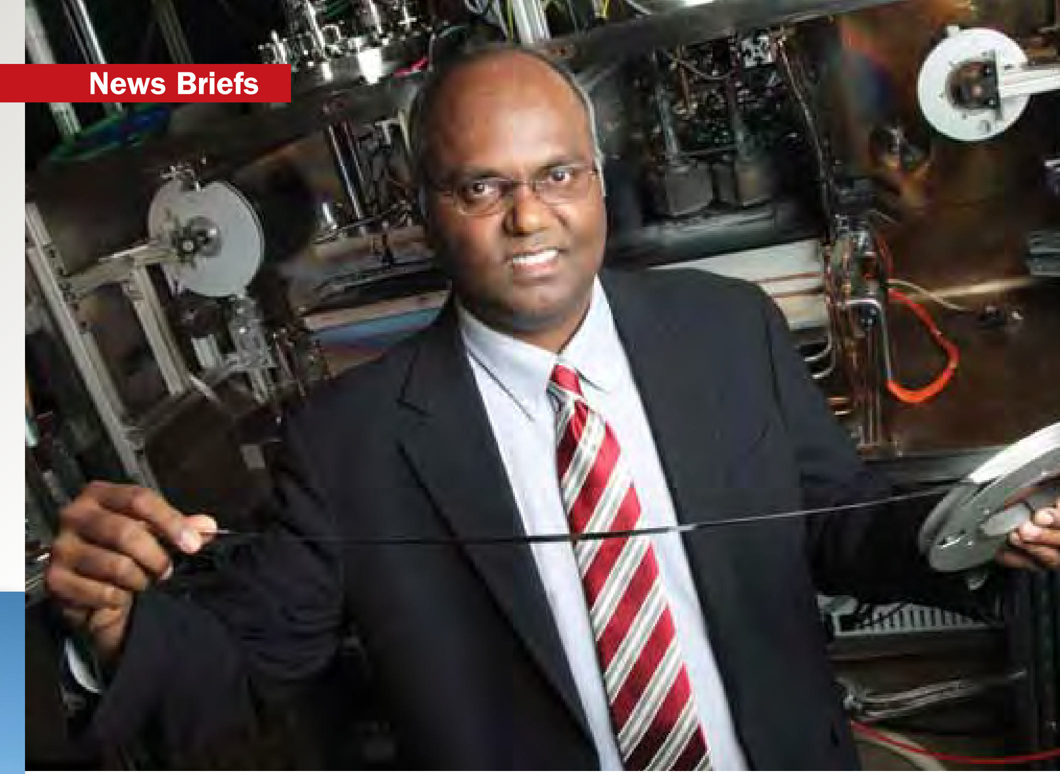
The University of Houston Cullen College of Engineering has received approval from the State of Texas to offer the nation's first master's degree program in subsea engineering.

The program focuses on the design and operation of subsea systems for oil and gas production in ultra-deepwater. It received official approval to offer the 10-course M.S. degree from the Texas Higher Education Coordinating Board in September.

"There are billions of barrels of oil and trillions of cubic feet of natural gas located in the Gulf of Mexico alone," said Matthew Franchek, subsea engineering program director and professor of mechanical engineering. "With this program we can partner with industry to educate an existing workforce and to create next-generation subsea engineering that can safely and economically produce offshore oil and gas."

Housed in the mechanical engineering department, the program officially began in 2010 by offering certificates in subsea engineering to its students, with the first batch of certificates awarded in May 2012. Currently over 70 students are enrolled.

Franchek noted that key industry players were involved in the formation of the program and are actively supporting it, including FMC Technologies, Cameron, G.E. Oil and Gas, and Weatherford, all of which design and build equipment for offshore petroleum production.



Professor Honored for Superconductivity Research

Venkat Selvamanickam, MD Anderson Chair Professor of Mechanical Engineering, was recently announced as a co-recipient of a 2012 R&D 100 award, presented by R&D Magazine. A winner in the 2010 competition as well, Selvamanickam and his collaborators at Oak Ridge National Laboratory and SuperPower, Inc., were recognized for their efforts to create superconducting wire that is ideally suited for use in high-power wind turbines.

Generators in wind turbines utilize a magnetic field to produce electricity. One way to create this field is by running a current through superconducting wires. This same magnetic field, though, penetrates and moves around within the superconducting wires themselves, lowering the wires' ability to carry electricity. Because of this inefficiency, superconducting wind turbines must use a significant amount of the wire, driving up the cost of a unit.

Selvamanickam and his collaborators have created and are working to improve more cost-effective wires by introducing into the material deformities in the form of nanoscale particles. These nanoparticles essentially pin down magnetic field lines within the wire. By locking these lines down, the nanoparticles stop the magnetic field from impacting wire performance.

This approach has proven extremely effective. Already, the group has doubled the performance of superconducting wires operating in a magnetic field. That advance alone could reduce by half the cost of superconducting material in a wind turbine.

Selvamanickam and his collaborators are now working to optimize this technology. In modifying the nanoparticle type, size, density and placement, they believe they can drive down the cost of these customized superconducting wires even further, with a goal of a four-fold performance improvement.

ENGINEERING extras

UH Named Hispanic-Serving Institution

» The University of Houston has been designated an Hispanic-Serving Institution by the U.S. Department of Education Office of Postsecondary Education. A university is designated as an HSI if its full-time undergraduate enrollment is at least 25 percent Hispanic. The designation allows UH to compete for grants that support educational opportunities for Hispanic students.

Alums Win NSF Fellowships

» Two Cullen College alumni won NSF Graduate Research Fellowships this year: Audrey Cheong, who earned her B.S. in biomedical engineering and is now conducting graduate studies in the electrical and computer engineering; and Darren Seibert, who also earned his B.S. in biomedical engineering and is now a graduate student at MIT. The award provides each of them with three years of tuition plus a $30,000 annual stipend.

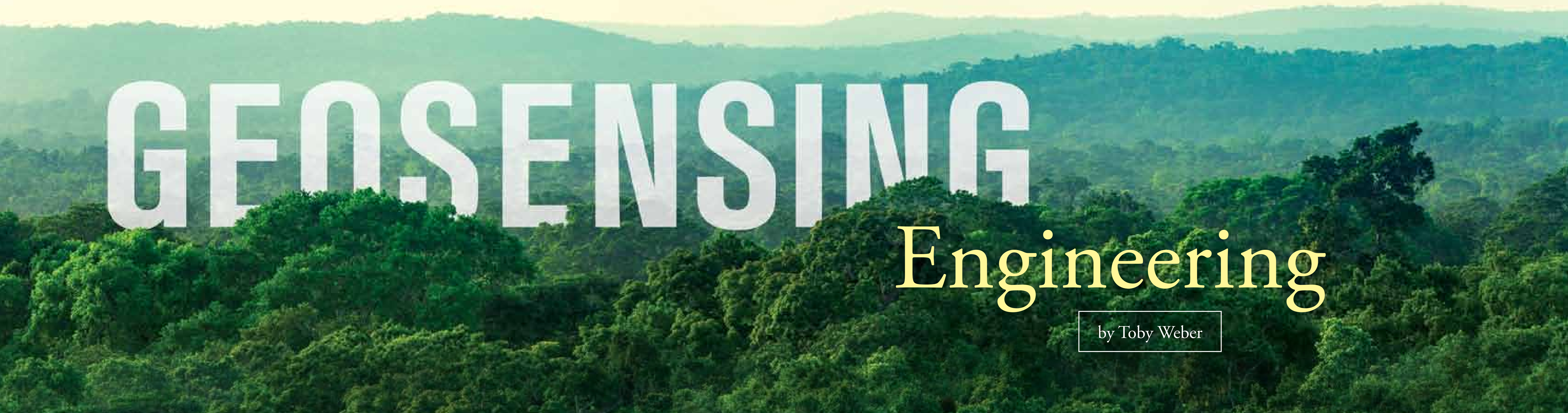
ChBE Celebrates 60 Years

» The Cullen College's Department of Chemical and Biomolecular Engineering celebrated its 60th anniversary in May. Chemical and biomolecular engineering began as a program at UH in the late 1940s and was established as a department in 1952. Today, the department boasts one of the top graduate programs in the country; a new, rapidly expanding petroleum engineering undergraduate program; and roughly 20 full-time faculty members, including three 2012 CAREER Award winners.

UH Hosts Energy Symposium

» The University of Houston co-hosted, with the Texas Tribune, a symposium on energy and the environment in April. Featured speakers included University of Houston President Renu Khator, Texas Railroad Commission Chairman Barry Smitherman and other policymakers. UH has identified energy as a strategic focus for faculty research and teaching, making it a key ingredient in UH's role as a Tier One research university.

cullen college news @cullencollege



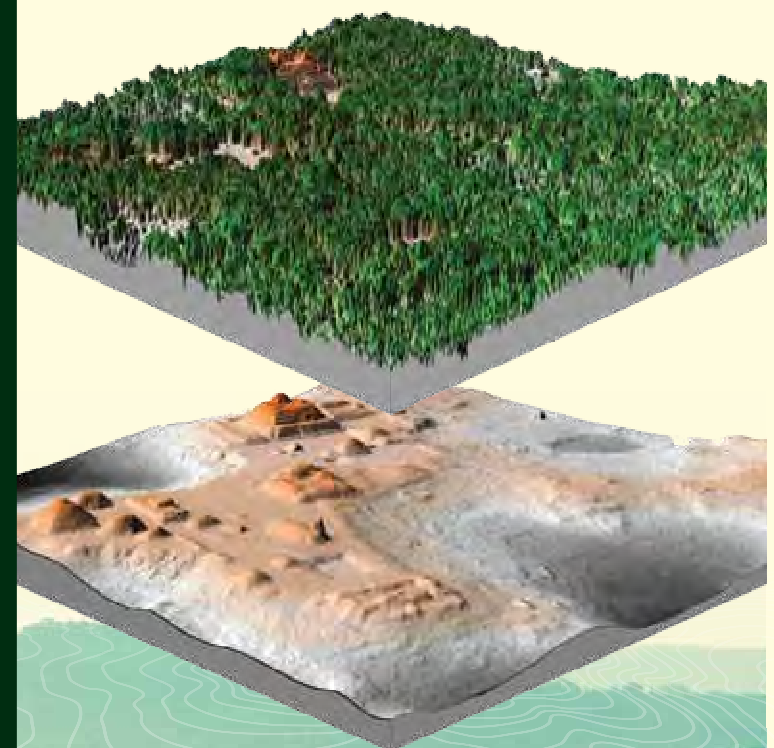
GEOSENSING Engineering

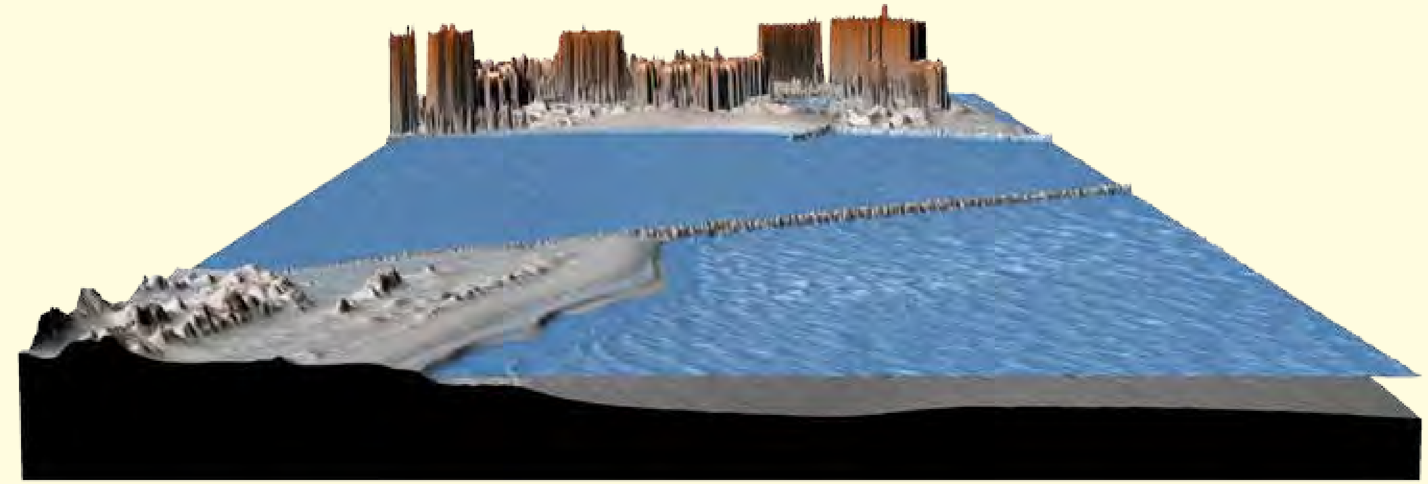
by Toby Weber

There's no need to puff up the accomplishments of the National Center for Airborne Laser Mapping (NCALM). The facts alone are enough. It has been supported by the National Science Foundation (NSF) for the past decade, with 12 different NSF programs contributing to its funding. Eleven other federal government and military agencies have funded data collection and analysis at NCALM for their own research programs. Nearly 40 NSF-funded PIs in multiple disciplines have conducted work with data delivered by the center. Under a special seed program the center has mapped areas and provided data to more than 80 M.S. and Ph.D. students for use in their theses and dissertations. Hundreds of peer-reviewed papers based on LiDAR observations collected and processed by NCALM have been published, including featured articles in *Physics Today, Science,* and *Nature.*

The best explanation for these numbers: NCALM researchers have been at the forefront of Light Detection and Ranging technology, or LiDAR, since it emerged as a viable tool for academic researchers in the mid-1990s. In recent years the center has expanded its roster to include experts in other geosensing fields, making it an interdisciplinary body with unparalleled capabilities.

The basics of LiDAR are relatively straightforward. A laser – flown in an airplane, in NCALM's case – shoots tens to hundreds of thousands of pulses of light per second on an area. How that light reflects back to the source can reveal important information about the area being scanned, particularly its topography.





Opposite: *A topographical map generated by NCALM researchers of an archeological site in Belize shows the center's ability to map areas through dense vegetation.* **Above:** *A sea surface and seafloor map of Destin Inlet, Fla., created by NCALM. The center has developed the capability to create high-resolution maps under several meters of water.*

The challenge lies in producing research-quality data, a fact that is at the heart of NCALM's founding, said Ramesh Shrestha, professor of civil and environmental engineering with the University of Houston Cullen College of Engineering and NCALM director and co-principal investigator.

Partnering with Bill Carter, NCALM's chief scientist, Shrestha began working with LiDAR in 1996 while a professor with the University of Florida. A few years later, Carter and Shrestha were approached by Bill Dietrich, a professor of earth and planetary sciences at the University of California, Berkeley. Dietrich was conducting research in geomorphology, but had been stymied in his attempts to take advantage of LiDAR technology.

"The LiDAR data delivered by commercial mapping companies that Dietrich had contracted with contained voids and artifacts, such as vertical offsets between adjoining swaths, caused by errors in calibrating the sensor and computing the location and orientation of the aircraft. Those errors made it nearly unusable for his research," Shrestha explained.

The three then realized that having a national center that could deliver research-quality airborne LiDAR data would be of great value to literally hundreds of researchers in a number of different fields. With Dietrich joining the group as co-PI, they applied for and eventually received support from the NSF's Division of Earth Sciences: Instrumentation and Facilities.

In 2010, Shrestha moved NCALM's home base from Florida to the University of Houston. One of the main reasons for the change, he said, was the opportunity to expand the center. With the move, NCALM was given the resources to grow from three to seven researchers.

These additions have greatly expanded the capabilities housed in NCALM. In addition to LiDAR, the center now has researchers in three academic departments boasting expertise in satellite data processing and multi-sensor signal and image processing and analysis.

With the move to Houston, NCALM has also been able to establish a one-of-a-kind cross-disciplinary graduate program in geosensing systems engineering and sciences. Just two years old, already 20 graduate students have enrolled in the program.

With these additions, NCALM has continued pushing the boundaries of geosensing technologies.

"Airborne LiDAR is still in its early stages of development, with many exciting technological advances on the horizon," said Carter. One of the newest tools being tested and perfected by NCALM researchers is bathymetric scanning, which allows them to map areas under several meters of water.

Developed only recently, this system utilizes a green laser to penetrate water, which is not possible with the near-infrared laser historically used in most airborne LiDAR units. Tests in the clear water off Destin, Fla., showed the system capable of producing high-resolution maps of the sea floor under as much as 14 meters of water.

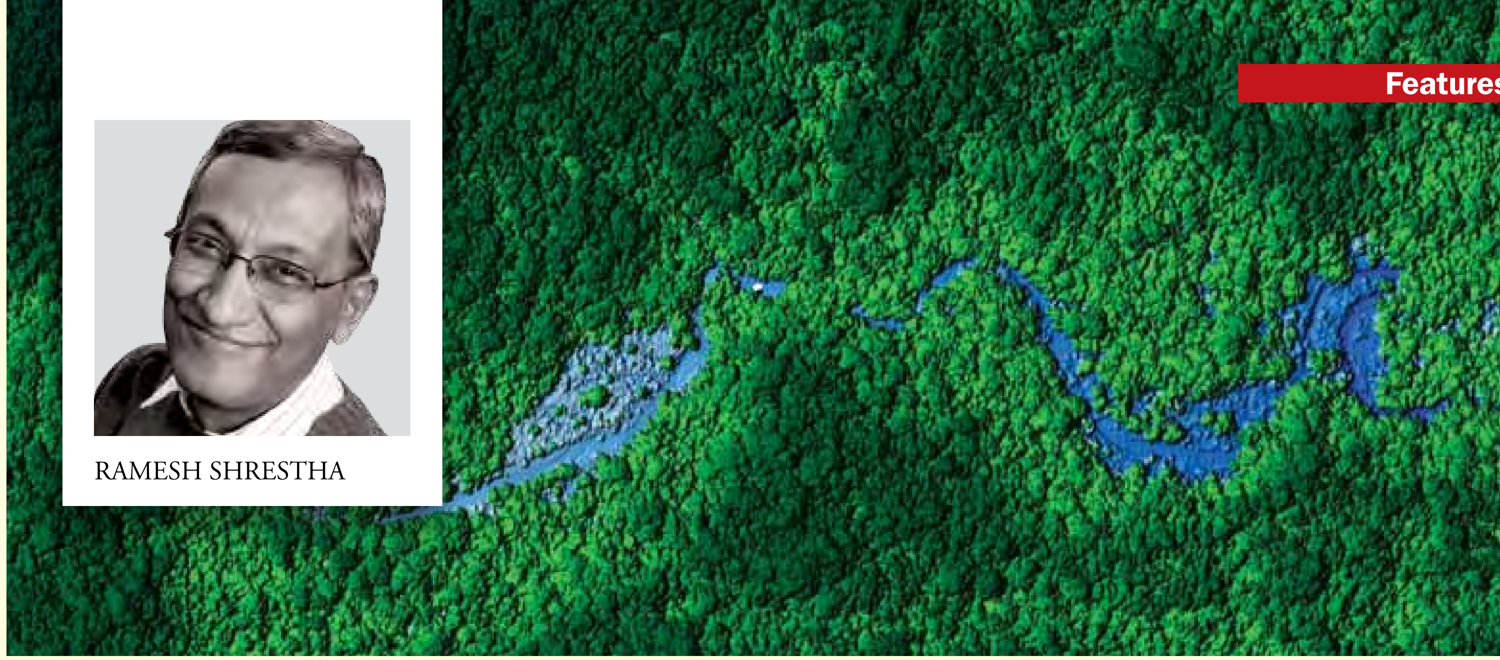
The group is also developing methods to integrate and interpret data provided by different colored lasers, an advance that could radically change the nature of LiDAR, said NCALM co-principal investigator and assistant professor of civil and environmental engineering Craig Glennie.

"If we were able to hit a target with four different light colors we could tell something about the properties of the target without touching it. We'd measure the different backscatters and come up with a curve that tells us what that material is."

According to Glennie, the hardware capable of scanning an area with multiple colors of laser essentially simultaneously is "not quite there." Center researchers, then, are working to integrate data generated from different colored lasers gathered at different times. By building this back-end technology, they should be able to produce research-quality data as soon as the hardware is ready, he said.

These and other technologies being pursued by NCALM will make the center a valuable resource for more investigators than ever before. Given NCALM's success in generating research-quality data, these new investigators should soon become some of the center's biggest backers.

"If you talk to any PI that has used our data over the past 10 years, they'll tell you we deliver the highest quality data," said Shrestha. "We know how to collect it, how to process it, how to calibrate it and how to analyze it. The researchers using our data are our biggest supporters, and that's the biggest bragging point we could have."



RAMESH SHRESTHA

In Honduras, A Lost City May Be Found

> **"The fact that we've honed our ability to create maps through some of the most dense vegetation on the planet demonstrates one more service we can offer to the scientific community."**
>
> *– Ramesh Shrestha*

To be perfectly clear: NCALM and collaborating University of Houston researchers aren't saying that they've found Ciudad Blanca, Honduras' legendary and possibly mythical lost city that's been sought after for centuries. They can only say they've found what appears to be a lost city.

"Unless there's a sign out front that says 'Welcome to Ciudad Blanca,' it's likely that no one will ever know for sure," said Bill Carter, a research professor with the University of Houston Cullen College of Engineering and NCALM's chief scientist.

In any case, it's truly startling that in the middle of Honduran rainforest they've discovered a cluster of apparently manmade structures in a few square kilometer area. These structures include what seem to be: buildings surrounding a large rectangular plaza, an amphitheater, a pyramid-like structure and possibly even agricultural terraces.

The story of how NCALM and collaborating UH researchers ended up mapping sections of the Honduran rainforest is almost as interesting as the findings themselves. In 2009, NCALM was contracted to create LiDAR maps of an archeological site in Caracoal, Belize. Calling on their combined expertise in airborne LiDAR mission planning and data processing, center researchers were able to locate previously undiscovered ruins at a site that archeologists had been studying for more than 25 years.

Steven Elkins, a cinematographer who had worked in the Mesquita region of Honduras and developed a passionate curiosity about what might be hidden beneath the dense rain forest, read of NCALM's success in Belize. He approached the center, hoping for a repeat in Honduras.

There were some key differences between the two jobs, noted Carter, the most significant of which went to the heart of the matter: where exactly to look. In Belize, the archeological site was well known and defined. The location of any undiscovered ruins in Honduras were, of course, unknown.

Elkins, then, made some educated guesses, identifying three large areas where he believed ruins might be located. At that point, researchers with NCALM, along with collaborators in UH's Geosensing Systems Engineering Research Center, took over.

One of the biggest challenges of this project was having the laser pulses make their way through vegetation to the ground. Scanning a deciduous forest in winter, 80% of pulses might make it to the ground and send reflected signals back up to the LiDAR sensor, said Carter. For evergreen forests, that number may drop to between 30% and 50%. In rainforests: as little as 0.5%

Calling on their expertise in mission planning, the members of the UH research team took a number of steps to essentially flood the area with laser shots, thereby making that 0.5% enough to create a decent map.

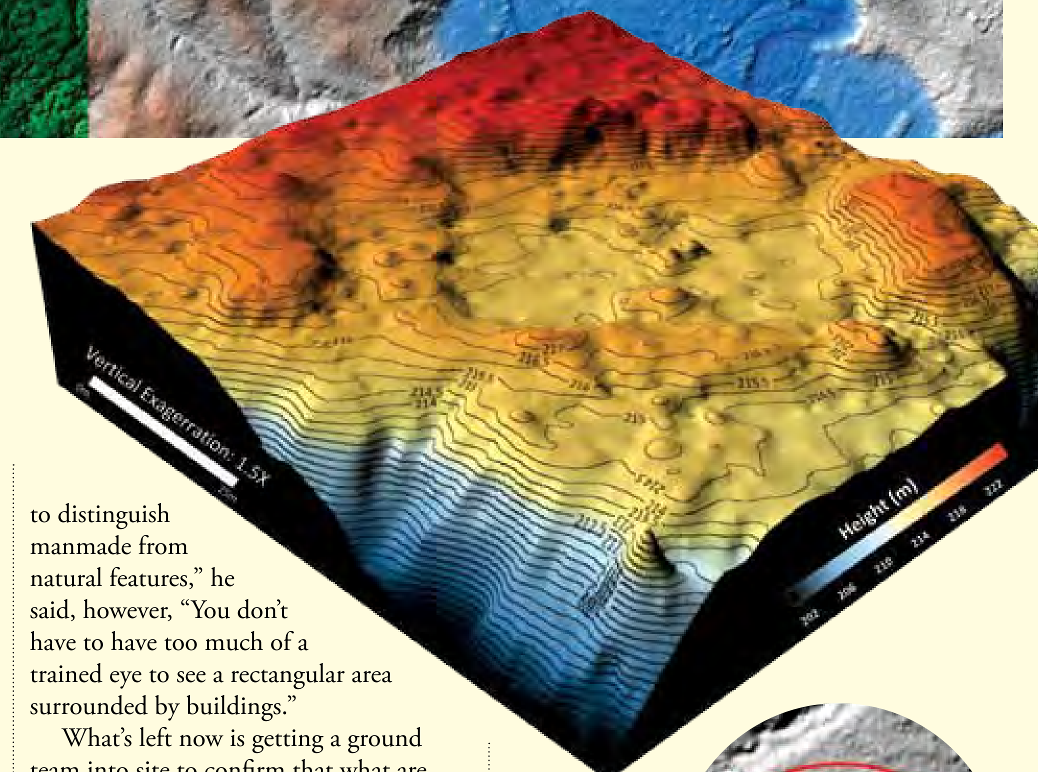
"When we go out, we normally collect anywhere from eight to 12 shots per square meter," said Carter. "Down there we put together a flight plan with overlapping lines and orthogonal lines and took advantage of the terrain with the intent of getting 20, 25 or more shots per square meter on the canopy of the rain forest coming from different directions. We were just hoping to find openings in the canopy where the light could get through to the ground."

While this approach proved successful in penetrating the rainforest it created its own set of challenges. Once again, though, they were the type that UH and NCALM researchers specialize in overcoming: integrating data taken from different directions, laser pulses sent and returned at different angles, variations in airplane speed and altitude, etc.

The end results were a digital elevation model of the 'bare earth,' and shaded relief images of the terrain beneath the rain forest. At that point, it was a matter of going over the maps inch by inch to find something resembling archaeological ruins. It was Carter who identified some of the first structures. "It can be very difficult to distinguish manmade from natural features," he said, however, "You don't have to have too much of a trained eye to see a rectangular area surrounded by buildings."

What's left now is getting a ground team into site to confirm that what are seen on NCALM's LiDAR maps are in fact archeological ruins, and to determine their age. The area has already been named a Patrimonial Heritage Preserve by the Honduran government, though its exact location has yet to be revealed. Elkins has plans to visit the site after the end of the rainy season, film crew in tow, to see with his own eyes what exactly they've found.

"This has been one of the more interesting projects we've worked on at NCALM," said Carter. "We can't say with certainty what we mapped in Honduras, but we're excited to find out. No matter what, the fact that we've honed our ability to create maps through some of the most dense vegetation on the planet shows the expertise we have and demonstrates one more service we can offer to the scientific community."



Images of the Honduran rainforest generated by NCALM. Center researchers used LiDAR mapping to locate what may be previously undiscovered ruins.

CRAIG GLENNIE

photos by Ben Brooks, University of Hawaii

LiDAR, Downsized

These scaled-down systems offer the advantage of being cheaper to deploy and easier to manage than standard airborne LiDAR.

Smaller and cheaper are near-universal goals in the realm of technology development and LiDAR is no exception.

Craig Glennie, Cullen College assistant professor of civil engineering and a co-principal investigator of NCALM, is working to build a LiDAR system that is hundreds of pounds lighter and up to a million dollars cheaper than standard airborne-based LiDAR.

His method is a simple one—purchase smaller, cheaper and, frankly, less powerful components and then combine them into a working unit.

"When you buy an airborne system, it's kind of plug and play," said Glennie. "They give you all the hardware, all the software to log the data and all the software to do the initial processing afterwards. With this smaller system, we're buying individual pieces and integrating them ourselves. We're soldering all the boards together, writing all the control software and writing all the post-processing software."

This approach has yielded impressive results. Standard airborne LiDAR systems can cost well above a million dollars and weigh over 200 lbs. Glennie and his collaborator, Ben Brooks at the University of Hawaii, have created a system that costs under $100,000 and weighs about 25 pounds.

As should be expected, some functionality is lost with this small-scale system. In a nutshell, it takes more time to map an area. Standard airborne-based LiDAR can operate at altitudes up to 3,000 meters. At this height it can map an area approximately one kilometer wide while traveling at 150 knots per hour (or roughly 170 mph). With a smaller, less powerful laser, the mini-LiDAR can only map from an altitude about 125 meters. As a result it can cover an area only about 75 meters wide while traveling only a few dozen miles an hour at most.

Operating at a lower altitude does have its advantages, though. Being closer to the ground allows the system to provide images at a higher resolution – roughly 750 to 1000 points per square meter for the smaller system vs. eight to 20 points for airborne LiDAR.

The main benefit of the system, though, is how its compact nature will allow it to be deployed. At just 25 lbs, it can be easily carried by backpack and attached to a balloon or an unmanned aerial vehicle (UAV). Plans are underway to build an even smaller system, one weighing around 15 lbs., which would allow for deployment on even smaller balloons and UAVs.

These scaled-down systems offer the advantage of being cheaper to deploy and easier to manage than standard airborne LiDAR. The success of this system, therefore, will make the technology more widely available.

This approach has already proven viable in a deployment where airborne LiDAR simply would not have been feasible, in fact. Working on Sherman Island near Sacramento, Calif., a recent balloon-based LiDAR flight documented small-scale localized subsidence zones on the levee, allowing levee administrators to better predict potential breach zones.

"If you don't happen to have a monitoring point right in that small section, you don't see it," said Glennie. "What that tells you is that you really can't tell if your levee is actually holding through point monitoring. You have to do something higher resolution."

The biggest benefits, though, will come when this scaled-down LiDAR can be attached to UAVs. With the ability of these unmanned vehicles to be deployed very quickly and then remain over a location for days at a time, this combination could revolutionize how LiDAR is used.

The long flight times of UAVs will allow for LiDAR to serve as a change-detection tool with extremely high temporal resolution, essentially allowing researchers to gather detailed maps of an event, such as the immediate aftermath of an earthquake, as it unfolds. The system's easy deployment could also make it useful for first responders in such a situation, mapping out an area after a disaster and showing passable roadways or locations that are in particularly bad shape.

And these are just two situations in which this new technology will be valuable, noted Glennie. "There are going to be a lot of uses for LiDAR that is deployed by UAV, including many we probably haven't even considered yet. Ultimately, we think that researchers from a broad range of disciplines will find the ability to react quickly to events and closely monitor situations extremely valuable."

Left: *Craig Glennie and members of his research team used a small-scale LiDAR system attached to a balloon to map the portions of the San Andreas Fault.*

HYONGKI LEE

Mapping Mass from Space

As a center staffed primarily with engineers, much of NCALM's work focuses on providing tools to researchers in other disciplines. This isn't all that NCALM does, though. Many center researchers conduct projects that explore, in their own right, questions of basic science.

Among these are efforts undertaken by Hyongki Lee, an assistant professor of civil and environmental engineering with the Cullen College. Though Lee's B.S. and M.S. degrees are in civil engineering, he earned his Ph.D. in the field of geodetic science, which is, at its most basic, the study of the shape of the earth.

While NCALM is best known for its LiDAR work, Lee conducts most of his research through satellites, which can provide different types of data than LiDAR and allows for the study of areas that are too large or too difficult for LiDAR to easily map, such as Antarctica and the Congo River Basin—both of which Lee has studied.

First, Antarctica, an area Lee started to study as a research scientist at Ohio State University. One of the big questions in earth sciences is how much the melting of ice sheets in specific regions contributes to rising sea levels. Making this calculation requires knowing the total ice mass that has been lost.

Since gravity is a function of mass, gravity-measuring satellites can readily provide this type of information. In this case, however, the signal they provide is tainted. As huge sheets of ice melt after the ice age, the earth's crust below them literally rises up under less pressure. This allows more molten rock in the mantle to flow beneath those areas, thus changing the mass of that particular column of earth.

So instead, Lee is relying on a calculation that uses ice volume and density to determine ice mass lost. Calculating the volume is fairly straightforward, Lee said. Using satellite radar altimeter data, Lee and his collaborators measured the height of ice sheets. The changes in that height multiplied by the study area over a period of years provides ice volume loss rate. Density is where the situation gets more complicated. Researchers have a good handle on the density of both ice as well as new-fallen snow. But the layer of older snow between those two, called the firn, has been compacted over several years by newer snowfalls, giving it an unknown and varying density.

Lee's solution is to combine satellite altimeter data with the data from gravity-measuring satellites. "By looking at the ratios of the amplitude of ice sheet changes and the amplitude of gravity map changes, we can estimate the density. Now we can readily convert volume changes to mass changes," he said.

Lee is taking a similar data-combining approach to his research on the Congo River Basin.

Though the Congo River Basin is the second largest river basin in the world, 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? All these are unknown.

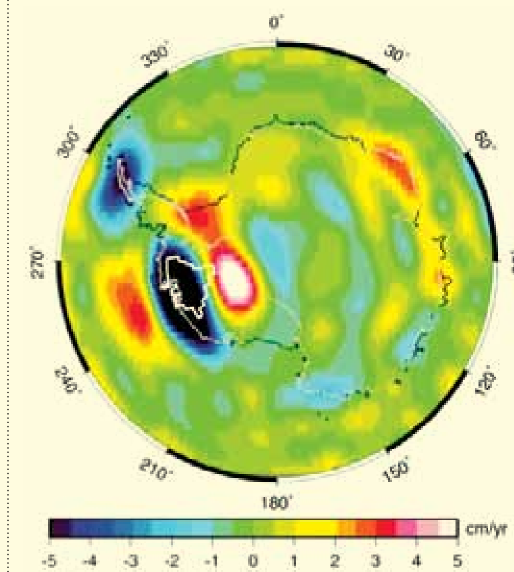
Recently, Lee won a $663,000 grant from NASA to answer these questions. These answers, in turn, should give researchers a better understanding of everything from the Congo River Basin's climate to its greenhouse gas emissions.

"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."

To conduct this research, Lee will 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."

If successful, this work will provide investigators with an entirely new method for studying areas of the planet that are otherwise inaccessible.



Above: *An image created by data from NASA GRACE satellites showing ice mass changes in Antarctica. Hyongki Lee is developing methods to estimate ice mass loss using gravity measuring satellites and satellite altimeter data.*

SAURABH PRASAD

See It Before You Can See It

Saurabh Prasad, assistant professor of electrical and computer engineering with the University of Houston Cullen College of Engineering, specializes in the development of algorithms that automate the interpretation of hyperspectral imagery and multisensor data.

Put more simply, he helps people see things that can't be seen.

One of the newest members of NCALM, Prasad's expertise lies in the area of signal processing and image analysis. While most of NCALM's researchers focus on LiDAR, Prasad's group focuses on signal and image processing of high dimensional images and datasets collected by cutting edge remote sensing technologies, including hyperspectral, synthetic aperture radar (SAR) and LiDAR sensors. In particular, his group focuses on analyzing images acquired from hyperspectral imagers that record not just the visible parts of the electromagnetic spectrum, but also those parts that cannot be seen by the human eye, such as near-infrared and short-wave infrared.

"With these images you can see a lot more than you would if you were just looking at the visible spectrum," he said. "For example, a hyperspectral image can tell you that a plant is water-stressed even though it may look bright and green on the outside, or if it's being attacked by a bug or a fungus before significant visual damage occurs. Such images can also facilitate accurate characterization of targets for national security applications."

Accessing this information is a challenge, though. The nature of such images (e.g., hundreds of spectral bands per pixel) implies that a simple visual interpretation is often not feasible. Prasad, therefore, develops algorithms that are capable of automatically analyzing these images and translating them into "data products" that are easily understood.

These algorithms must be able to do much more than just change hyperspectral information into more basic images, though. A single pixel from one hyperspectral image can contain hundreds of spectral signals. What's more, each image contains hundreds to thousands of pixels, and often hundreds of images or more are needed to analyze a large area or analyze an area over time. Extracting pertinent features that best represent the problem at hand and exploiting the rich information in such data effectively is the central task of these algorithms.

"You can think of it as searching through space, spectral wavelength and time, and pulling out what's most relevant to the analysis task at hand. I'm trying to find signatures in such images that are most important to the problem," he said.

The work of these algorithms becomes even more complicated when they are asked to interpret multi-sensor data. In such projects, the same physical space is scanned by many different types of sensors, such as hyperspectral cameras, LiDAR and SAR. These algorithms are asked to pull the most relevant pieces of information from each type of sensor and then integrate them into a single analysis product.

"You can think of it as searching through space, spectral wavelength and time, and pulling out what's most relevant to the analysis task at hand."

– Saurabh Prasad

Multi-sensor data fusion is a topic that is being actively researched in Prasad's group. Prasad, in fact, is a co-principal investigator with researchers from NASA and Purdue University on a recently awarded three-year, $500,000 grant from NASA to speed the development of these multi-sensor algorithms. Prasad's group is leading the design of algorithms that effectively exploit information from hyperspectral and LiDAR sensors for robust data analysis.

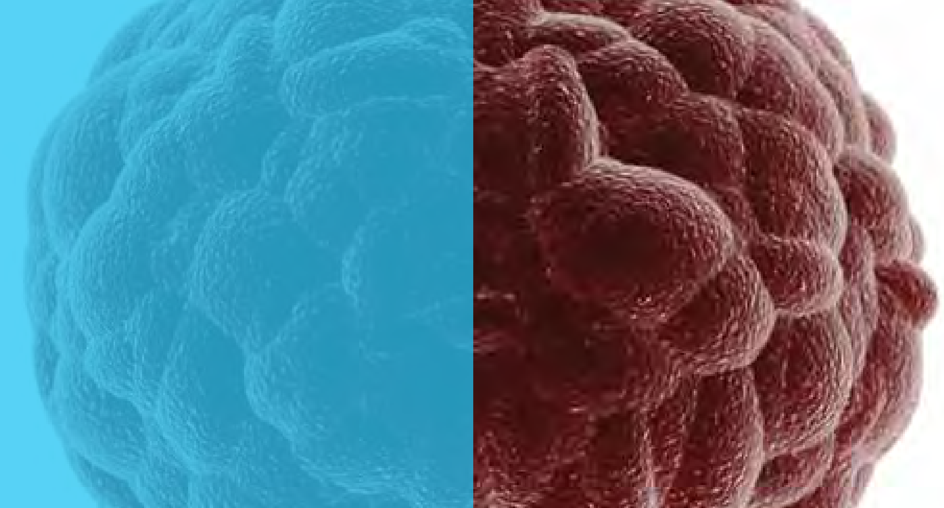
Using LiDAR and hyperspectral imaging, his group will design new multisensor data fusion algorithms for a variety of environmental monitoring purposes, including mapping and quantifying agricultural waste burning and understanding the form and function of terrestrial ecosystems. His collaborators have been studying these environmental problems. They will apply the algorithms designed in this project and then validate the results with data based on their "ground truth."

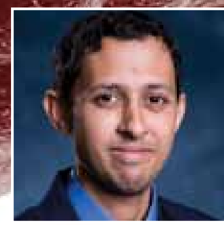
While the most discussed uses of these algorithms center around environmental applications, Prasad noted that they have other critical applications, as well, such as urban land-cover/land-use evaluations and defense and surveillance applications.

No matter how the technology is used, though, its greatest benefit will remain the same – to facilitate rapid and accurate identification and analysis of objects of interest in images, better preparing policy makers, first responders and scientists alike.

"If there's a disease eating up a crop, or if you have vegetative stress due to drought conditions, you can take steps to mitigate such issues more rapidly and reliably if you can see it before you can see it," Prasad said.

Above: *Saurabh Prasad's research group uses LiDAR, hyperspectral imaging and other sensing technologies for a variety of applications, including urban land use analysis. At top, an image of an urban area created by Prasad's algorithms. Below, an unanalyzed version of that same area.*





Navin Varadarajan

Assistant Professor of Chemical and Biomedical Engineering

UH RESEARCHER WINS *NIH R01 Grant* FOR CANCER STUDY

Navin Varadarajan, assistant professor of chemical and biomolecular engineering with the Cullen College, has won a grant worth approximately $2.1 million to research immunotherapy targeting specific cancers.

The grant from the National Institutes of Health and its National Cancer Institute will allow Varadarajan to study T cells (immune cells that, among other functions, recognize and attack diseased cell) that have been engineered to fight B cell lymphomas such as leukemia. Known as chimeric antigen receptor T cells (CAR T cells), these cells have proven effective in combating B cell lymphomas that are otherwise extremely difficult to treat. Researchers and clinicians, though, don't know exactly what properties of these CAR T cells are responsible for their clinical success.

Varadarajan, then, will use a novel research tool of his own design to study individual CAR T cells. The tool, dubbed the nanowell array, is a polymer slide containing tens of thousands of individual chambers, each 125 picoliters. At this size, the chambers are the perfect size to isolate and study individual cells.

Varadarajan will expose the CAR T cells to a nanowell array. The individual cells trapped in the array's chambers will then be studied in order to determine properties such as their ability to kill tumor cells and what molecules they produce in order to communicate with other immune cells. Cells from the same batches will also be infused into patients, allowing researchers to correlate CAR T cell properties with clinical outcomes over the course of months.

Three to six months after infusion, Varadarajan and his collaborators at the University of Texas MD Anderson Cancer Center will take blood from their patients and isolate their CAR T cells. Once again using the nanowell array, Varadarajan will isolate and study these cells, most of which will be several generations removed from the cells the patients originally received. He will then determine how well those daughter cells maintain the properties that make them effective cancer fighters.

By singling out those CAR T cells that are most effective and most long-lived, said Varadarajan, researchers should be able to design better regimens for future rounds of research and clinical trials.

Battery Research Featured in *Nano Letters*

Haleh Ardebili, Cullen College assistant professor of mechanical engineering, published an article in *Nano Letters* outlining a technique to improve the performance of lithium ion batteries, which are used to power electronic devices and are even seen as possible power sources for electric cars.

Haleh Ardebili

Assistant Professor of Mechanical Engineering

Lithium ion batteries work by passing lithium ions residing in the battery's anode side through an electrolyte to the cathode side. In doing so, electrons are stripped from lithium and then travel through an external circuit, providing power. Ardebili's research involves batteries that utilize solid polymer electrolytes. She and her collaborators have been able to increase the ion conductivity of these devices by adding to the polymer electrolyte a hybrid filler made of carbon nanotubes insulated by clay platelets.

Microscopy and spectroscopy techniques indicate that the addition of this filler disrupts the tendency of polymer chains in the electrolyte to come together to form tightly packed crystalline structures. According to Ardebili, the addition of fillers seems to "disrupt the crystallinity by forcing the polymer to wrap around the hybrid nanoparticles. They're causing irregularity in the packing formation."

This irregularity allows polymers such as polyethylene oxide to move more freely, making it easier for lithium ions to pass through the electrolyte and thereby increasing power output. In addition, the nanofillers cause lithium salt in the electrolyte to dissociate at a higher rate, resulting in more free lithium ions in the electrolyte and even higher power output. With an electrolyte that is just 10 percent filled, these factors combined to increase conductivity by two full orders of magnitude.

Researcher Observes Negative Quantum Capacitance

Pradeep Sharma, chair and professor of mechanical engineering, has co-authored a paper that outlines the first observation of negative quantum capacitance, a phenomenon limited to nanoscale materials.

The paper, which was published in the journal Nature Communications, involves a new breed of capacitor built out of nanowires that were constructed in the lab of Rice University's Pulickel Ajayan and Jun Lou.

Capacitors are energy storage devices widely used in electronics. While they have the ability to discharge energy very rapidly, their total energy storage ability is typically low. As capacitors are made smaller, though, their capacitance, or ability to store an electronic charge, increases per unit area.

So while researchers expected these nanowire devices to have high capacitance, they were surprised to find them storing far more energy than predicted. "The capacitance was almost fifty times larger than it should have been. At that point the question became why," said Sharma.

Professors Ajayan and Lou approached Sharma, an expert in theoretical and computational modeling of nanomaterials, to help interpret these experimental results. After detailed quantum mechanical modeling, Sharma and his students realized this higher-than-expected capacitance was a consequence of so-called negative quantum capacitance arising from the interface of the different materials in the nanowires, specifically a metal and a dielectric material.

When compared to classical capacitance, quantum capacitance adds up in such a way that its contribution is very small and usually neglected. On the nanoscale, however, quantum capacitance is quite influential. Usually, quantum capacitance is positive. The notable element in this study is that the results can only be explained by invoking the concept of negative quantum capacitance. By combining with classical capacitance, this negative capacitance actually produces the larger-than-expected results.

With the existence of negative quantum capacitance now confirmed, Sharma said that by tailoring the metal-dielectric interface, researchers could leverage the phenomenon to create nano-devices with dramatically higher energy capacity.

RPSEA Awards $2.5 Million for **Drilling Materials Research**

Cumaraswamy "Vipu" Vipulanandan, professor of civil engineering and director of the Center for Innovative Grouting Materials and Technology (CIGMAT) with the Cullen College, is developing a new type of cementing slurry that will enable offshore oil rig operators to easily monitor the health of a well, both during its construction and then throughout its operational life. He recently won a more than $2.5 million, 3-year grant from the Research Partnership to Secure Energy for America, and funded by the U.S. Department of Energy (DOE), to conduct this work. Oil field services firm Baker Hughes is providing additional funding of $500,000 as a cost share.

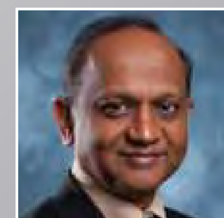
This new technology rests on additions to the standard drilling mud and cementing slurry. These additions include nano-scale particles of calcium, silica, iron and polymers, among others.

According to Vipulanandan, they will turn the drilling mud and cementing slurry into piezomaterials, meaning their electrical properties will change when they encounter mechanical stresses, temperature changes and chemical reactions.

Under this design, during well construction electrical leads will be placed in the outer casing of the well. As the slurry is poured to form the inner wall of the well, the sensors will be used to monitor how quickly the slurry is hardening, how much of the well has been completed and if the process is going as intended.

The new cementing mixture will also allow operators to monitor operational wells. When the hardened cement encounters a mechanical stress or strain, the technology's sensing and monitoring capabilities will make it easy to detect and locate structural problems.

Vipulanandan's collaborators on this grant include Ramanan Krishnamoorti, chair of the UH Department of Chemical and Biomolecular Engineering, as well as Guido Gustavo Narvaez and Qi Qu, both researchers with Baker Hughes.



Cumaraswamy Vipulanandan
Professor of Civil Engineering

BME Professor Developing System to **Diagnose Eye Diseases**

Kirill Larin
Associate Professor of Biomedical Engineering

Kirill Larin, associate professor of biomedical engineering with the University of Houston Cullen College of Engineering, has won a $1.2 million grant from the National Institutes of Health to develop a system that will use a puff of air blown directly into the eyeball to diagnose various eye diseases.

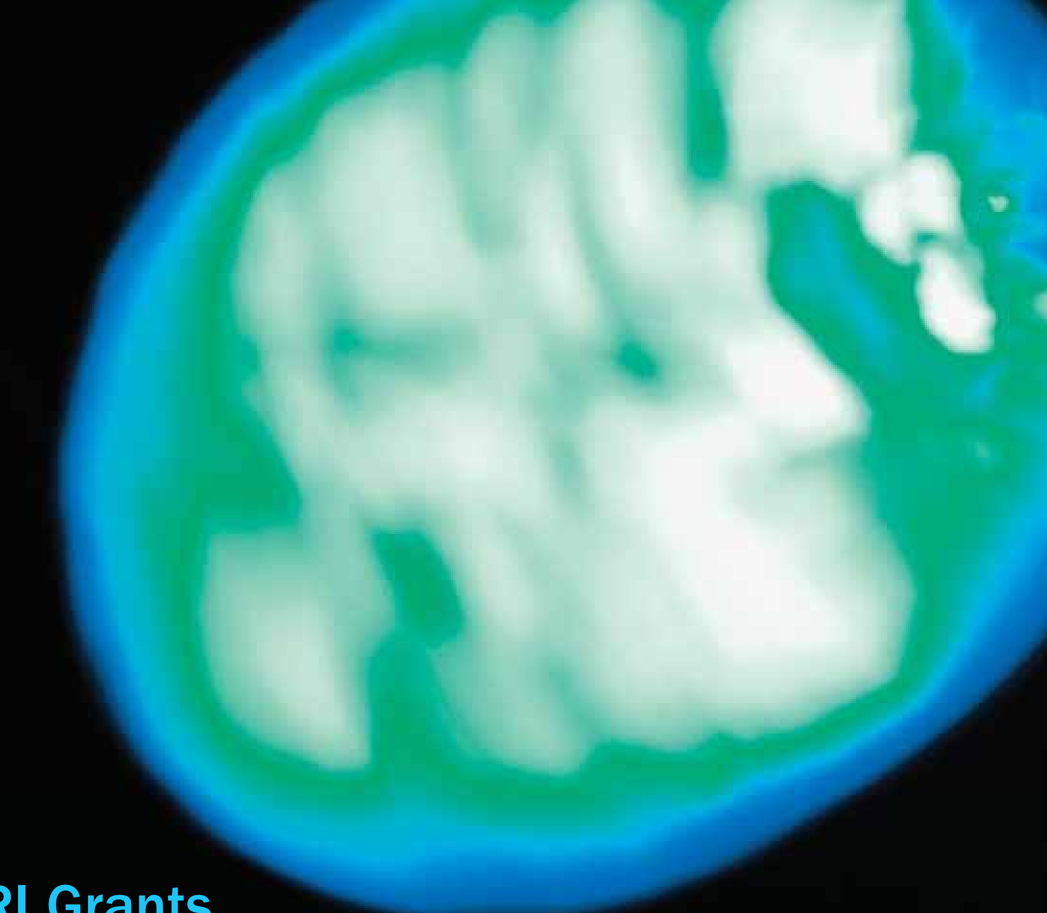
It's established that several eye diseases can change the biomechanical properties of the cornea. Myopia, keratoconus, and glaucoma, for instance, can change the cornea's shape and stiffness.

Larin intends to measure such changes by observing how the cornea moves after the puff of air. "The air puff will propagate mechanical waves on the cornea. We'll then measure the speed and attenuation [or weakening] of these waves."

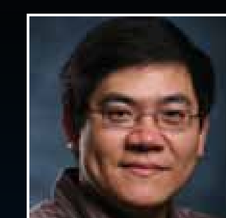
These measurements will be taken using an optical coherence tomography technique, which utilizes a harmless laser beam to sense movement down to mere billionths of a meter. The data that is collected will then be fed into models developed by the research team. These models, in turn, will determine the biomechanical properties of the cornea, such as its elasticity.

According to Larin, such information should allow for better detection of eye diseases and greater accuracy in the performance of eye surgeries such as Lasik.

Larin's collaborators in this project include Michael Twa, assistant professor in the UH College of Optometry and Salavat Aglyamov, a biomedical engineer with The University of Texas at Austin.



ECE Researcher **Wins NASA, GoMRI Grants**



Wei Chuan Shih
Assistant Professor of Electrical and Computer Engineering

Wei Chuan Shih, an assistant professor of electrical and computer engineering with the University of Houston Cullen College of Engineering, has won two grants in recent weeks: one from NASA's inaugural Space Technology Research Opportunities for Early Career Faculty grant program to develop an environmental monitoring system for space missions; the other from the Gulf of Mexico Research Initiative (GoMRI) to devise an oil leak detection tool for unmanned offshore rigs.

The NASA grant is worth up to $600,000 over three years. Though Shih is still designing the device, he envisions it consisting of a microfluidics chip – essentially a self-contained system roughly the size of a smart phone – that can be hooked into a spacecraft's or space station's existing air and water filtration units. Inside the chip will be a gold nano-structured substrate that will capture viruses and bacteria it contacts. The plasmonic properties of this substrate – plasmons being a type of electromagnetic wave – will support the recognition of these potential pathogens through various sensing and/or spectroscopy methods. Ideally, the system will be able to scan for bacteria and viruses automatically or will be simple enough to use with minimal training, Shih noted.

The GoMRI grant is valued at up to $740,000 over three years. It addresses the challenge of monitoring for oil leaks at unmanned drilling platforms. Current regulations require the companies responsible for these platforms to monitor them for oil leaks on a regular basis.

While this is normally performed by helicopter, Shih is developing a compact, inexpensive system that uses hyperspectral imaging to detect oil on the water's surface by searching for infrared radiation over large patches of water. Intense computation work will then allow he and his collaborators to separate the IR signal of oil from that of water.

"Scientifically, this is a new idea, doing hyperspectral infrared imaging," he said. "Oil has different surface properties than water. The emissivity [the ability to emit energy by radiation] of water is very different from oil. Our model allows us to extract the presence of oil on top of water."

Once completed, platform owners/operators should be able to attach this new system to unmanned platforms. When oil leaks from a well, the sensor will detect it and alert a nearby manned platform, likely via Wi-Max, a version of Wi-Fi with a range of several miles. All told, Shih expects the system to cost in the $20,000 to $50,000 range.

Faculty News

Elebeoba E. “Chi-Chi” May

Associate Professor of Biomedical Engineering

Education

Ph.D. Computer Engineering,
North Carolina State University

Career Overview

Elebeoba May joined Sandia National Laboratories immediately after earning her Ph.D. in computer engineering in 2002 as a senior member of the technical staff in the Computation, Computers, Information and Mathematics Center and was promoted to Principal Member Technical Staff in 2005. As a member of the computational biology department she initially developed new modeling paradigms to describe biological systems, such as error control coding models of DNA regulatory regions. Desiring to develop more biomedically relevant and accurate models of these systems, she applied for and won a National Institutes of Health Mentored Quantitative Research Development Award, known as a K25 grant. With this grant she pursued course and experimental work in immunology and molecular biology, studying latency and reactivation in tuberculosis and completing roughly a master's-level education in that field. After completing the K25 grant in 2010, she transferred to Sandia's growing biosciences division, where she worked for two years before joining UH this fall.

Research Interests

May's primary research interest is in understanding the dynamics of pathogen response to microenvironmental changes caused by host immunomodulatory mechanisms. She conducts these investigations through a combination of computational simulations and experimental work, allowing her findings in each area to inform her work in the other. May's goal is to create highly reliable and predictive multi-scale models of host-pathogen interactions that take into account the immune state of the host. With these models, she hopes to predict and study how pathogens chronically persist or re-emerge in immune-compromised patients and discover new biochemical targets for molecular therapeutics. The pathogens she intends to focus on include Mycobacterium tuberculosis; Burkholderia pseudomallei and Francisella tularensis, both of which are seen as potential bioterrorism agents; and Yersinia pestis, strains of which were responsible for the plagues that killed tens of millions (and maybe more) worldwide in the 14th century.

photo by TBS Photography

Accolades

CHEMICAL AND BIOMOLECULAR ENGINEERING

Demetre Economou received the Abraham E. Dukler Distinguished Engineering Faculty Award from the UH Engineering Alumni Association.

Ramanan Krishnamoorti received the Fluor Corporation Faculty Excellence Award, the highest award given by the UH Cullen College of Engineering.

Jeff Rimer and **Gila Stein** each received a two-year, $80,000 grant from the Norman Hackerman Advanced Research Program. Stein also received a Teaching Excellence Award and Junior Faculty Research Award from the college.

CIVIL AND ENVIRONMENTAL ENGINEERING

Reagan Herman received an Outstanding Lecturer Award from the college.

Kyle Strom received a Teaching Excellence Award from the college.

ELECTRICAL AND COMPUTER ENGINEERING

Ovidiu Crisan retired from a 26-year career as professor in the Department of Electrical and Computer Engineering.

Zhu Han received two best paper awards at the Institute of Electrical and Electronics Engineers (IEEE) Wireless Communications and Networking Conference.

Paul Ruchhoeft received the W.T. Kittinger Teaching Excellence Award, the college's most prestigious teaching honor.

Donald Wilton retired from a 29-year tenure as professor of electrical engineering.

INDUSTRIAL ENGINEERING

Suresh Khator received the 2012 International Educator of the Year award at the 2012 Indo-American Chamber of Commerce of Greater Houston Awards Banquet.

Erhun Kundakcioglu received a Teaching Excellence Award from the college.

MECHANICAL ENGINEERING

Stanley Kleis received a Career Teaching Award from the college.

Yashashree Kulkarni received a Teaching Excellence Award from the college.

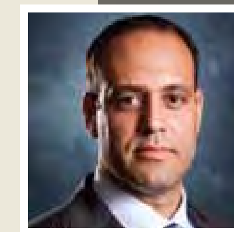
Venkat Selvamanickam received the Senior Faculty Research Award from the college.

Larry Witte retired after a 45-year career from the UH Department of Mechanical Engineering.

PETROLEUM ENGINEERING

John Lee received the Distinguished Service Award from the Society of Petroleum Evaluation Engineers (SPEE).

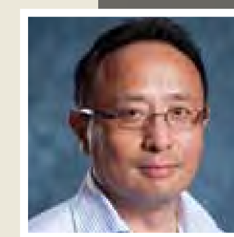
New Faculty



Anastassios Mavrokefalos, Ph.D.

Assistant Professor of Mechanical Engineering

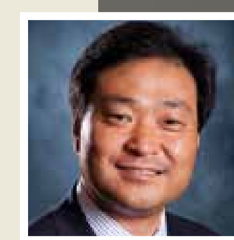
Mavrokefalos' main research activities relate to producing materials that enable cleaner and more efficient energy conversion, such as nanostructured thermoelectric materials, thermo-photovoltaics and solar photovoltaics. He boasts expertise in micro-fabrication techniques, experimental investigation of transport properties in low-dimensional systems, various microscopy techniques and computational methods.



Guan Qin, Ph.D.

Associate Professor of Petroleum Engineering

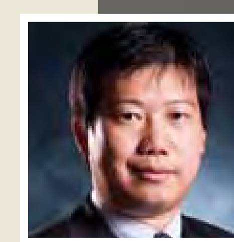
Qin's research interests focus on developing and applying efficient numerical algorithms of subsurface flow processes in numerical reservoir simulations, and building accurate subsurface geological models through integrating various data observations at multiple length scales, which often involve seismic and micro-seismic well logs and production history.



Jae-Hyun Ryou, Ph.D.

Assistant Professor of Mechanical Engineering

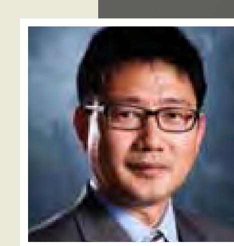
Ryou's research centers on the development of semiconductor materials and devices for photonic and electronic device applications, such as photovoltaic solar cells, light emitting diodes, transistors and semiconductor lasers. He specializes in creating compound semiconductors that combine materials from the third and fifth families on the periodic table, as well as from the second and sixth families.



Yan Yao, Ph.D.

Assistant Professor of Electrical and Computer Engineering

Yao joins the university with an endowed Welch Professorship in High Temperature Superconducting and Chemical Materials, awarded by UH's Texas Center for Superconductivity. He specializes in the development of nano-scale materials and devices for energy applications. He will use the funds provided by the professorship to develop next-generation electrodes for rechargeable magnesium batteries, which are particularly attractive for the central material's abundance, environmental friendliness, operational safety, and high energy density.



Yingchun Zhang, Ph.D.

Assistant Professor of Biomedical Engineering

Zhang specializes in the development of algorithms that draw relevant information from raw data gathered from biological sensing and imaging technologies, such as electroencephalograms, electromyograms and electrocardiograms. His projects include using EEG technologies to identify small portions of the brain that are overly active in epileptic individuals and EKGs to locate sections of cardiac tissue that are responsible for arrhythmias.

photo by Tom Shea

SURF's *up*

Engineering Research Boosts the Undergraduate Experience

For engineering undergraduates, spending a summer conducting research opens a world of opportunities for those seeking an enriched academic experience.

The **UH Summer Undergraduate Research Fellowship (SURF)** program allows students to sharpen their research skills in preparation for graduate school, and allows those headed for the engineering industry post-graduation to expand their practical knowledge. The project is a focused, 10-week research experience under the direction of UH faculty.

by Esmeralda Fisher

HYPERSPECTRAL IMAGING

Patrick Xu is a senior studying electrical engineering. He participated in the 2012 SURF program under the guidance of Saurabh Prasad, assistant professor of electrical and computer engineering with the UH Cullen College of Engineering. For his research project, Xu identified and analyzed different objects from a satellite map, and classified them using hyperspectral imaging, with its many advantages over traditional imaging.

"By just looking at a map, one cannot tell if a certain feature exists," said Xu. "For example, a point could be a tree or it could be a house – the image accuracy is not consistent." Common examples of traditional imaging include Google street maps, a spatial image taken from satellite cameras that contains pixel information.

Think of a 3D cube of a traditional image: the x and y axes represent the pixel information of the image, and the z axis contains the spectral band information, which is captured via airborne sensors. These wavelengths of light, or reflectances, are acquired and processed to generate spectral information about an image.

"By using hyperspectral imaging, we're able to distinguish between corn fields or a body of water, after noise reduction interpolation," Xu said. "This is very useful in agriculture or geosciences."

FLUID MECHANICS

photo by Nine Nguyen

For mechanical engineering senior **Hilario Torres**, the hands-on experience of his SURF research was invaluable. After approaching professor Ralph "Will" Metcalfe and associate professor Stanley Kleis for a project in fluid mechanics, he chose a project involving the study of blood flow, specifically, finding a low-cost, non-invasive way to screen for cardiovascular disease.

Using a device that is similar to blood pressure cuffs, the researchers measure vascular reactivity. The device stops blood flow to the subject's arm for a brief amount of time, and this lowers temperature in the arm. "We put a probe on the subject's finger and we're able to see the temperature drop during occlusion," said Torres. "Core temperature is warmer than room temperature, thus the heat transferred from the finger to the surrounding air during occlusion causes the fingertip temperature to drop. The occlusion holds for about two to five minutes, and after cuff deflation we see the temperature rebound above its original value. We can back track this temperature overshoot to blood vessel dilation and thus a measure of vascular reactivity."

Torres studies the temperature rebound, how much the finger temperature goes over the degree it normally is, and comes back. It's a good indicator of how much the subject's arteries dilate. The more they dilate, the more blood flow, and the more heat transferred to the hand.

While not diagnostic, the vascular reactivity test is a good indicator of overall cardiovascular health. The advantage is that it is inexpensive to administer, but can illuminate symptoms of potential abnormalities. "With current noninvasive tests, there are many people who are asymptomatic, and they are being told that they're at a lower risk [for cardiovascular disease] than they really are," Torres said, who worked in conjunction with Fairway Medical Technologies, a company that produces the new device with a cuff, probe and software that plots out temperature curves.

- Chemical engineering major **K.C. Schuette** performed research with Professor Peter Vekilov to design a microfluidic device that studies the kinetics of sickle cell polymerization of hemoglobin. Sickle cells are rigid and shaped like crescent moons. Under the guidance of Professor Vekilov, Schuette studied the polymerization process that spreads out over the surface of the red blood cell, a process that tightens the cell into a rigid shape. "Vekilov is an expert in protein crystallization," said Schuette. "Sickle cell anemia is a crystallization happening on the red blood cell. My part in this is to understand the kinetics of the virus and how the polymerization takes place on the red blood cell. If we can stop the first step of the mechanism, there's a possibility that we could wipe out the virus."

  Schuette programmed a temperature control system so that the polymerization process could be studied at constant temperature. The process works by sending a current through a thin, microscopic wire, which heats up due to the resistance of the wire, and the control system varies the current to maintain a constant resistance.

- Mechanical engineering major **Jeremy Evans** worked with Professor Gangbing Song to test smart aggregates on a cement block in order to better understand how it can be implemented in large scale civil structures. "We simulate a piece of foundation and embed piezoelectric transmitters/actuators, which are encased in concrete or marble in it," Evans said. By sending a charge, it changes the charge into a mechanical wave, which is accepted by another device on the corresponding side. This allows the wave propagation to be studied throughout. Structural health monitoring is the most prevalent implication for this technique.

- Industrial engineering major **Rebecca Habib** investigated data from the UH ECE 2300 Circuits Analysis courses to determine students' potential areas of difficulty with the course content. Working with Associate Professor Len Trombetta and Dr. Diana De La Rosa-Pohl, Habib analyzed past quiz and homework grades and made recommendations for improvements. She plans to pursue a Ph.D. in engineering education.

Conversations *with* Engineering Cougars

Dmitry Galushko is a chemical engineering major who received a scholarship from Southwest Chemical Association. Given to one high-achieving student in chemical engineering from each university in Texas, this award reflects Dmitry's dedication to excellence in academics and professional development at the Cullen College of Engineering. As a senior, Dmitry shares his perspectives and gives a bit of advice for success at Cullen College.

What are some things you hope to accomplish as the Vice President of the Chemical Engineering Honor Society (OXE) at UH?

I want to do fundraising for an engineering workshop, as preparation for some of the challenging classes that engineering students take. Workshops are a great way to encourage students to work hard and be successful in college. Another goal is to organize professional workshops for some of the newer students next semester, for example, a workshop on interviewing skills.

How did you find your internship?

The Engineering Career Fair is how I found my job at BP. That's the great thing about the University of Houston: students are given the opportunity to meet recruiters face-to-face. Getting a job through the career fair is definitely a long process. You want to make sure that you study hard and you know your stuff. Industry professionals want to hire someone that they can rely on. The important thing is to do your research on the company beforehand; don't just go to the interview and ask 'what do you do.' You have to impress them and show them you want the job.

What or who inspired you to pursue engineering?

My dad was a big motivation to me because he was an engineer. Engineering is one of those majors where you can make a big impact. Everything comes together – you work on really cool projects, you have good pay and the opportunity to travel around the world, so engineering was my clear option. A degree in chemical engineering gives you real universality to go into any industry.

Why did you choose to attend the University of Houston?

I'm originally from Russia. I came here about five years ago to study because UH is a really good school. The engineering department is ranked really high. One of the most important qualities about UH is that it's located in the center of the city. That sounds like a cliché, but it's a reality. With the career fair, you see that a lot of companies come here because it's near their headquarters; BP is located just 25 minutes away. So it's ideal for companies to come here and recruit.

Is there a professor at Cullen College who has particularly inspired you?

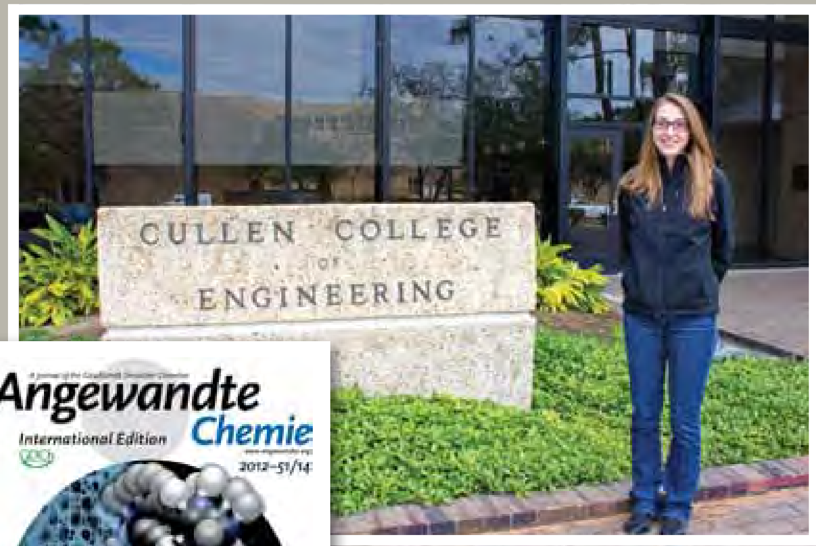
My favorite professor is Dr. Peter Vekilov. I took his classes, and he invited me to do research with him. He really motivated me. He's not only an expert in his field, really well-established and respected, but he has amazing people skills. Dr. Vekilov is an example of a mentor that every engineering student should have.

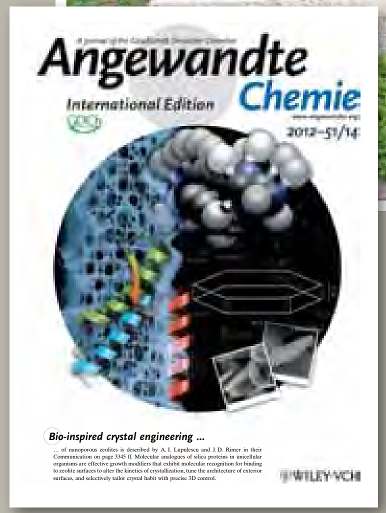
Do you have any advice for incoming freshmen?

Decide what you want to do early, because engineering is very broad. There are many things you can do; engineering gives you a lot of skills to work in any industry. Start trying to get an internship. You should definitely get industry experience. An internship is beneficial to figure out what you want to do, and it looks good on your résumé. Try to get involved in student organizations because it's a great way to meet friends and do something important in college.

photo by Nine Nguyen

ChBE PhD Candidate Wins AIChE Award





Alexandra Lupulescu, a chemical engineering Ph.D. candidate performing research with assistant professor Jeffrey Rimer, is the 2nd place winner of the 2012 AIChE Environmental Division's graduate student award, for the paper titled "Tailoring Silicalite-1 Crystal Morphology with Molecular Modifiers" published in Angewandte Chemie International Edition.

"The article discusses a novel method of optimizing zeolite crystals to improve their performance in catalysis, ion-exchange, and separations, among other areas," said Lupulescu. "This is achieved via a novel, bio-inspired technique that utilizes zeolite growth modifiers (ZGMs), which are molecules that bind selectively to specific crystal faces, to alter growth rates, thereby changing the bulk crystal morphology. This method has great potential, whereby a priori knowledge of ZGM molecular recognition can be used to achieve unparalleled control of zeolite size and shape, and therefore tune and optimize properties for specific applications.

Lupulescu will also be presenting and participating in the Catalysis and Reaction Engineering Division poster competition at this year's AIChE meeting in Pittsburgh. She was selected by the CRE Division Travel Awards Committee to receive the award for travel to the AIChE Annual Meeting.

Graduate Student Receives AAGS Fellowship

Darren Hauser, a graduate student in the multi-disciplinary Geosensing Systems Engineering program associated with the National Center for Airborne Laser Mapping (NCALM) at the University of Houston, is the recipient of the 2012 American Association for Geodetic Surveying (AAGS) Graduate Fellowship Award. His research involves the development of a small, affordable and mobile LiDAR unit deployable on a backpack, as well as terrestrial and airborne vehicles.

Working with Civil and Environmental Engineering Assistant Professor Craig Glennie, Hauser recently traveled to California to help test the viability of this kind of small surveying system. The sensors were built on a platform by researchers from the University of Hawaii at Manoa. The platform was then connected to a weather balloon. He also conducted work from the ground for comparison.

"I integrated laser scanners and other sensors related to navigation and positioning systems in a backpack to test, and now I'm processing the data collected in the backpack while walking around," Hauser said. "Lidar work is mostly conducted on planes, helicopters, trucks, SUVs or cars, so we're trying to downsize it."

Hauser received his bachelor's degree in surveying engineering at Penn State University. Once he completes his masters degree, he plans to seek a job in private industry somewhere on the East Coast, ideally with smaller company that's ready to take the next step in the surveying engineering world by using new technologies.

On Aerial Maps

Taken from *The Engines of Our Ingenuity*, Episode #284

Dr. John Lienhard

As a young model-airplane builder, I sent my proxies into the sky, while I – bound to the earth – could only watch from below. I thought a lot how I could make them tell me what they'd seen up there. Once I put a tiny camera, with a pneumatic timer, in the belly of a huge glider I'd made. But all I got for my trouble was a gray blur.

My fascination mirrored 19th-century fascination. Photography had matured quickly after the Daguerreotype process proved workable. Those first pictures took fifteen minutes to expose. But cameras were now being turned on everything in sight, and film speeds were relentlessly being improved.

So it's no surprise that in 1858 a Paris photographer took his gear 240 feet into the air to photograph the village of Petit Bicetre. A Paris cartoonist jibed at him for carrying photography to the "highest" art, but no matter. The seed was sown.

Mapmakers saw the potential of combining cameras with flight from the beginning. In 1839 a scientist told the French Academy that the new art of photography would serve mapmaking. As the airplane matured, it was able to serve that purpose. Aerial photo reconnaissance became a prime element in the business of World War I.

As a result, you could buy a commercial aerial-mapping camera by 1920. Of course a camera gives you only a photograph -- not a finished map. Hours and hours of data reduction are needed to process one hour of photography. But anyone who's walked the woods as a surveyor knows the hard alternative.

Now computers and image enhancement are bringing whole new orders of accuracy to the business. Suddenly, we have topographical maps of the far side of the moon and the canals of Mars.

Being able to stand and see what we could only imagine before changes what we see. When I was five my father showed me a panorama shot from a balloon 66,000 feet above the Black Hills. He pointed to the gentle curve of the far horizon and said, "See, the world really is round." Suddenly I knew that outrageous claim was true after all. Decades ago we first saw the island Earth as it looked from the moon -- all fragile, blue and white, and far more beautiful than we'd dreamed. And it hasn't been the same place since.

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

Landslide *Victories*

Most landslides are not the quick, dramatic and brutal events that make the news. Instead they take place slowly, with sections of earth creeping downhill bit by bit. As a result, identifying creeping landslides and knowing their boundaries can be difficult.

Guoquan Wang, a member of UH-based National Center for Airborne Laser Mapping and an assistant professor in the departments of earth and atmospheric sciences and civil and environmental engineering, has developed methods to identify landslide boundaries by integrating airborne and ground-based LiDAR with GPS tracking.

Airborne LiDAR provides a general overview of the landslide area, while ground-based LiDAR offers high-resolution data that can more easily identify the forward edge of a landslide, which often measures just a few centimeters high. GPS antennas placed in the landslide area provide information on land movement over very small time increments.

"Answering many key scientific questions depends on high-resolution and high-accuracy topographic data," said Wang. "Integration of these different data sets will greatly increase both data density and accuracy. That will create new challenges in data processing and management, but also new research opportunities."

photo by TBS Photography

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The University of Houston and the American Bureau of Shipping have developed a strong relationship throughout the past year. Collaboratively, employees of ABS and UH have worked to establish opportunities which will enhance the growth of both organizations in years to come. As evidenced by both institutions' desire to serve the public through the facilitation of academic excellence and research opportunities, American Bureau of Shipping has awarded the UH Department of Mechanical Engineering with a gift of $20,000 in scholarships for juniors and seniors for the 2012–2013 academic year.

ABS has been a strong supporter of training and education in the marine engineering sector since its foundation in 1862. It is a commitment that continues whenever economic circumstances permit. To this end, the ABS Scholarship Program provides financial support to deserving engineering and naval architecture students based on GPA, class rank, leadership ability, and recommendations.