UNIVERSITY OF HOUSTON | DEPARTMENT OF MECHANICAL ENGINEERING

MOMENTUM

RESEARCH HIGHLIGHTS 2013

MESSAGE FROM THE CHAIR

Pradeep Sharma

M.D. Anderson Professor and Department Chair

The central mission of the Mechanical Engineering (ME) department at the University of Houston is to perform cutting-edge research in the broad area of mechanical sciences and educate globally competitive engineers.

A modern mechanical engineer is very versatile: for example, cell biology, drug delivery, missile design, radiation hardened materials, quantum dots, hypersonic flights, shale gas exploration, nanostructured Li-ion batteries for energy storage, environmentally friendly engines, high temperature superconductive materials, sensors, artificial muscles, ultra strong materials are all topics that use mechanical engineers. This particular list of topics is intentional—our Mechanical Engineering faculty are currently performing active research in all these areas.

The University of Houston's highly ranked ME department boasts close ties with Houston's energy and engineering industrial complex as well as the medical center. Our graduates can be found in key positions in some of the leading companies both locally and around the world.

The mechanical engineering program has seen record growth in recent years, and with an undergraduate enrollment of over 600 students, it is the most sought after major within the engineering college.

I invite you to explore our website at www.me.uh.edu and see what we have to offer. If you need more information about our program, please email me at psharma@uh.edu.

Pradeep Sharma
M.D. Anderson Professor and Department Chair

MOMENTUM

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STATE *of the* DEPARTMENT

As some of you might recall, the Cullen College of Engineering and the department of mechanical engineering were established in 1942, which makes ME a young department in the world of engineering academia. ME started its evolution to an engineering research department in the mid 1960s. Our research strengths established in the 1960s and 70s spanned transport phenomena (heat and mass transfer) and mechanics.

This is an exciting time in the evolution and growth of our department. At about 650 students currently, our undergraduate program has never been stronger – we have set all time enrollment records for ME for each of the past three fall entering classes. Our BSME graduates are finding themselves in a very receptive and rewarding job placement environment, and we look forward to following the career growth of these new alumni in the coming years.

Equally exciting has been the growth in our graduate and research programs. The ME research expenditures as well as journal publications are the highest among the departments in the college. Our Ph.D. enrollment is rising sharply, and our faculty have been successful in winning research grants from both federal agencies and local and national industry. As you might have seen in press reports or heard in the speeches of our chancellor, the overriding mission of UH right now is the march towards Tier-1 excellence, and the strong growth in the ME research productivity in the past couple years has made our department a strong contributor to the UH Tier-1 mission.

Amidst all this change and good news, we are, of course, reminded that time marches on, and so, we have had quite a few changes in our faculty group. Professors Charles Dalton and Larry Witte have retired, Professors Keith Hollingsworth and Liping Liu relocated, and last year, we lost Professor David Zimmerman to untimely death. At the same time, we have also recruited seven new faculty in recent years: Professors Yashashree Kulkarni (2009), Haleh Ardebili (2010), Ashutosh Agrawal (2011), Jae-Hyun Ryou (2012), Philippe Masson (2012), Anastassios Mavrokefalos (2012), Xuemei Chen (2012) and Bonnie Dunbar (2012). In particular , we are very proud of the fact that almost 20 percent of our faculty are women.

contents

EXTRAS

ABET Accreditation

ABET has officially announced the final outcomes of its accreditation visit. ME has been accredited until 30th September 2018 (the maximum duration allowed by ABET, 6 years). Our best practices to be ABET compliant will continue as before.

Review of ME Graduate Program

ME graduate program was reviewed by the Texas Higher Education Coordinating Board (THECB). Three external reviewers, including Dr. Karthik Ramani (Purdue University), Dr. Adrienne Lavine (UCLA), and Dr. Yonggang Huang (Northwestern University), visited the department on October 17-19, 2012. The reviewers have submitted a very positive and supportive report on our graduate programs – their recommendations and our plans for the future are being forwarded to the THECB at this time.

New Faculty Searches Launched

We are launching two new faculty searches for senior hires. The positions are for Energy and Manufacturing (chaired by Venkat Selvamanickam), and Bio-mechanics/Biophysics (chaired by Lewis Wheeler).

Subsea M.S. to be Offered Online

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

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

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

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

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

Establishment of Endowment and Scholarships

GE Oil & Gas Establishes ME Scholarship Program

GE Oil & Gas will provide a total of $100,000 in scholarship funding to the Department of Mechanical Engineering over the next five years to establish the GE Oil & Gas Scholars Program.

This scholarship program is intended to benefit two outstanding ME students, who will hold the title of GE Oil & Gas Scholars during their tenure at UH. These students will receive $10,000 a year – coming out to $5,000 a semester – beginning in the fall of 2013 and lasting until their graduation.

The goal of this scholarship program is to allow the students to become more immersed in the GE Oil & Gas culture by introducing them to leadership at GE Oil & Gas as well as providing them with opportunities to work on research projects or internships within the company.

The first $20,000 in funding will be received by May 2013. In the meantime, the scholarship selection committee will be hard at work selecting which two students will be the first recipients of this award.

David Zimmermann Faculty Endowment

We have started the process of establishing the David Zimmermann Faculty Endowment. This income from this $100,000 endowment will be used to reward high-quality faculty who are eventually likely to receive a University professorship. This fellowship will be awarded for two years at a time.

Larry Witte Faculty Scholarship

The Larry Witte scholarship for junior faculty has already exceeded the minimum amount ($25,000) necessary to form a permanent endowment and it has been executed. We will be running a campaign over the summer to increase its worth and hence the scholarship amount. As per Dr. Witte's wishes, the scholarship will be used to support the needs of junior faculty.

Emerging New Research in ME:

Novel Drug Delivery Using Elastic Nanoparticles

Professor Ashutosh Agrawal's research group has launched a new research initiative into learning how elastic (as opposed to rigid) nanoparticles can be used as novel and effective drug delivery vehicles. This work is motivated by recent developments such as the fabrication of red blood cell-mimicking synthetic particles and polymeric particles that switch shape when subjected to external stimulus.

In Dr. Agrawal's view, such elastic biomimetic particles have the potential to set up a new paradigm for drug delivery and imaging modalities, thus improving health care at large. This would be particularly critical for developing improved technologies to improve the health, safety and performance of defense personnel as these biomaterials can provide versatile and efficient platforms for delivering medicine to prevent and treat combat casualties and expedite would healing and tissue regeneration. They can help develop and optimize targeted therapies for internal hemorrhage and trauma-associated conditions. They can enable the development of novel sensors for tracking chemical compounds and biochemical processes in the body for health monitoring thus allowing deployment of early intervention strategies.

Developing Three-Dimensional Scaffolds for Stem Cell Growth Using Electro-Responsive Hydrogels

The prospect of developing treatments based on adult human stem cells has generated tremendous excitement in the medical community and the general public. Treatments of the kind envisioned will require efficient methods to isolate, harvest, and culture large quantities of the necessary stem cells. However, these cells are rare and when grown in culture, tend to undergo unwanted differentiation.

Professor Yi-Chao Chen's research group has launched a new research program, which will build on the demonstrated ability of electro-responsive hydrogel to undergo large, controllable shape changes under applied electric fields and, thus, their potential utility as three-dimensional scaffolds for generating the quantities and varieties of adult human stem cells needed to make treatments possible.

In Dr. Chen's view, this research is a significant effort in the field of regenerative medicine. This is a multidisciplinary project, building on advances in mathematics, mechanics, physics, materials science and biochemistry.

Developing Novel Fuel-Cladding Material for Nuclear Reactor Safety

Developing new fuel-cladding materials, along with the associated tools for risk prediction and life-cycle analysis, is a critical need of the US nuclear industry. In a major new research initiative, **Professor Ken White** is leading a team of researchers from UH, Rice and DOE labs to develop new carbon nanotube reinforced SiC cladding materials.

Also working on this project team is Professor Yashashree Kulkarni of our department. In addition to developing the new nanotube reinforced cladding material, Drs. White and Kulkarni are also working on building multi-scale models for microstructure design guidance as well as for making computational predictions of fuel-cladding performance.

Numerical Prediction of Behavior of Elastomeric Seals

Dr. Ralph Metcalfe is working on developing a mathematical model for predicting the behavior of elastomeric seals under conditions in which temperature effects can modify film viscosity and thereby change film thickness. This work is supported by Kalsi Engineering, Inc., a mechanical engineering consulting firm founded by our distinguished alumni, Dr.Manmohan Kalsi (1970 MSME, 1975 PhD ME). Kalsi Engineering was established in 1978 to provide consulting engineering services in research and development, design, analysis and testing of mechanical equipment, seals,valves and downhole drilling equipment. Kalsi Engineering is world-renowned for its consulting expertise in valve technology, especially wherever the demand of safety and reliability is very high, such as in nuclear power plants and petrochemical plants, where the failure of a valve can trigger heavy financial losses or loss of life.

Former Astronaut
Joins the Department and Leads UH STEM Center

Former NASA astronaut and engineer Dr. Bonnie J. Dunbar joins the faculty in the department of mechanical engineering and will be leading a new University STEM Center (science, technology, engineering and math). A member of National Academy of Engineering, Dunbar, will provide transformative leadership in the development of a new integrated university STEM Center, building upon currently strong programs in several of the colleges, and leveraging their success in the larger K-12 community.

"Developing a pipeline for careers in science, technology, engineering and mathematics will play a major role in the sustained growth and stability of the U.S. economy, and is a critical component to helping our nation win the future."

Dunbar, who accepted her first corporate job as systems analyst for The Boeing Company in 1973, has devoted her life to furthering engineering and science education. One of her goals for the STEM Center will be to engage and support educational programs for K-12 education. Of note, Dunbar said, is UH's designation as an Hispanic-serving institution – one of only two Hispanic-serving higher education institutions in the nation that also are Tier One. This reflects UH's commitment to Closing the Gaps, the Texas Higher Education Coordinating Board's plan to close the state's educational gaps in student participation, student success, excellence and research by 2015. The initiative's key goal of increasing underrepresented student participation and success in Texas higher education meshes with her vision for STEM education. "Developing a pipeline for careers in science, technology, engineering and mathematics will play a major role

Photo Credits: NASA

in the sustained growth and stability of the U.S. economy, and is a critical component to helping our nation win the future," Dunbar said.

Dunbar also is expected to teach in the classroom next year, an opportunity she embraces. "I will be developing a new undergraduate course designed to inspire and retain our engineering undergraduate students—it will explore with them how engineering has transformed our lives throughout history and will be presented through the lens of aerospace and space exploration," she said. "We may offer it to all undergraduates to help them better understand how math, science, and engineering are important to developing the technologies surrounding them every day and solving many of society's "grand challenges", from communication and transportation, to the environment –and even social problems as well."

Prior to joining UH, Dunbar was based in the Seattle area, consulting around the country and internationally on STEM education and space flight technology. A former President and CEO of the Museum of Flight in Seattle, Dunbar is a much beloved figure, inspiring young people, including legions of young girls and women wherever she goes. She credits much of her success to her family, her teachers and professors, mentors, and very positive work experiences at the Rockwell International Company where she worked on the first Space Shuttle, Columbia, and her 27 years at NASA.

Before joining Boeing, Dunbar owned her own aerospace and STEM education consulting company, Dunbar International LLC. Among her projects, she led the effort to bring a retiring Space Shuttle to Washington State and helped complete fundraising for Aviation High School, which is being co-located at the Seattle Museum of Flight. Previously, she was President and CEO of the Seattle Museum of Flight for five years. During her tenure at the museum, K-12 STEM programs were expanded to reach nearly 140,000 students per year. Dunbar also founded the Washington Aerospace Scholars program for high school juniors in partnership with NASA and the State of Washington and expanded participation in the Aviation Learning Center, the Aerospace Camp Experience and Challenger Learning Center.

As a NASA mission specialist astronaut and veteran of five space flights, Dunbar logged more than 50 days in space. Dunbar trained in Star City Russia for 13 months and flew the first docking flight between the Russian Space Station MIR and the Space Shuttle in 1995. Dunbar served as payload commander on two flights, participated in a 13-day Spacelab flight as well as the eighth docking mission to MIR. Following her flight career, Dunbar served in the government Senior Executive Service for seven years, holding various senior management positions at NASA Headquarters in Washington, D.C., and at the NASA Johnson Space Center (JSC). As Assistant Director at NASA JSC, Dunbar founded the annual NASA- University Engineering Research Summit and was responsible for university relations and grant management.

Prior to working for NASA, Dunbar was a senior production operations research engineer with Rockwell International Space Division, where she helped develop equipment and processes for manufacturing the thermal protection system for the Space Shuttle. For her work, she was named Rockwell Engineer of the Year. Earlier, Dunbar was a visiting scientist to Harwell Laboratories in Oxford, England and a Systems Analyst with Boeing Computer Services. Dunbar received a Ph. D. in engineering from the University of Houston, master's and bachelor's degrees in engineering from the University of Washington and graduated from the Kennedy School for Senior Managers in Government at Harvard University.

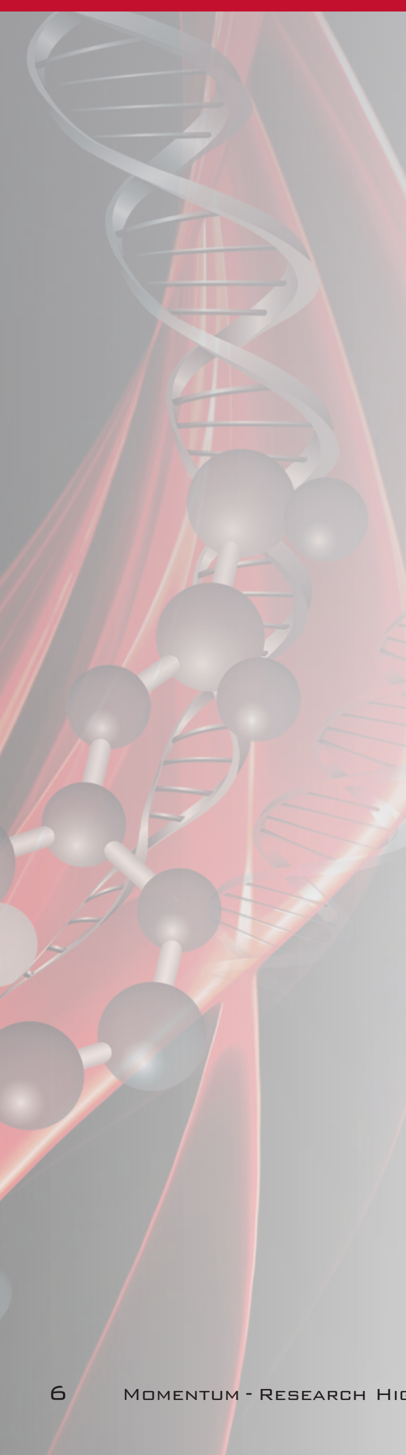
Dunbar is a Fellow of the American Institute of Aeronautics and Astronautics, Fellow and Life member of the American Ceramic Society, Fellow of the Royal Aeronautical Society, an elected member of the Royal Society of Edinburgh and was elected to the National Academy of Engineering in 2002.

She has been awarded the NASA Space Flight Medal five times, the NASA Exceptional Leadership Medal, the NASA Distinguished Service Medal and the Washington State Medal of Merit. For her service to engineering education, she was awarded the American Association of Mechanical Engineers Ralph Roe Award in 2009 and in 2012 was awarded the University of Washington's College of Engineering Diamond Award for lifetime public service. Dunbar also is a founding board member for the Washington State Academy of Sciences and the Academy of Medicine, Engineering and Science of Texas. She holds seven honorary university doctoral degrees.

Dunbar recently was elected to the august Executive Committee of the International Association of Space Explorers (ASE) at the XXV Planetary Congress of the ASE, held this year in Saudi Arabia. She is the first women space flier in that committee's 25- year history. In April, she will be inducted into the Astronaut Hall of Fame in Florida.

Dunbar grew up in the Yakima Valley of Washington State on a cattle ranch homesteaded by her parents in 1948. She learned to fly with the Rockwell Flying Club at the Orange County Airport in 1977 and maintains her pilot's license. In addition, she logged more than 1,000 hours as co-pilot in NASA T-38s as part of Spaceflight Readiness Training for the astronaut corps.

– Story by Richard Bonnin (rbonnin@uh.edu) –



Researchers Developing Automated **Battlefield Drug Delivery System**

Soldiers wounded in battle may one day owe their lives to research being conducted at the University of Houston Cullen College of Engineering.

Karolos Grigoriadis and Matt Franchek, both professors in the college's mechanical engineering department, are working with physicians at the University of Texas Medical Branch (UTMB) at Galveston to develop a system that automatically delivers lifesaving medications and fluids to the cardiovascular system for resuscitation after traumatic injury. They have won a three-year grant from the Office of Naval Research, including $561,000 supporting the UH investigators.

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

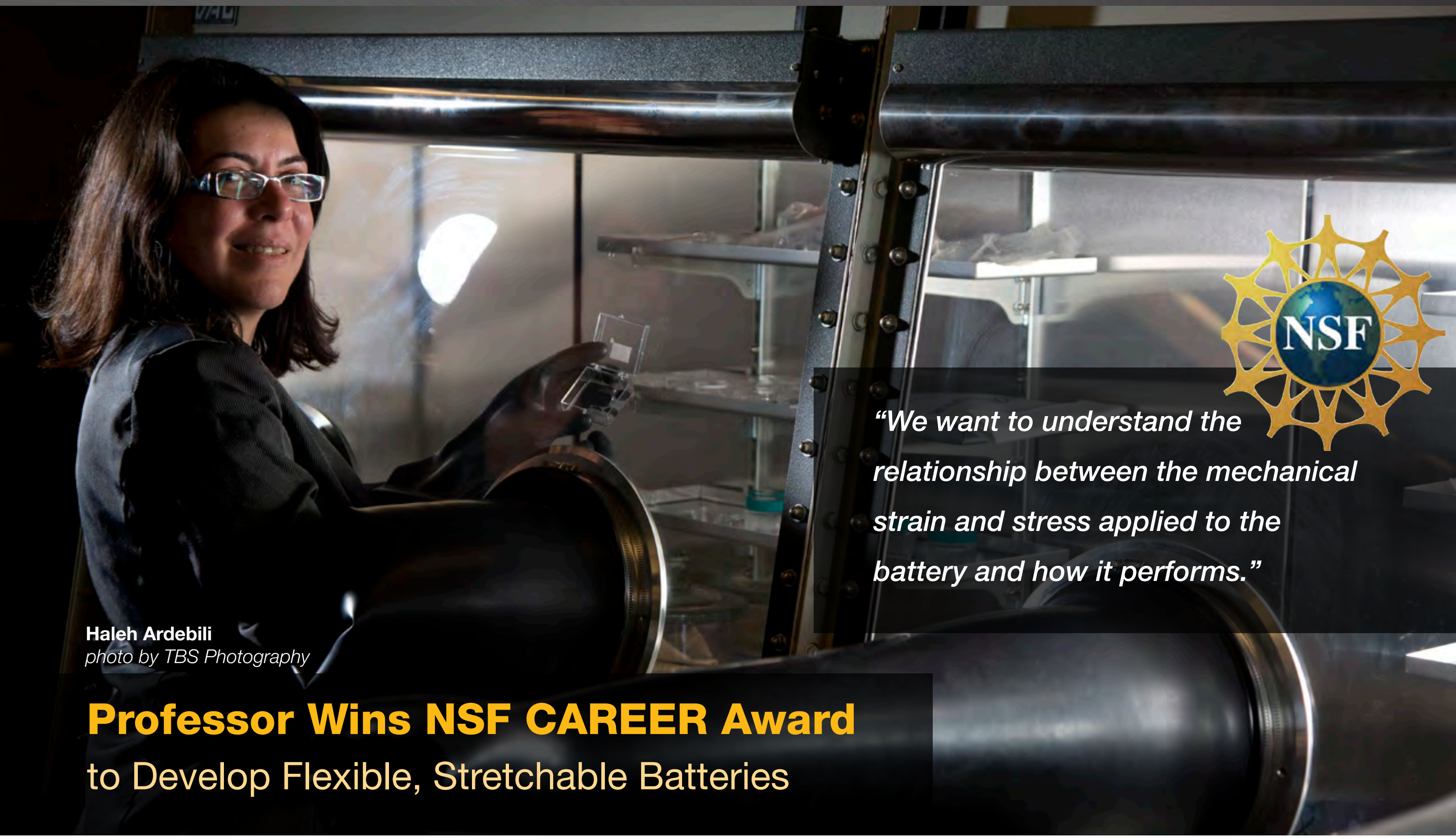
Developing these algorithms is where much of the UH work lies, said Grigoriadis. Using data provided by UTMB-Galveston, the research team will first create mathematical models of how the cardiovascular system responds to different medications. "From a systematic, mathematical viewpoint, the effect of these drugs is not known," he said. "So the first objective of this research is to provide a quantitative model of the effects of the drugs on physiological variables like blood pressure and heart rate. With that information, we will try to automate the delivery of these drugs and fluids through a system that can be used on a battlefield, a hospital, or during emergency care."

One important aspect of these algorithms, Grigoriadis said, will be the ability to adjust the medications being delivered. If a patient is not responding as expected, for instance, the system must be able to recognize that fact and then automatically deliver a new set of medicines or dosages. In addition, the system will take into account how different drugs interact with each other and calculate the best combination of medicines for a particular patient.

The device will also have an override function, allowing physicians to change medications and dosages as they see fit. "We're not out to replace doctors," Grigoriadis said. "But there can be great variability in the level of care available on a battlefield or other emergency situations. With this device we should be able to optimize the delivery of these medications and have a significant impact on care."

– Story by Toby Weber (wweber2@uh.edu) –

Professor Wins NSF CAREER Award
to Develop Flexible, Stretchable Batteries



Haleh Ardebili
photo by TBS Photography

“We want to understand the relationship between the mechanical strain and stress applied to the battery and how it performs.”

National Science Foundation CAREER Awards are designed to assist early-career investigators launch long-term, productive research careers. They are one of the most prestigious honors available to faculty in the STEM fields (science, technology, engineering, mathematics) and are among the handful of awards factored into the official Top American Research University Rankings.

Ardebili, who joined the college in 2010, won a five-year, $400,000 CAREER Award to explore the fundamental science underpinning flexible, stretchable lithium ion batteries. “Such batteries,” she said, “could be integrated into textiles or could be worn around the wrist like a bracelet. When sewn into fabric, they could be used to power equipment worn by soldiers in the field or to supply energy to patches placed on the skin and used for medical purposes, such as patient monitoring or diagnostics. A battery worn around the wrist, meanwhile, could be a convenient backup power source, serving as a charger for a smart phone that’s low on power, for example.”

According to Ardebili, there are several hurdles to making effective stretchable, flexible batteries. One of the biggest is how bending and stretching impact a battery’s ability to store and discharge energy – a question that she intends to answer with this research. “If it stretches, we have to make sure it does not lose its electrochemical performance,” she said. “That’s the motivation to study the fundamental side of it. We want to understand the relationship between the mechanical strain and stress applied to the battery and how it performs.”

While she will use some computer simulations to carry out this work, Ardebili is primarily an experimentalist. She and her research team will spend much of the next five years in the lab constructing, testing and analyzing different types of flexible, stretchable lithium ion batteries. In the end, they hope to have developed components for the commercial production of these batteries, along with a set of rules for making such devices.

“Technology has been moving in this direction for some time,” she said. “Whether they’re used in flexible electronics, for medical applications or for something else, these can provide an additional feature that electronics developers can work with. For any product, that’s important. If you have a new feature, you can develop all new applications for it.”

– Story by Toby Weber (wweber2@uh.edu) –

Cooling System Research
Wins NSF Support

Dong Liu

Dong Liu, assistant professor of mechanical engineering, and Paul Ruchhoeft, associate professor of electrical and computer engineering, recently won a $300,000 NSF grant to develop a highly efficient cooling technology that can be used in various energy applications. This technology is based on nuclear boiling heat transfer, which exploits the phase change from liquid to vapor and is an excellent way to transfer heat out of an energy system.

"We want to generate a surface that is tunable and can adapt to the varying boiling conditions."

Excellent does not equal perfectly efficient, though. As Liu describes it, there are three main regimes where the boiling process can be modified to improve the thermal performance. The first is the initiation of boiling itself. "There's an energy barrier that you have to overcome to enact the phase change," said Liu. The second results from this change from liquid to vapor. If boiling becomes too violent, the bubbles generated may coalesce, creating a dry vapor layer that prevents the liquid from wetting the heating surface. Dryout of the surface not only deteriorates the effectiveness of boiling heat transfer, but can also cause a catastrophic temperature rise in the surface itself. In fact, dryout can literally burn stainless steel surfaces during the so-called critical heat flux (CHF) stage. The third regime involves the intermediate stage between the onset of boiling and CHF, which demands heat can be transferred as much as possible without incurring a significant temperature rise.

The way to address all three of these issues, said Liu, is by engineering surface wettability – the ability to get and stay wet – of the boiling surface. To speed the initiation of boiling, the surface should be hydrophobic, or water-repellant, which would encourage bubble formation. During intensive boiling, however, the surface should be hydrophilic, or water-attractive, to facilitate rewetting of the boiling surface. In the middle phase, the surface should strike a balance between hydrophilicity and hydrophobicity to enable best heat transfer.

Other research has attempted to improve boiling heat transfer by structurally modifying the boiling surface, rendering some part hydrophobic and the rest hydrophilic. While this approach helps, said Liu, it is limited in that it treats boiling as a spatial process instead of the time-dependent process that it actually is.

"Instead," he said, "we want to generate a surface that is tunable and can adapt to the varying boiling conditions." To achieve this, Liu and Ruchhoeft rely on a physical effect known as electrowetting, in which the surface wettability can be switched between hydrophobicity and hydrophilicity by applying an electric field.

According to Liu, electrowetting is typically used to manipulate liquid droplets in microfluidic studies. This research, though, will exploit the ability of electrowetting to control vapor bubbles that form during the boiling process, which is much less understood. Once they have a better grasp of this capability, Liu and Ruchhoeft will work to optimize the technology, particularly, to determine what properties the electric fields applied at different points in the boiling process should possess, as well as the best way to manufacture the tunable, adaptive boiling surfaces.

– Story by Toby Weber (wweber2@uh.edu) –

Grant Seeks to Further Research on
Improved Fuel Efficiency and Emissions

Karolos Grigoriadis

With engine emissions requirements as strict as ever and federally mandated fuel economy standards set to rise, the National Science Foundation (NSF) has awarded professors at the University of Houston Cullen College of Engineering $200,000 to further their research on computational models and algorithms to optimize engine performance in both areas.

The three-year grant's principal investigator is Karolos Grigoriads, professor of mechanical engineering with the Cullen College. Grigoriadis and his collaborators have spent much of the past 20 years developing and refining algorithms for improving engine fuel efficiency and lowering emissions, partnering with companies such as Cummins, Ford and General Motors in the process. In addition to the NSF, their work has received funding from the U.S. Department of Energy, the Army Research Office and many companies in the engine and automotive sector.

The approach these researchers take addresses both the engine itself, as well as the catalyst used to reduce harmful emissions through chemical reactions. "It's important to have a model of the whole system, the engine and the catalyst," Grigoriadis said. "We need to understand the input/output behaviors of each individual subsystem and we need mathematical models that describe this behavior. The algorithms are designed based on these models and they adjust and optimize in real time the coupled behavior of the engine and the catalyst."

Through these algorithms, then, vehicles' onboard computing systems are able to use engine data (such as load and speed), predict catalyst performance (such as the amount of oxygen in the catalyst at a given moment) and then tweak their combined operation to meet stricter pollution and mileage standards.

Grigoriadis is collaborating on this project with Matthew Franchek, professor of mechanical engineering, as well as Vemuri Balakotaiah, professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair in the Cullen College's Department of Chemical and Biomolecular Engineering.

– Story by Toby Weber (wweber2@uh.edu) –

Wind Energy Project Wins Early Extension, *Bump in Funding From ARPA-E*

A wind energy research team led by the University of Houston Cullen College of Engineering has made such rapid progress in its work that it has received an accelerated grant extension along with a $900,000 increase in total funding from the U.S. Department of Energy's Advanced Research Project Agency-Energy.

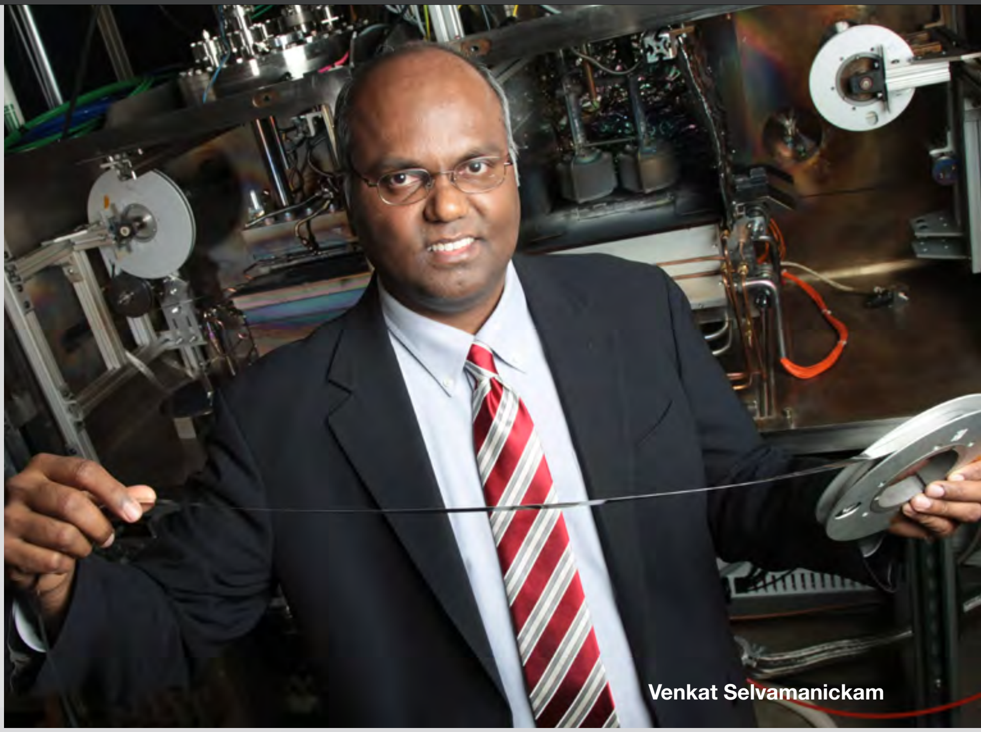
The research effort is helmed by Venkat "Selva" Selvamanickam, M.D. Anderson Chair Professor in the college's mechanical engineering department. Collaborators include SuperPower Inc., the DOE's National Renewable Energy Laboratory, Tai-Yang Research and TECO-Westinghouse Motor Company.

Their research focuses on developing wind turbines that use superconducting wire to generate and transport electricity, which would allow for more efficient and more affordable units. Superconducting materials carry electricity without any electrical resistance, resulting in no energy lost during transport.

Wind turbines, however, generate magnetic fields, which results in magnetic flux lines – essentially the pull of magnetism –running through and moving within the superconducting wires. These flux lines interfere with the wires' ability to transport electricity, lowering its performance. As a result, the cost of wind turbines that use superconducting wire is driven up significantly.

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

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


Venkat Selvamanickam

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

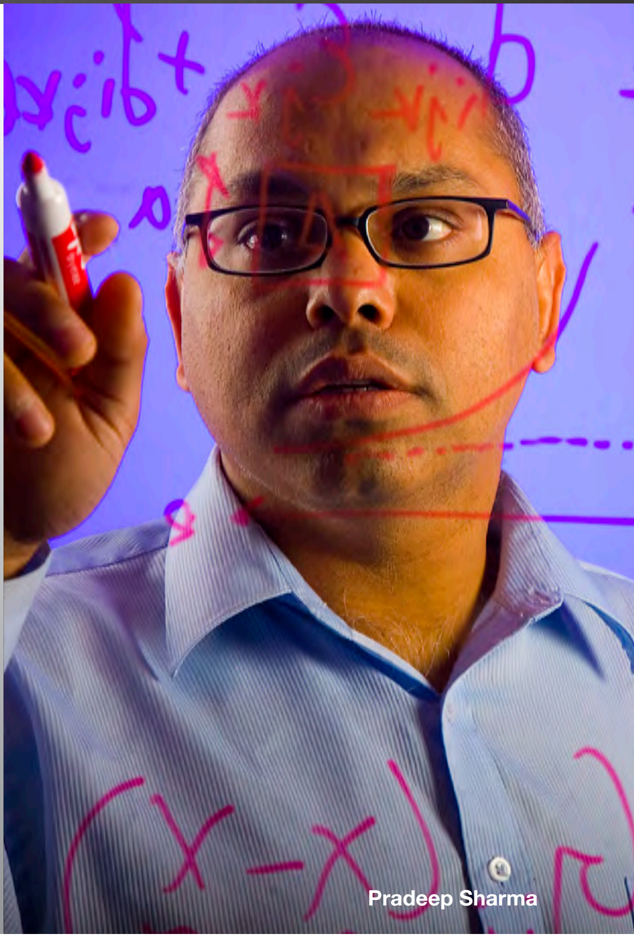
ARPA-E administrators were so impressed by the team's progress that they released the final $1 million ahead of schedule and also awarded the researchers an additional $900,000 to perform their work. "They saw the progress we made in the first 3 quarters," Selva said. "They said that rather than wait until June of next year to make a decision, they would give us a performance-based acceleration of the award. Not only that, they actually found more funds, so they increased the total project to $4 million."

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

– Story by Toby Weber (wweber2@uh.edu) –

Paper Outlines First Observation of Nano-Scale Phenomenon

The defining characteristic of nanotechnology, where devices and their features are measured in billionths of a meter, is size. But size isn't the only thing that sets the nano-realm apart. Materials and devices can behave differently – startlingly differently, even – at the nano-scale than they do when in larger forms.


Pradeep Sharma

Pradeep Sharma, chair and professor of mechanical engineering, has recently co-authored a paper that outlines one such phenomenon and provides a likely explanation for it.

The paper, which was published in a recent issue of the journal Nature Communications, involves a new breed of capacitor built out of nanowires. These devices were constructed in the lab of Rice University's Pulickel Ajayan and Jun Lou, who led the project represented in the article.

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. It's well known, though, that as capacitors are made smaller, 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 the 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's 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.

– Story by Toby Weber (wweber2@uh.edu) –

Sharma Named ASME Fellow

Pradeep Sharma, chairman of mechanical engineering at the University of Houston Cullen College of Engineering, has been named a fellow of the American Society of Mechanical Engineer (ASME).

Fellow is the highest elected membership level within the ASME. It recognizes individuals for exceptional engineering achievements and contributions to the engineering profession. Only about 3,000 of the ASME's 120,000 worldwide members have achieved this status.

The official citation recognized Sharma for making "outstanding contributions to understanding size-effects of coupled mechanical and physical phenomena in materials, establishing the mechanics theory of flexoelectricity, and elucidating the coupling between quantum mechanical phenomena and elasticity of nanostructures."

Sharma's research efforts focus on multidisciplinary investigations into properties, behavior and performance of materials and systems from the atomistic level to the gross macroscale. His current research topics include nanoscale piezoelectricity and generalized electromechanical couplings; coupling of strain to quantum mechanical behavior of quantum dots; self-assembly of nanostructures; energy storage and nanocapacitors; quantum definition of stress; and surface energy, stress and elasticity.

His most recent work includes co-authoring a paper outlining the first observation of negative quantum capacitance (published in Nature Communications), and a National Science Foundation-funded project studying quantum field induced strain in nanostructures.

– Story by Toby Weber (wweber2@uh.edu) –

Yashashree Kulkarni

Kulkarni Receives Bill D. Cook Fellowship

The Bill D. Cook Fellowship is a Mechanical Engineering endowment that is designed to attract and reward emerging young faculty. Professor Yashashree Kulkarni was recently named the Bill D. Cook Assistant Professor in 2012. The fellowship is for five years and carries a generous annual stipend. Dr. Yashashree Kulkarni also received the Outstanding Teacher Award, awarded by the Cullen College of Engineering in 2012 for excellence in teaching and service to the students of the college.

Venkat Selvamanickam

Professor Selvamanickam
Wins Entrepreneur Award

Dr. Venkat (Selva) Selvamanickam has been chosen as the recipient of the Cullen College of Engineering 2013 Entrepreneur/Innovation Award. This award recognizes alumni who have accepted a high level of risk to pursue an opportunity in an enterprise or venture to introduce new methods, techniques, practices and technologies into the workplace that increased efficiency and productivity in the generation of new products and services. Selection criteria for the award includes demonstrated ability by the recipient to create economic change by developing a new process, introducing a new product, creating a new company, introducing a new method of production, opening a new market or altering an existing product/service that has created a positive impact in the marketplace. The award also recognizes alumni who have exhibited the qualities of leadership, management and team building skills necessary for the operations of a successful business, including the introduction of new or significant improvements to existing processes that increase productivity, decrease cost, improve quality, or enhance the competitive position of their company.

Dr. Selvamanickam created and led a team of forty scientists, engineers and technicians at SuperPower in Schenectady, New York to develop and scale up his new superconductor wire technology to pilot-scale manufacturing. As SuperPower's Chief Technology Officer up to 2008, he led the company to numerous world records and world firsts including the first manufacturing and shipment of second-generation (2G) superconductor wire. This achievement led to the demonstration of the world's first in-grid 2G superconducting device.

Dr. Selvamanickam returned to the University of Houston in 2008 as the M.D. Anderson Chair Professor of Mechanical Engineering. He will receive the Entrepreneur/Innovation Award at the 2013 Cullen College of Engineering Alumni Awards Gala on June 13, 2013.

Lienhard's 'Inventing Modern' Featured by Amazon

John Lienhard

John Lienhard, M. D. Anderson Professor Emeritus of Technology and Culture with the University of Houston's Cullen College of Engineering, is no stranger to mass media. He has been broadcast thousands of times on public radio stations across the country thanks to "Engines of Our Ingenuity," a segment he created to illuminate the links between technology and culture. Now Lienhard is being featured on another medium. Online retailer Amazon has selected his book "Inventing Modern" as a featured e-book for the month of May.

The book, which can be downloaded to the Kindle e-book reader for $1.99, explores what modern means in light of the first half of the twentieth century and the emergence of awe-inspiring creations such as skyscrapers and the radio. According to the book's description, one force behind this era's modernity was "a new concept of boyhood - the risk-taking, hands-on savage inventor. Driven by an admiration of recklessness, America developed its technological empire with stunning speed… The rediscovery of mystery powerfully drove Modern as well. X-Rays, quantum mechanics, and relativity theory had followed electricity and radium. Here we read how, with reality seemingly altered, hope seemed limitless."

– Story by Toby Weber (wweber2@uh.edu) –

ASCE Honors Professor Song for Aerospace Service

Gangbing Song

Cullen College Professor of mechanical engineering Gangbing Song has been named the recipient of the 2012 Outstanding Professional Service Award from the Aerospace Division of the American Society of Civil Engineers.

The award is intended to honor an individual who has improved the conditions under which civil engineers "advance aerospace sciences and technology and space exploration and construction."

Song's contributions in this arena revolve primarily around his work as an organizer of the Aerospace Division's biennial Earth and Space Conference. He organized conference sessions in 2002 and 2004, symposiums in 2006 and 2008, and served as general chair of the conference in 2010. He is also head of the division's dynamics and control committee.

Song will receive the award at the Earth and Space 2012 Conference, set to take place in Pasadena, Calif., in April. This is the second time Song has been honored by the Aerospace Division in recent years. In 2007, he received the division's Outstanding Technical Contributions Award in recognition of his work on vibration control and correction of thermal deformation for aerospace structures, such as satellites that utilize solar panels and antennas.

"I've benefitted greatly from my involvement in the ASCE Aerospace Division. I'm glad to be able to give back to the division through my involvement in the conference and the dynamics and controls committee and am honored that the division has chosen to recognize my contributions," said Song.

– Story by Toby Weber (wweber2@uh.edu) –

Department Welcomes New Faculty

In addition to hiring Professor Dunbar (page 6), Anastassios Mavrokefalos, Jae-Hyun (Jay) Ryou, Philippe Masson and Xuemei Chen joined the ME faculty in 2012. Anastassios, Jay and Philippe are Assistant Professors in the Thermal Science and Materials Science groups respectively. Xuemei is an Instructional Assistant Professor.

Anastassios received his Ph.D. from the University of Texas at Austin in 2008 and was a post-doctoral associate at the Massachusetts Institute of Technology from 2009 to 2012. His research focuses on how energy transport processes in novel nanostructured materials affect energy conversion efficiency, storage density, thermal transport and light management. Specific areas of interests are thermoelectric energy conversion and refrigeration, solar energy utilization and micro/nanoelectronic devices.

Anastassios Mavrokefalos

Jay received his B.S. and M.S. in metallurgical engineering from Yonsei University, Korea, and his Ph.D. in materials science and engineering from the University of Texas at Austin, Austin. From 2001 to 2003, he was with Honeywell Technology Center and Honeywell Vertical Cavity Surface Emitting Laser (VCSEL) Optical Products, Plymouth, MN, as a Research Scientist and then with the Center for Compound Semiconductors as a Principal Research Engineer and an Adjunct Professor with School of Electrical and Computer Engineering at the Georgia Institute of Technology, Atlanta. His research interests include semiconductor material and photonic/electronic devices based on quantum nanostructures.

Jae-Huyn (Jay) Ryou

Philippe has been working in the area of electro-mechanical systems, power application of superconductivity and Multi-Physics modeling since 1999. He received a Ph.D in Electrical Engineering from the Université Henri Poincare, France in 2002. He spent 6 years at the FSU-Center for Advanced Power Systems i n Tallahassee, FL, working on the development of high power density superconducting machine for aircraft propulsion as part of the NASA/DoD URETI on Aeropropulsion and Power and on numerical modeling of electro-thermal instabilities in superconductors for the US Air Force Research Lab. At the same time, he was appointed by the FAMU-FSU College of Engineering as adjunct professor for the Department of Electrical Engineering. In 2009, he joined the Advanced Magnet Lab as Senior Scientist where he worked on superconducting motors and generators as well as resistive and superconducting magnets for high energy physics and medical applications. In 2012, he joined the University of Houston as a faculty member of the Department of Mechanical Engineering and as a member of the Texas Center for Superconductivity.

Philippe Masson

Xuemei obtained her PhD in Mechanical Engineering from Washington University in St. Louis in 2008 and her B.S. in Engineering Mechanics from Peking University in 2004. Xuemei's PhD research was primarily on turbulence modeling while I also worked on some other projects like liquid crystal phase transition and interfacial instability analysis. Upon graduation from Washington University, She joined Virginia Tech as a Postdoctoral Associate, where my research involved simulation of a glass extrusion process, topological chaos in Non-Newtonian fluids and aerodynamics of flying snakes.

Xuemei Chen

Outstanding

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

Outstanding Senior: *John Alred*

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

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

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

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

STUDENTS

chosen for 2012-2013

Outstanding Junior: *Ryan Hannemann*

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

Hannemann emphasizes that engineering students at the University of Houston have a definite advantage in the job market. "We're so lucky to be in Houston," he said. "We're just integrated into the oil and gas network because of location." Aside from the benefit of education in the Energy Capital of the World, Hannemann says that the key to landing your dream job is to focus on grades and networking. "Try and keep your GPA as good as you can, and start networking early," he said. "Go to the career fairs. Those career fairs are so effective and the fact is the majority of people I talk to aren't using them. Create a networking base beforehand; it makes it easier when you talk to company reps at the career fairs. Also try and volunteer for the career fairs. I usually volunteer whenever I can. It's not a waste of your time, it's an investment."

In the near future, Hannemann's goal is to supplement his engineering background with the business side by earning an MBA.

– Story by Esmeralda Fisher (efisher@uh.edu) –

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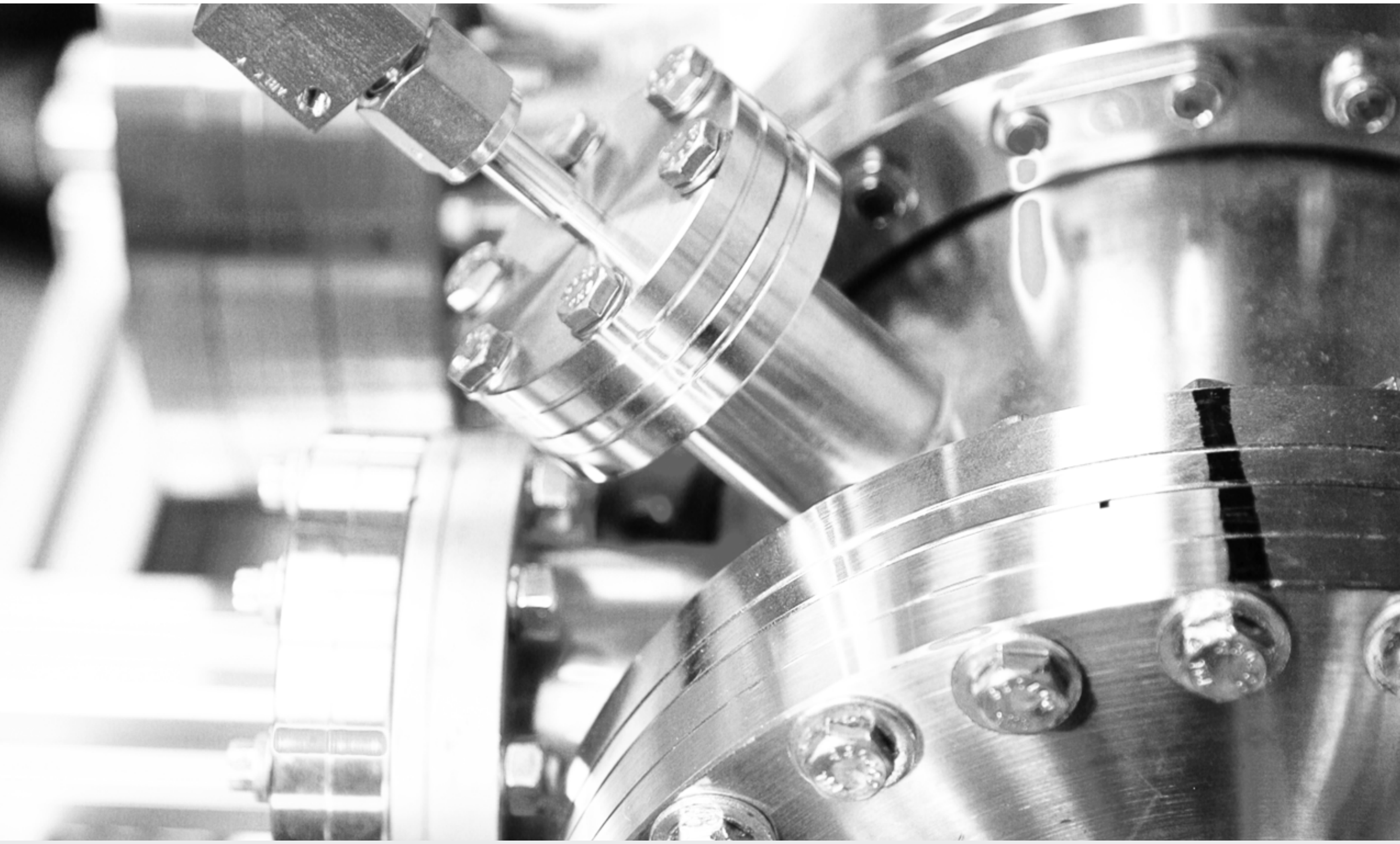

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