The Catalyst

Message from the Chair

Happy New Year, CHBE alumni and friends!

2015 has been an eventful year for our Department. At the 102nd Commencement back in May, 59 students graduated with Bachelor's degrees (a 15% increase from the previous year), making it the most popular Engineering major. 15 graduate students received PhD degrees (a 35% increase), making it the most popular Engineering degree last year also!

Last Fall, 84 students took sophomore-level CHBE301 "Chemical Engineering Fundamentals." Our program graduates saw entering classes of 15 first-year MCHE/MS students and 16 first-year PhD students. Five graduate students received prestigious fellowships, including two from NSF and one from the Coast Guard.

Our Department continues to grow in the faculty ranks. Dr. Abbas Firoozabadi (a member of the National Academy of Engineering) joined this Spring as Distinguished Visiting Professor. Drs. Marya Cokar and Xiankuan Zhang (SABIC, Chief Scientist) joined last Fall to teach courses in transport and industrial catalysis, respectively. Very excitingly, Professor Fred C. MacKintosh (a world-recognized expert in complex fluids and biopolymers) will be joining our department as the Abercrombie Professor of Chemical and Biomolecular Engineering in July 2016. More info about Fred later to come!

I am very proud that our professors are getting recognized for their teaching. Dr. Biswal received a 2015 George R. Brown Award for Superior Teaching; Drs. Nagrath and Chapman were recognized as finalists. Our undergraduates voted Dr. Vargas as their "Favorite Faculty" last year. And, by the way, Dr. Vargas was a finalist for the Sophia Meyer Farb Phi Beta Kappa Prize for Teaching!

Our faculty continues to bring recognition to CHBE and Rice through research and service to our profession. Dr. Verduzco received the 2015 Most Promising Engineer/Scientist Award from the Hispanic Engineer National Achievement Awards Conference (HENAAC). Dr. Gonzalez was named Editor-in-Chief of the Journal of Industrial Microbiology & Biotechnology, and appointed to Science Magazine's Board of Reviewing Editors. Dr. Pasquali was named A. J. Hartsook Professor of Chemical and Biomolecular Engineering, one of a handful of Chaired Professorships at Rice. I myself received the 2015 Excellence in Applied Catalysis Award from North American Catalysis Society/Southwest Catalysis Society. Our staff members are some of the hardest-working folks on campus, and our very own Karen Shelton received the 2015 Hardy M. Bourland Staff Award for Distinguished Service from School of Engineering.

It is so wonderful to share that our generous alumni made notable commitments to our students last year. There now exists the Sunit Patel '85 Endowed Fellowship for support of chemical and biomolecular engineering graduate students; the Michael Gibson Fellowship Fund for meritorious performance at the undergraduate/graduate levels; and William W. Akers Endowed Engineering Scholarship for engineering undergraduate students (Dr. Akers is professor emeritus of our Department).

What’s next? The Initiative in Molecular Nanotechnology! Announced last Fall, the University will grow our Department by up to eight tenured/tenure-track faculty, as part of the larger strategic plan of expanding and strengthening Rice's efforts in molecular nanotechnology. We in the Department are excited by this unprecedented opportunity, and I hope that you are, too.
John Hofmeister, former President of Shell Oil Company and Founding CEO of Citizens for Affordable Energy presented the 2015 Chevron Lecture on Energy on April 7, 2015 hosted by the Chemical and Biomolecular Engineering Department at Rice University.

John Hofmeister’s presentation was challenging and motivating. He concentrated on business, economic, and policy issues centered on energy. Mr. Hofmeister explained his vision for how energy can boost the U.S. economy while working toward longtime sustainable solutions. He encouraged establishing an energy vision for the country and taking the politics and the two year election cycle out of energy policy in the same way that the Federal Reserve System removes politics from monetary policy. Mr. Hofmeister encouraged students as well as alumni and faculty to work to solve technical and policy issues surrounding energy. Mr. Hofmeister’s thought-provoking message was followed by a significant amount of feedback and discussion.

This annual lecture series was established to increase visibility of energy related topics in recognition of the strong interaction between Chevron and Rice University in areas related to energy research. The event, held in Cohen House on the Rice Campus, attracted almost 200 students, faculty, alumni, and friends from most of the major energy and service companies. A networking event, supported by the Department’s active alumni association, prior to the lecture and after the lecture featured research posters of Chemical and Biomolecular Engineering students and post-docs.

Past speakers included Lynn Orr (2013), who was Director of the Precourt Institute for Energy at Stanford, but now is the DOE Undersecretary for Science and Energy, and Carlos Aguilera (2014), Vice President and General Manager, Business Development, Chevron Africa and Latin America Exploration and Production Company.

Video of the complete lecture can be found online at bit.ly/2015chevron.
South Sudan is one of the world's newest countries, gaining independence from Sudan in 2011. Unfortunately, the young nation’s transition into sovereignty has been problematic, partially due to the recent internal conflict that has severely limited accessibility to natural resources. Stifled oil and gas production over the past few years has caused fuel prices to spike, forcing more civilians to turn to rudimentary energy sources for home heating and cooking, such as wood and charcoal. This change has significantly increased the local deforestation rate, which is at an all-time high. Additionally, potable drinking water has become a treasured resource in this war-torn country. Team bubbleGHUM developed a chemical process that would operate solely on local biomass waste to help mitigate some of country’s most immediate problems—clean water, high fuel price, and deforestation—while still being profitable for foreign investors.

Our team elected to design in the grain basket South Sudanese state of Western Equatoria. The main staple crop in Western Equatoria is sorghum. Sorghum stover is the grain’s agricultural byproduct (stalks and leaves), which is usually burned or left to decay in the fields. Sorghum stover is an optimal feedstock because it is an abundant, renewable waste with a relatively high energy density.

Dimethyl ether (C2H6O) has been named by Volvo as one of the fuels of the 21st century that has the potential to revolutionize the transportation industry. DME burns more cleanly than traditional fossil fuels while still maintaining about 60% of diesel’s energy density. Additionally, there are various uses of DME both as a 30% diesel additive as well as for portable cooking and heating. Team bubbleGHUM believes there is large market potential in Eastern Africa due to high-energy prices, which could bring large returns while lowering charcoal consumption.

The proposed sorghum stover to DME plant incorporates several innovative technologies, which were all modeled in Aspen Plus, Aspen HYSYS or ProMAX. Initially, sorghum stover would be dried, ground and gasified in order to convert it into syngas (CO, H2, CO2). A slurry reactor would convert the syngas to DME using a leading-edge direct synthesis technology. Using a dual-functional catalyst lowers the capital cost of the plant compared to the traditional technology that requires methanol as an intermediate. Separations are carried out to remove sulfur dioxide and carbon dioxide to ensure high purity products while minimizing corrosion. Cleaned syngas and DME streams are separated through cryogenic distillation after the CO2 scrubber. Process water is produced throughout the system, which is distilled and purified to make potable water for local distribution. All utilities would be generated on-site using an advanced process called biomass trigeneration. This system produces electricity, various steam qualities, and refrigeration through waste heat integration.

One of our team’s goals was to create a design that would be mutually beneficial for the local community and the plant. The proposed design would have an annual production of 257M tons of DME or 1.2 million barrels of oil equivalent. About 80% of the DME produced would be sold at a competitive world price for profit, which equates to about 5% of annual oil consumption in Sudan and South Sudan. The remainder of the DME would be sold locally in 6 kg reusable tanks at a highly subsidized price in order to gradually reduce charcoal consumption for cooking and heating. Additionally, 281M tons/yr of potable water would be produced and distributed locally in exchange for collected stover. The fixed capital and operating costs of the proposed design are $225.7 million and $17.2 million, respectively. The design’s cash flows equate to a net present value of $124.4 million.

Our team is excited to enter the “real world” after a great four years at Rice. Lisa will start at Anadarko Petroleum in the Woodlands as a production engineer. Aaron has recently started as a control systems engineer in Baytown at Bayer. Anna is working near Corpus Christi as a process engineer at OxyChem. Lindsey will begin soon as a production engineer outside Baton Rouge with BASF Corp. Karim is finishing up his senior year at Rice and Ayushi will be entering a graduate engineering program this fall.
Reflection on Outstanding Chemical Engineering Senior Award
By Lindsey Witte

I was honored to be nominated by the ChBE faculty for a Texas Society of Professional Engineers Outstanding Senior Award. I was quite surprised when I initially received the nomination because I had many hardworking peers who deserved similar recognition. For example, Sarah Munday went above and beyond TAing sophomore level courses and Parth Agrawal dedicated a lot of extra time in biomedical research. I want to thank these two individuals as well as other classmates for motivating me to do my best both inside and outside the classroom.

During my senior year I wanted to give back to the ChBE Department for all the support I had received. First, I wanted to grow AIChE’s pre-professional development opportunities through the external VP position. In the fall I worked to arrange a plant tour with BASF in Freeport. While in the spring I worked with Rice Alumnus and St. Arnold Brewery owner, Brock Wagner, to arrange a brewery tour for the graduating class and faculty. Also, in the spring I helped to expand the Lunch and Learn Program. Both undergrad and graduate students were invited to listen to monthly speakers discuss topics ranging from chemical value chains to work-life balance. I am confident that the incoming AIChE officers will continue to expand the pre-professional development opportunities by utilizing the Rice alumni network.

The other major effort I was dedicated to was co-launching an internal ChBE student advisory board with Parth Agrawal. With the sophomore class size rising above 80 students there was a growing need to establish a more formal means of relaying feedback back to the department. The ChBE Undergraduate Board meets every other week to discuss different ways improve the curriculum and student experience. Last semester we discussed topics such as best teaching practices and changes to the sophomore curriculum. Maggie Jerome and Alex Metcalf will lead this group next year and I am excited to see what they target to improve.

I want to thank the class of 2015 and the ChBE faculty for a great four years. I will miss Rice, but I am excited about working for BASF in Geismar, Louisiana as a production engineer.
The George R. Brown Award for Superior Teaching

Dr. Sibani Lisa Biswal

By: Yongchao Zeng, Gautam Kini, Daniel Du, Xindi Duan, Jeffrey Joyce and Brett Anderson

Dr. Sibani Lisa Biswal received the 2015 George R Brown Award for Superior Teaching. It is presented to top Rice professors as determined by the votes of alumni who graduated within the past few years. This is not the only education award Dr. Biswal has ever received. Early in 2012, she was recognized by the Rice Graduate Students Association with the Faculty Teaching and Mentoring Award for her outstanding service to graduate student education.

In academia, Dr. Biswal has won the Best Fundamental Paper (South Texas Section AIChE Oct 2014), ADNOC R&D Award (Abu Dhabi National Oil Company Feb 2013), Best Applied Paper (South Texas Section AIChE Oct 2013), Donald J. Nash Award (AAAS SWARM Annual Meeting April 2010), NSF Career Award (National Science Foundation Dec 2009), ONR Young Investigator Award (Office of Naval Research 2007). Everything Started as a TINKER

Acting on her curiosity and the excitement of discovery, Lisa started to explore the art of innovation at a young age. Her father, a material scientist working in the semi-conductor industry, fostered Lisa’s precocious interests by explaining what a motherboard, RAM and other components did, prompting Lisa to build her own computer. Rather than merely observing someone else’s handiwork, Lisa set out to build things that suited her interests. For example, on one occasion she bought paneling from Home Depot, and pulled out hammers and nails to construct tree houses and forts in the yard with her father’s help. As she grew older and the challenges grew more intricate, so did her mind and curiosity.

Not a Nerdy NERD

Science and engineering were always her calling. Lisa received her undergraduate degree in chemical engineering at the California Institute of Technology. Caltech is a place where one can be an awesome “Nerd” without being stereotyped into a pocket protector as Lisa would describe. She still remembers the stories of putting a CD into the microwave oven to see the sparks fly and throwing a bottle of liquid nitrogen into the pond to make ear-splitting explosions. These unconventional experiences distinguished chemical engineering from other engineering disciplines in her mind. Generally, there is a wide field of possibilities, more broad and rigorous training and allows students to be quite flexible. Moving on, Lisa went to Stanford and earned her doctorate degree in chemical engineering under the supervision of Dr. Alice P. Gast who is now the president of Imperial College London in the UK. Lisa defended her PhD thesis “Exploring novel structure formation and mechanics of linked chains of magnetic colloidal particles and their application in microfluidics” in 2004. She joined Dr. Arun Majumdar’s group at UC Berkeley as a post-doctorate researcher where she continued her research in engineering soft matter. After completion of her post-doctorate degree, she decided to set out a career as a faculty member to pursue her enthusiasm for teaching.

Down to Texas to Teach the OWLS

It is of no surprise that Lisa chose to become a professor. As early as elementary school, Lisa would play the teacher, instilling rudimentary knowledge to her younger brother. In high school, Lisa became a tutor and helped her friends excel in math and science classes. Her friends recalled how Lisa would change her voice and shift to a “teaching mode” when she was explaining chemistry to them. Lisa chose to start her career at Rice University for many different reasons. Besides the very strong reputation of the School of Engineering, she was most impressed by the students. Rice Owls turned out to be the most responsive, curious students who asked insightful questions in her trial lectures. Lisa uses an avant-garde style of teaching as she always tries to encourage the students to step outside of their comfort zone and think outside of the box.
She avoids providing a simple recipe for students to follow to solve problems. Instead she always emphasizes the basics and then inspires students to tackle those unknown challenges of their own interests. A well-known quote from her ChBE 301 class is that “even the most difficult problems can be broken down into a simple balance of inputs and outputs”. She would like to give open problems and let the students understand that there is always more than one single correct solution and the right answers could be completely different based on the assumptions they make.

An Extraordinary and Inspirational ADVISOR

“Lisa has been a great advisor, mentor and friend,” said Daniel Du, who successfully defended his PhD thesis this April under Lisa’s guidance. Daniel further commented that “I have been very fortunate to be the only student she took in the year I came to Rice University. During my Ph.D. study, she has been patiently teaching me techniques in multiple disciplines as well as discussing novel research ideas with me. As a recent graduate, I would recommend this five year Ph.D. program at Biswal group to anyone who is interested in conducting top-notch scientific research while enjoying a perfect work-life balance.” Besides hands-on experiences, Lisa always stresses the ability to communicate. She tells her students that if you want your research to matter worldwide, it is of great importance to describe the work in a language that is understandable to people outside the science community. It is harder to explain something really hard in easy terms. “I am very fortunate to have been co-advised by Lisa,” said Gautam Kini, one of four from her first batch of graduate students. “During my PhD study, she was a very positive influence as she stands for the many important attributes one seeks in an advisor, researcher and teacher. I have been very impressed and inspired by her commitment and dedication to the department – she is one of the reasons why so many freshmen and sophomores elect to study Chemical Engineering after going through her Mass and Energy Balance class. That she invests so much in her students, even before she obtained tenure and continues to do so even today, speaks volumes of how much she cares for her students and the larger cause of their education. I also recollect she was pregnant with Isabel when she was entrusted the task of teaching the graduate course in Transport Phenomena. Lisa took up that challenge with a smile, developed and successfully taught the course while also managing her graduate students and advising them on research. I have learnt a lot from her and value the training I received under her.”

Becoming an Outstanding SCIENTIST

Dr. Gast had tremendous positive impact on Lisa. Dr. Gast’s ascension to the highest administrative position in academia is not only impressive but also hugely inspiring. Her story, from a successful chemical engineer to the president of one of the world’s top academic institution, represents a great fight against the glass-ceiling barriers that females are still facing. Lisa advocates equal rights for women and feels that sometimes women are required to prove themselves more than men, at work. She represents women by serving on a variety of science and engineering communities. Dr. Majumdar, the Director of Advanced Research Projects Agency Energy (ARPA-E) is another influential icon for Lisa. He inspired her to work for the greater good and make an impact not only in terms of scientific papers but also in terms of how people perceive energy and be provided with greener and more affordable energies. Now Lisa’s research interests have extended to how to apply her expertise in colloidal systems to fields such as how to recover hydrocarbon fuels and sequestrate the carbon dioxide at the same time. If successful, the project may be able to provide the greenest barrels of oil the world has ever seen.

FAMILY is Her Rock

Family is a vital part of Lisa’s life. When she’s not researching or teaching, Lisa spends her time with her husband, Jeff, and their two little girls, Isabel and Eliana. They keep her super busy at home. On weekends, they visit a lot of parks and zoos, hike, and ride bikes. It was a lot of fun for Lisa and Jeff to watch their girls grow and learn. When asked if she and Jeff are expecting the girls to follow their chemical engineering careers, Lisa laughed and said they would rather educate them to be good citizens of the world and try to be supportive of whatever they wish to do with their lives.
Rice Mourns the Loss of Harry A. Deans

Harry A. Deans, a professor of Chemical Engineering at Rice University for 25 years, died near his home in Georgetown, Texas, on Dec. 22 at the age of 82.

“I’m saddened to hear of the passing of Dr. Deans. He was an excellent student, and was one of the better teaching faculty members at Rice. Students liked him and he had a way with words,” said William W. Akers, professor emeritus of Chemical Engineering and former vice president for administration at Rice.

Deans was born on June 17, 1932, in Dallas. He entered Rice at the age of 16, earning a B.A. in 1953, a B.S. in 1954 and a master’s degree in 1956. He was a Fulbright Scholar in Germany and Israel, and in 1960 Deans earned his Ph.D. in Chemical Engineering from Princeton University.

He joined the Rice faculty as an assistant professor of Chemical Engineering in 1959, became an associate professor in 1963, and a full professor in 1968. In 1974, Deans was awarded the George R. Brown Prize for Excellence in Teaching.

“I was a graduate student while Professor Deans was a faculty member at Rice. Harry is known throughout the petroleum industry as the inventor of the single-well tracer test to quantify the residual oil saturation remaining after water-flooding,” said George Hirasaki, the A. J. Hartsook Professor Emeritus of Chemical Engineering at Rice.

In 1984, Deans joined the chemical and petroleum engineering faculty at the University of Houston and remained there for eight years. He spent three years at Exxon Production Research in Houston before moving to a position at the University of Wyoming for twelve years. Deans’ work focused on developing enhanced oil production techniques. He was a member of the American Institute of Chemical Engineers and of the Society of Petroleum Engineers.

“Harry was one of the most outstanding teachers at Rice, and his research in petroleum reservoir analysis was also very well received,” said Sam A. Davis, a professor emeritus of Chemical Engineering who played bridge, golf and basketball with Deans, and went flying with him.

“In every case, I saw why he was such an excellent teacher. His introductory Chemical Engineering and reservoir analysis courses were rated excellent by everyone who took them. When he was in our department, we had active interactions with the students, and Harry was the reason. When he left, we had a huge hole to fill in our department and at Rice,” Davis said.

Survivors include his wife of 40 years, Beth Deans, of Georgetown, Texas; his former wife, Karolyn Deans of Tallahassee, Fla; a sister, Tish Keppel of Richmond, Va.; daughters Catherine Genzer of Wharton, Texas; Lauren Lillie of Tallahassee, Fla., and Melissa Steger of Pittsburgh, Pa.; sons, Daniel Deans of Ashburn Va, and Andrew Deans of San Diego, Calif.; a step-son, Greg Buckles of Houston; a step-daughter, Debbie Kimball of Fort Worth; and grandchildren Kayleigh, Paige, Nicole Collin, Cameron, Jonathan, Alex, William, Elizabeth, Daniel, Tristan and William.

Services were held at Christ Episcopal Church in Cedar Park, Texas, on Jan. 17 followed by a Service of Remembrance at the Havens’ Center of St. Stephen's Episcopal Church in Houston.

—Patrick Kurp, Engineering Communications

The family requests memorial gifts be made to Rice University for the Dr. Harry Deans Memorial Fund. These gifts may be made online at giving.rice.edu or mailed to: Rice University, Office of Development MS-81, P.O. Box 1892, Houston, TX 77251-1892.
STARTING UP DEXMAT

Commercializing Carbon Nanotube (CNT) Technology from Rice University
Authors: Dr. Dmitri Tsentalovich and Francesca Mirri – August 11, 2015

DexMat manufactures high-performance carbon nanotube (CNT) fibers and coatings for the aerospace market using a proprietary solution processing technology that was developed over the last ten years by a multitude of researchers in Professor Pasquali’s laboratory at Rice University. As graduate students in the Pasquali lab, our research focus was on understanding the key CNT properties and processing parameters required to make highly conductive, strong, flexible and lightweight CNT fibers and coatings. The properties of CNT fibers and coatings made in our lab were so good, that we were able to make prototype aerospace cables that performed as well as commercial cables, but were 40% lighter. We realized that this type of weight savings is highly desirable in aircraft and satellites and decided to form DexMat to commercialize the CNT technology.

The idea to form the company for making CNT materials had occurred to us through the course of our research. When we realized the myriad of potential medical applications for CNT fibers, in addition to all of the aerospace applications, we recognized there was a great opportunity for a company making high quality CNT fibers and coatings on a large scale. With Professor Pasquali on our team, we knew that we had the right technical people for DexMat to be successful. However, to help manage the company and bring manufacturing experience to the team, we also recruited Dr. Alberto Goenaga to serve as our CEO.

We immediately got to work on raising funds for our new venture. It was a lot of work, considering that both of us still had to work full time on finishing our PhDs. However, support and flexibility from Professor Pasquali, Alberto Goenaga, the CHBE department, and the Rice Alliance for Technology and Entrepreneurship enabled us to fulfill all of our commitments. Being trained as chemical engineering graduate students provides us technical credibility in the eyes of governmental and private investors. In addition, entrepreneurship courses at Rice University and mentorship from people we met through the Rice Alliance aided us in preparing a sound business plan for DexMat. Our hard work was rewarded in April when we won $67,000 in prize money at the Rice Business Plan Competition and again in May when DexMat was selected for a $150,000 Air Force Phase I SBIR grant. Currently, we are engaging angel investors and strategic partners to raise additional funds that will enable us to set up small production facility for producing CNT fibers and coatings at scale. Having already overcome a number of challenges we recognize there are many more to come. We confident that with our team and our technology, DexMat will be successful.

Having worked on producing CNT fibers and coatings in the lab for the past 6 years and we are thrilled to have the opportunity to develop a business that will actually apply this technology. While the first DexMat products will be used in aerospace cables, we are confident that our CNT materials will eventually be used as conductive thread in wearable electronics, electrodes in medical devices, and electromagnetic interference shielding in all types of electronics. We believe that CNT materials will enable the development of devices that are simply not possible to make today with rigid, heavy, metal-based conductors.

If you have a good team and you are excited about your technology and the problems that it will be used to solve, we think that starting your own company is absolutely worth it!
Dimethyl Ether and Potable Water Production in Somalia

East African countries currently face numerous environmental issues including deforestation and water scarcity. In Somalia, the majority of home cooking and heating is fueled through charcoal and may be reducing forest cover by 3% annually. Additionally, only 29% of Somalis have access to clean water and often travel up to 6 miles in dangerous conditions to obtain it. This year’s senior design project challenged the 2015 Rice ChBE Senior Design groups to address these issues. The groups were asked to design a facility that could produce enough transportation fuel to transport coal throughout Somalia to replace the usage of wood fuels as well as a facility that would generate agricultural and potable water for the surrounding community.

Somalia Energy Solutions, consisting of Taylor Boelkes, Carolyn Cooper, Ryan DuBois, Paige Horton and Xinran Liu chose to produce dimethyl ether, an organic compound that can be used as a substitute for diesel in train and truck engines, through coal gasification. In the process, coal is gasified by a British Gas/Lurgi gasifier to generate syngas. After sulfur removal, the syngas enters the water gas shift reactors to create a 1:1 ratio of H2 to CO in the syngas. The process stream then enters a single slurry reactor to convert the syngas directly to dimethyl ether, methanol, and water. The stream leaving the reactor enters a liquid gas separator to remove the vapor before entering a dividing wall distillation column. The dimethyl ether, methanol, and water are then separated at purities above 99%. The dimethyl ether is used for transportation fuel. The methanol is sold to the surrounding textile industry for use in their processes.

The water is sold as agricultural water since it could contain methanol. Additionally, the facility needed to produce its own electricity and steam due the lack of infrastructure in the surrounding area. Heat integration of the process was used in order to provide steam. A solar thermal energy system was used in order to generate the required electricity. Due to the lack of potable water in Somalia, Somalia Energy Solutions wanted the design to generate a significant amount of potable water. To accomplish this, a multiple effect distillation unit was used in order to generate enough potable water for approximately 780,000 Somalis. Somalia Energy Solutions believes that the plant would have a capital cost of approximately $150 million and would break even in its fifth year. Ultimately, Somalia Energy Solutions believes that there are much simpler ways to reduce deforestation in Somalia. However, due to Somalia’s current lack of infrastructure and political stability, Somalia Energy Solutions believe that the design is a realistic and cost effective solution to the current environmental issues.
The graduate students here at Rice University’s Chemical and Biomolecular Engineering Department (ChBE) are leading the revolutionary research of the next generation. Inclined to tackle challenges that perplex professionals and scientists alike, the diverse research groups think in the most unconventional yet pragmatic way to solve the day-to-day problems affecting our society and environment. Issues like recovering oil from harsh conditions and discovering cures to eliminate cancerous cells create the foremost front of their investigation. The students conduct experiments, attend conferences, and collaborate with each other to produce multiple journal papers citing their expanded knowledge. Their meticulous and compelling revelations are manifested in the descriptions below.

We encourage you to take a tour through each of the three subdivisions’ distinct areas of study and draw inspiration from them.
**Biswal Group**

The Biswal research group is best known for its multidisciplinary projects. These projects are separated into two parts: energy-based and micron-scale soft matter sections. In the energy section, a large emphasis is placed on mobility control to extract crude oil. Interfacial phenomena under the stresses of reservoir conditions are studied with high pressure, high temperature systems. Microfluidics is applied to investigate the deposition and inhibition of asphaltene in porous media. The Biswal group is also developing novel silicon based anode materials for improved lithium ion batteries.

In the soft matter section, they use external magnetic fields and bead-bead polymer linkers, geometries such as chains, lattices, and droplets to synthesize and manipulate as models for atomic-level polymer and crystal systems.

**Chapman Group**

In the Chapman research group, statistical mechanics, molecular theories and structure-property relations in complex fluids reign at the top of its priorities. The current projects focus on polymer solutions, associating fluids (patchy colloids), confined fluids in shale formation nano-pores, asphaltenes and electrolytes. The students utilize molecular simulation, NMR and experimental techniques to validate their theoretical models. This year in May, they organized a three day international conference to discuss the applications of Statistical Associating Fluid Theory (SAFT), an EoS developed by Dr. Chapman. The conference was popular amongst engineers spanning several countries, industries, and institutions.

**Hirasaki Group**

The Hirasaki group works in close collaboration with Biswal’s research group. Its research areas include the study of low-tension surfactant and foam flood for Enhanced Oil Recovery (EOR) processes, asphaltene deposition, core analysis, gas hydrates and carbon capture and storage. Different foam processes are developed to control the mobility of gases for a variety of reservoir conditions. Recently, they have successfully tailored a strong-foam-ultra-low-tension surfactant formulation that has the potential to greatly improve the oil recovery efficiency in fractured reservoirs. Compared with conventional foam processes, in which only fluid-mobility control is achieved, the new formulation not only generates strong foam but also decreases the water-oil interfacial tension to ultra-low values and eliminates the capillary forces that trap the oil in reservoir matrices.

**Miller Group**

The Miller group, in collaboration with Professor Hirasaki, has been researching development of processes to use surfactants for increasing recovery of petroleum from existing reservoirs. Approximately two thirds of the oil that has already been discovered in the world cannot be recovered economically with current technology. Suitably chosen surfactants can permit recovery of oil that has been bypassed or trapped in the pores of reservoir rock during water flooding. Therefore, finding surfactant formulations effective in reservoirs that have high temperatures and salinities is their primary objective. For surfactant and other enhanced oil recovery processes to be successful, it is necessary for the injected fluids to contact a large portion of the reservoir; meeting this criterion is challenging because reservoirs are typically highly heterogeneous in permeability. Injection of gas with surfactant can lead to foam formation in paths through the reservoir, thus causing more resistance to flow, and thereby diverting the surfactant solution to less porous sections of the reservoir and increasing process efficiency. The research deals with finding surfactant formulations that produce stable foams at high temperatures and salinities and in the presence of crude oil.

**Vargas Group**

The Vargas group is focused on developing innovative experimental approaches and simulation tools. These advances will help scientists understand and predict the structure, phase behavior, thermodynamic and transport properties of complex fluids, at high temperatures and pressures. An important component of their current research program is finding solutions to major flow assurance problems in the oil industry, such as asphaltene deposition. Furthermore, they develop integrated approaches for an efficient and sustainable enhancement of the production of conventional and unconventional energy resources.
Pasquali Group
The Pasquali group focuses on the flow of complex fluids and the behavior, processing, and application of carbon nanotubes (CNTs). The group explores properties such as phase and flow behavior in solution and CNT channels. The students also create macroscale CNT materials such as fibers, films, and foams which have applications in coaxial cables, batteries, and wearable electronics. Additionally, the group has been working to purify and process boron nitride nanotubes for use in high temperature applications.

Verduzco Group
The Verduzco group focuses on the development of complex polymeric materials. It employs advanced polymer synthesis techniques and nano-scale characterization tools to design and characterize polymers at multiple length scales. Currently there are four major areas of interest. Firstly, they harvest and store energy within all-conjugated block copolymers. Secondly, they manufacture bottlebrush polymers as functional materials with applications in surface modifiers, anti-fouling coatings and drug delivery. Thirdly, they study the shape change in response to external stimuli liquid crystal elastomers for biomedical applications. And lastly, they develop polymer coated nanoparticles for enhanced oil recovery. The unifying theme of this work is the combination of precision molecular design and synthesis along with quantitative analysis of structure, properties, and performance.

Wong Group
The Wong group is currently working on a variety of projects in which catalysts and nanomaterials are being applied to novel applications. The research program is studying exciting areas of energy (chemical production from oil/gas and biomass), downhole oil detection, enhanced oil recovery, and environmental cleanup (water purification). In developing and applying material synthesis techniques, they also explore the relationship between the structure and catalytic properties of various nanomaterials.

Gonzalez Group
Gonzalez’s research group recently engineered a functional reversal of the β-oxidation cycle that can be used as a general platform for the synthesis of short-, medium- and long-chain carbon products with structural and functional diversity. Through a system-level, quantitative assessment of the metabolic capabilities of the engineered reversal of the β-oxidation cycle, they demonstrated that product synthesis can be coupled with cell growth to achieve high fluxes, titers and yields. The superior capabilities of the β-oxidation reversal originate from its higher energetic efficiency, which is enabled by the use of acetyl-CoA as an extender unit. This engineered β-oxidation reversal is currently exploited in their laboratory for the production of alcohols, alkanes, and omega-functionalized products.

Nagrath Group
The Nagrath lab focuses on the biological systems of metabolic diseases, specifically cancer. Its aim is to understand the role of metabolism in cancer progression, growth, and metastasis. The students use genetic and metabolic design principles to analyze healthy and diseased biological states. By careful study of the results, they can develop potential therapies that exploit metabolic vulnerabilities in cancer. They are working to uncover the metabolic interactions between cancer cells and cells in neighboring tissues that support cancer growth and metastasis. Their research integrates both experimental and theoretical tools to develop a recipe for maintaining normal function of various organs. Their lab also makes a concerted effort to use engineering principles, such as multi-objective optimality and non-equilibrium thermodynamics to develop mathematical models for analyzing and understanding complex diseased states.
Dear Chemical and Biomolecular Engineering Student,

Congratulations. You’ve been spending the past several years of your life in one of the best universities in the world. Your investment in education will benefit you in ways you can’t imagine at this time.

What’s next for you? Oil and gas employment may be slow right now, but the upward part of the cycle will return in the foreseeable future. In addition, there are many more opportunities for someone with your background. ChBE graduates have contributed to traditional process industries such as chemicals, polymers, pharmaceuticals, food processing, agricultural products, forest products, minerals, and many other essential services to society with an annual value exceeding several trillion dollars. Low domestic prices for chemical feedstocks like natural gas are leading to a renaissance in the US chemical industry.

Your ChBE training in disciplines like conservation of mass and energy, transport phenomena, reaction kinetics, and process dynamics and control, along with strong backgrounds in advanced math, chemistry, biology, and physics enable you to create new products and processes. That knowledge provides a foundation for understanding, modeling, and making beneficial changes to numerous natural and artificial phenomena, such as the environment and living organisms. Society has a great need to replace older process technologies with greener, safer, and renewable processes and products.

Above all, at this most critical time in human history expect the world to change even more rapidly than it has in the past. In response, be flexible and prepare to benefit from new opportunities.

Best wishes for continued success,

Vic Edwards, BA ChE, 1962

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Dr. Victor Edwards is the 2015 recipient of the Norton H. Walton/Russell L. Miller Award from the Safety and Health Division of the American Institute of Chemical Engineers. This award is the highest award sponsored by the Safety and Health Division of AIChE given for process safety engineering efforts. Dr. Edwards was instrumental in the creation of the annual Process Plant Safety Symposium, which is now a part of the Global Congress on Process Safety held annually as part of the Spring National Meeting of AIChE. He chaired the first Process Plant Safety Symposium in 1992 and the 1997 International Plant Operations and Design Conference. In 2013, Vic chaired the AIChE Global Congress on Process Safety. Vic has contributed more than sixty publications to the engineering literature, including several book chapters and section 10 of the Chemical Engineers’ Handbook. Edwards earned his B. A. from Rice University and his Ph. D. from the University of California at Berkeley; both degrees in chemical engineering.
The application of chemical engineering skills to the manufacture of renewable chemicals through microbial means is a growing career option for ChemE student. Renewable chemicals include biofuels, commodity chemicals, specialty chemicals, nutraceuticals, etc. The markets for these renewable chemicals are expanding for multiple reasons. For some compounds, synthetic chemical routes do not exist. For other compounds, end users seek to avoid the uncertainty of crude oil prices or simply prefer a cheaper renewable alternative. By combining the traditional chemical engineering skills of thermodynamics, reaction engineering, and heat/mass transfer with knowledge of biochemistry, cell biology, and microbial genetics, a bioengineer is a valuable player in the process of bringing these renewable products from academic idea into commercial reality.

There are many roles that a bioengineer can play in the process. The first division is between Process Development and Process Engineering. There is some overlap, but process development mostly deals with designing lab and pilot scale experiments and process engineering mostly deals with designing commercial scale plants. Another division is between Upstream and Downstream. Upstream deals with the fermentors and the production of the chemical and requires deep knowledge of microbial processes. It is concerned with pre-treatment of the feedstock, storage of the feedstock, the microbial seed train, etc. Sterilization of the reactors, the medium, and the feedstock may be required. Downstream deals with the resultant broth from the fermentation. Downstream is concerned with byproduct removal, meeting product specifications, minimizing wastewater disposal costs, recycling water to the front of the process, etc.

To prepare for a career in renewable chemicals, I would try to acquire the following skills. First of all, get experience growing cells in bioreactors. The bigger the bioreactor, the better. It is good to know how to clean, operate, and maintain the reactor and the associated equipment. Secondly, become intimately familiar with the E. coli metabolic network and how it operates under different conditions: aerobic vs anaerobic, sugar vs glycerol vs fatty acids, fed vs carbon-limited, different temperatures, different pH's, genetic deletions, genetic over-expressions, etc. The biochemistry textbooks give the basic metabolic pathways, but that's analogous to a genome sequence. It's a parts list, but the interactions between the parts is where the action is at. One needs to ably manipulate this metabolic network through design of process conditions to produce a desired product. This knowledge is found by reading the literature and by experience. Thirdly, be familiar with process modeling software, such as AspenONE and SuperPro. The first two skills lean more towards process development and the third skill leans more towards process engineering, but it's good in any case to have some fluency in all three skills.

- Matthew Wong, Ph.D.
Rice ChemE students have many tough decisions to make throughout the degree period, the least not being if Baker 13 should be part of one’s memories. Other important topics on career development include which ChemE focus track or electives to complete, which internships or co-ops to take, and/or which research opportunities to pursue. The ChemE program offers a foundational education that has relevant application in nearly every industry. It includes learning the language to setup a problem, develop and apply solutions, and communicate technically and professionally. I’ve taken to heart that the university will teach the backbone of what is needed for a career in ChemE, and the remainder of the education will come from personal motivation and job requirements. Although centered in the oil and gas hub that is Houston, Rice ChemE graduates take a variety of jobs across all industries. Chemical engineering has been notably applied in the oil and gas field, and many fundamental concepts lend themselves to oil and gas applications, but every chemical engineering student should understand that each industry benefits from chemical engineering and the same fundamental concepts lend themselves to other industrial applications.

As you plan your technical education track, it should include adventuring into different applications of the fundamental chemical engineering concepts – biological, energy, food, environmental, materials, etc. It's important to learn what is personally interesting and what is not. However, once a dream industry is chosen (be prepared to adjust!), it is not required to mainly take classes that focus on your chosen dream industry. As concepts are introduced in the context of one industry, mentally re-apply the same concept to your industry of choice. This skill will enable you to research your dream industry, engage your creativity and critical thinking, and make you flexible and effective on-the-job as you approach new problems. Even while you are still a student, look for opportunities to apply fundamental concepts from the classroom in non-classroom venues – Engineers Without Borders, ChemE Car, or a research project with a professor, to name a few. Regardless of what your dream industry is, these skills will prepare you to be successful. Equally important is the “soft skills” education track during your college career. Present your ideas, work, or research and maximize each opportunity to develop communication - technical, managerial, and operational communication all look and feel different. Network with graduate students, professors, and professionals, as opportunities abound in many industrial fields, if you merely ask.

In conclusion, your education should be a firm foundation that will be continually built upon as you work. Gather “tools” and learn their limits, and continually add to your “toolbox.” After you graduate, you cannot guarantee which industry you will land in, but a fluid understanding of the fundamentals will prepare you well for the challenges of a full career.

-Nick Hoeft
Daniel Allison
After Rice, Daniel spent the summer working as a chemical engineer at a cotton seed oil manufacturing plant in Itumbiara, Brazil. Daniel returned to attend law school at University of Virginia, and graduated in 2008. After law school, Daniel returned to Houston to practice corporate finance law at Vinson & Elkins. Daniel is currently a senior associate in the corporate finance group at Sidley Austin and advises institutional lenders and borrowers on a variety of financing transactions, primarily focused on the various aspects of the energy industry. Daniel and his wife, Erin, enjoy traveling, cooking and wine.

Laura Hall
After graduation, Laura worked as a process engineer for Lyondell. Laura left Lyondell because she felt homely in the Nomex jumpsuit that Lyondell forced her to wear, and because she knew that she would never achieve her life-long dream of becoming a trophy wife in that jumpsuit. Laura graduated from Berkeley Law in 2011, and she now practices patent litigation in Newport Beach, California. Despite the odds stacked against her, Laura finally found a man to marry. Laura is still working with Margot to improve Margot's appearance and poise; it's an ongoing process.

Margot Herrman
After Rice, Margot took a job as a process engineer while living in Houston with fellow CHBE grad Laura Hall. With Laura's encouragement, Margot decided to capitalize on her good looks, poise, and singing talent by joining the pageant circuit in North Dakota. After winning second runner-up for Miss Fargo twice but falling short at the state level, Margot decided it was time to pursue greener pastures in California. Today, she is trying to be the next Marissa Mayer out in San Francisco, California where she resides with her main dude Randy, and her gigantic Border Collie, Paris.

Karen Alexander Horowitz
After Rice I went to law school at the University of Washington in Seattle and graduated from there in 2008. I am now working as a lawyer for Thurston County (Olympia), Washington. I am married to another former Rice student, Neal Horowitz (Baker '05). We have two kids, ages 7 and 2.
Class of 2005 A Few Updates...

Chapman McDaniel
Since graduation, Chapman has worked as a Reservoir Engineer at Shell. During that time, his work has taken him to projects in California, Brasil, Canada and the Netherlands. Chapman met his wife Margaret in 2011 in New Orleans, where they now reside with their dog Bonnie. Chapman’s current hobbies are cooking and visual arts. His achievements in this area include a Tetris bookshelf, built with fellow Rice Alum Cris Hussar.

Venmathy Rajarathinam
After Rice, Ven obtained her PhD in chemical engineering from Georgia Institute of Technology. Ven’s extremely proud parents still display this degree in their home to this very day. Ven began working for Intel Corporation in 2010, first in Hillsboro, OR and now in Chandler, AZ. She works on the development of materials for future (often secret) products and technologies. When Ven is not creating awesome tech for the future, she likes to spend time volunteering in literacy and STEM programs, traveling, cooking and exploring new restaurants with her wonderful husband Rob (who is writing this summary), her many friends, and their dog, Marvin (he travels quite well actually but prefers quiet evenings in the Arizona warmth).

Scott Selinger
After being disavowed as a graduate by the Chubby department, Scott was lost in a sea of bewilderment. The mid-2000's were a simpler time, before millennials started crowd-sourcing memes and live-streaming blogcasts, and Scott just felt like it was time to disappear back into nature. The conscious uncoupling from society took him from San Antonio, up the Rio Grande and Colorado Rivers to rural Oregon, where he worked briefly as a park ranger and a technician at a sensory deprivation chamber. As usually happens to wayward young men and the The Beverly Hillbillies, Scott eventually realized that Californie was the place he ought to be, so he loaded up his truck and moved to Redwood City, now living as a kept man, littermate, manny, and primary care physician for his wife Claire, dog Poppy, daughter Sadie, and a bunch of California techie hippies, respectively.
Alumni Advisory Committee

The CHBE Alumni Advisory Committee was established in 2009 and has been active over the past 6 years supporting the CHBE department, alumni, and students. Over the past year we have set up sub-committees which each focus on the following specific areas.

Newsletter - Produces the annual CHBE Newsletter. Writes articles, collects alumni updates, edits, and coordinates the distribution of the newsletter to all Rice Chemical Engineering alumni.

Corporate and Development - Enhances long-term connections between companies, the department, and the Alumni Advisory Committee.

Networking - Holds network events for students, alumni, and faculty. Coordinates mentoring activities between alumni and students and works with the AICHE student chapter and Graduate Student Association (GSA).

Website - Maintains the Alumni section of the CHBE website and organizes social media outreach to alumni.

We are always looking for enthusiastic alumni to help serve on the committee or work on projects. If you are interested in joining one of our Sub-committees, contact Garrick Malone (gmalone@alumni.rice.edu) and Charles Meyer (charles.meyer@shell.com).

As a reminder, we send out event reservation information through the Rice alumni office, so make sure your contact information is up to date on the online alumni directory (https://online.alumni.rice.edu).
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You can make a tax-deductible donation to our department at giving.rice.edu.

Here are some suggestions for department initiatives that can be supported by your gift:

- **Undergraduate Support**
  - Lab Equipment and Repairs (Please list fund number G81612/715000 in the special instructions box)

- **Faculty Support** (Please indicate fund number G82873/715000 in the special instructions box)

- **Paid internships within ChBE** (Please list fund number G81613/715000 in the special instructions box)

- **General Support** (Please indicate fund number G80609/715000 in the special instructions box)

- **Graduate Recruiting** (Please list fund number G81430/715000 in the special instructions box)

Feel free to contact our Department Chair, Michael Wong (mswong@rice.edu), for additional opportunities.

Our faculty, staff, and students thank you for the continued support!