Chemical Engineering at . . .
The University of Tulsa

GEOFFREY L. PRICE

Collins Hall and the main entry to the university.

When people think of Oklahoma, they often think of the Dust Bowl of the 1930s and images of drought, or perhaps Indian country with miles of undeveloped wilderness. As different as the modern Department of Chemical Engineering at the University of Tulsa is from such images, the department *was* founded in the 1930s and the university was originally a school for Native American girls, a heritage of which we are proud. We have become a high-quality program, perhaps slanted a bit toward undergraduate teaching, but certainly well balanced in teaching and research. We offer an ABET-accredited B.S. degree, a Master of Science degree (which is research-based), a Master's of Engineering in Chemical Engineering degree (which is coursework-based), and a Doctor of Philosophy (Ph.D.) degree.

THE UNIVERSITY SETTING

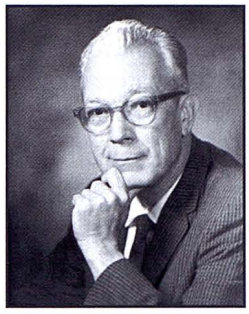
The University of Tulsa (TU) is a comprehensive, private university, providing education in Arts and Sciences, Business, Engineering and Natural Sciences, and Law. Our 200-acre campus is just a few miles east of downtown Tulsa. The campus is beautifully maintained with Tennessee ledgestone buildings throughout the site. Current enrollment is 3,084 undergraduate students and 1,103 graduate students (including Law), with one in 12 undergraduates being National Merit Finalists. With 306 full-time faculty, the student-to-faculty ratio is 11:1. Even with the relatively small number of students, the university competes in NCAA Division I sports.

TU is currently 75th in the *US News & World Report* college and university rankings, with virtually unparalleled dedication to small-class sizes. This is the highest ranking TU has ever received in this publication, and marks the ninth consecutive year that TU has been ranked in the top 100. The *Princeton Review* has named the university one of the nation's best institutions for undergraduate education, citing the school's "unequivocal emphasis on academics." The university recently completed a $698 million comprehensive fund-raising campaign that created program support, built infrastructure, and established student scholarships and faculty endowments. There were 54 endowed professorships on campus in 2010-11.

The Department of Chemical Engineering is one of 10 departments and schools in the College of Engineering and Natural Sciences (ENS). ENS is the largest of the colleges on campus with 1,195 undergraduate students enrolled in 2010-11. Currently housed primarily in Keplinger Hall, TU has embarked on a massive expansion that includes the addi-

tion of two new ENS buildings: J. Newton Rayzor Hall and Stephenson Hall. Rayzor Hall was completed in 2011 and will house the Electrical Engineering and Computer Science departments, and Stephenson Hall will be completed in 2012 and will house the McDougall School of Petroleum Engineering and Department of Mechanical Engineering.

The Department of Chemical Engineering has nine full-time faculty. Undergraduate enrollment was 124 and graduate enrollment was 27 in the 2010-11 school year. Like many other chemical engineering programs around the country, the department has been growing in student numbers for the last seven years. Nonetheless, our student-to-faculty ratio has remained very low, and it is similar to the campus-wide ratio. Because of the low student-to-faculty ratio, the faculty are able to devote considerable effort to both undergraduate teaching and research. The historical trends in student population and B.S. graduates are given in Figure 1.



Wilbur "Doc" Nelson, founder of the Chemical Engineering Department.

HISTORY

Looking back into the foundations of the Department of Chemical Engineering, an important day was Nov. 22, 1905. This was the date that the first drilling operation struck oil over what became known as the Glenn Pool, near the modern day city of Glenpool, OK, about 17 miles south of Tulsa. Glenpool is known as the town that made Tulsa famous. The drilling activity and oil production that escalated rapidly from the discovery of the Glenn Pool, which was the largest oil field known, spurred the growth of Tulsa, and Tulsa soon became known as the "Oil Capital of the World," a moniker it maintained through the 20th century.

Meanwhile, the Presbyterian School for Indian Girls, founded in 1882 in Muscogee (modern spelling "Muskogee"), OK, became Henry Kendall College in 1894, and moved to Tulsa in 1907. Because of the importance of oil in the area and the vast financial interests spawned by the oil industry, as Henry Kendall College grew in Tulsa many students, alumni, trustees, and supporters were involved in the oil industry. Henry Kendall College became the University of Tulsa in 1921.

The School of Petroleum Engineering at the University of Tulsa began in 1928. **Waite Phillips**—brother of **Frank Phillips**, the founder of Phillips Petroleum Company—donated money to build the first Petroleum Engineering building in 1929. **Wilbur L. "Doc" Nelson** joined the university as the first head of Petroleum Engineering in 1930, and in 1932 Petroleum Engineering was divided into production and refining entities, and Doc Nelson became head of Petroleum Refining. In 1937, two B.S. engineering degrees were offered at the University of Tulsa, in petroleum engineering and chemical engineering. Doc Nelson became head of the Chemical Engineering Department in 1939 when its modern name was taken. Nelson remained head of the department until 1954 and taught part-time through 1972.

Nelson is easily recognized as the person that brought the department to national and international prominence and is often called the founder of the department. The *Oil & Gas Journal* published more than 2,000 articles by Nelson, and his book *Petroleum Refinery Engineering* became the worldwide standard. The Nelson Index, an index that describes a measure of the complexity

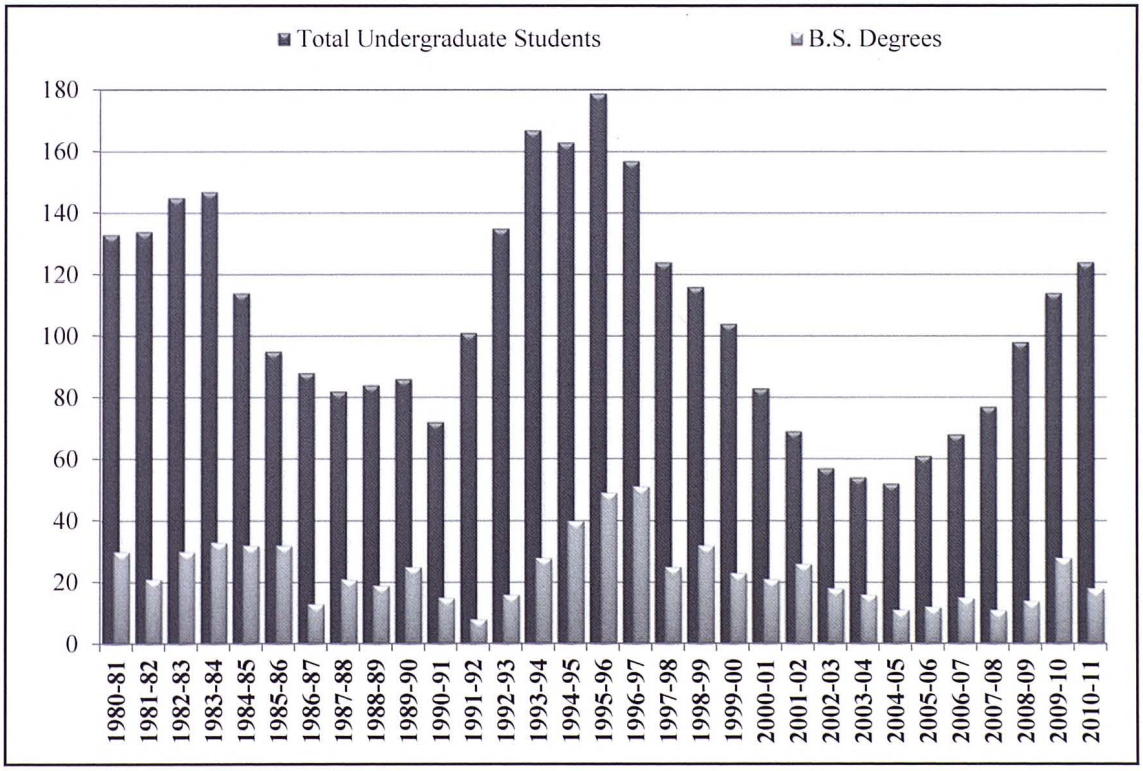


Figure 1. *Trends in undergraduate student populations and graduation rates.*

of petroleum refineries, is still in use today. Under Nelson's leadership, the department became internationally recognized for its program, which emphasized petroleum refining. Professor **Paul Buthod**, who authored the heat transfer chapter in Nelson's refining book, served as department chair for 14 years and was responsible for maintaining and expanding the department's reputation in petroleum refining. Buthod was truly a legend at TU, winning numerous outstanding teacher awards. In 1967, the department was granted a Ph.D. program, and in 1968 Professor **Francis S. Manning** was brought in as chair to help develop the fledgling program. Soon, the department was graduating two to three Ph.D.'s every year because of the many gifted students who came to study.

Since that time, the department has maintained a strong undergraduate program suitable for careers in oil, gas, and energy, but also diversified particularly into alternative energy and environmental areas. Today, alums of the department hold positions in a diverse array of chemical engineering sectors.

Another important event, more in the recent history of the department, was the formation of the Industrial Advisory Board in 1979. This Board meets twice per year, and helps keep the department in touch with the practical aspects of chemical engineering. A listing of the current advisory board members is in Table 1.

TABLE I
Department of Chemical Engineering
Industrial Advisory Board

Ken Agee, President Emerging Fuels Technology
Mark Agee, Investor and Consultant
J. David Iverson, Managing Director Kayne Anderson Capital Advisors
Dan Lansdown, Process Consultant Domain Engineering
Chris Mayfield, Process Engineer ONEOK Partners
Calvin C. McKee, President (retired) Warren Petroleum Company
Tom Russell, CEO Thomas Russell Co.
Tom Steiner, President Vaprecom, Inc.
W. Wayne Wilson, Senior Fellow Emeritus ConocoPhillips Company
Omar Barkat, Executive Director PetroProTech
Wayne Rumley, CEO R&R Engineering Co., Inc.
Rakesh (Rock) Gupta, Manager of Engineering Thermal Process Engineering, Inc.
Jim Beer, Sales Engineer Hartwell Environmental Corporation
Darla Coghill, Science Department Chair Will Rogers College High School, Tulsa, OK
Chris Collins, Senior Analyst CITGO Petroleum Corporation
Jon Edmondson, Business Planning Mgr - Alaska Shell Exploration & Production Company
Reed Melton, Vice President Thermal Process Engineering, Inc.
Derrick Oneal, Process Engineering Manager Thomas Russell Co.
Troy Reusser, Vice President Koch Methanol, L.L.C.
Sharon Robinson, Senior Vice President Copano Energy, L.L.C.

FACULTY

The department consists of nine full-time faculty members, and all have Ph.D.'s in chemical engineering. Ages, interests, and academic experience levels are diverse: The latest two joined in Fall of 2008, while the most senior arrived in 1968.

Selen Cremaschi, assistant professor, earned both her B.S. (1999) and M.S. (2001) degrees from Bogazici University (Turkey) and received her Ph.D. (2006) from Purdue University, all in chemical engineering. During her Ph.D. studies, she worked as a research assistant at the NASA Specialized Center of Research and Training in Advanced Life Support (ALS/NSCORT), and her work focused on developing novel algorithms for process synthesis and design optimization under uncertainty. Following her graduation, she served as a post-doctoral research associate and assistant research scientist in e-Enterprise Center of Discovery Park, Purdue University, before joining our department in 2008. Her research interests are in process synthesis, design, and optimization under uncertainty. Her research group works at the intersection of operations research and chemical engineering, and develops

Chemical Engineering faculty in Keplinger Hall. Left to right: Ty Johannes, Laura Ford, Geoffrey Price, Christi Patton Luks, Selen Cremaschi, Dan Crunkleton, Frank Manning, Keith Wisecarver, and Kerry Sublette.

systems analysis and decision support tools for complex systems, especially for the energy area. Cremaschi received a Tau Beta Pi Teaching Excellence award in 2010 and an NSF CAREER award in 2011.

Wellspring Assistant Professor **Tyler (Ty) Johannes** also came to the department in 2008. He brings biochemical engineering expertise to the department and his areas of research focus are synthetic biology, directed evolution, and bioenergy. Johannes holds a B.S. in chemical engineering (2002) from Oklahoma State University, and both an M.S. (2005) and Ph.D. (2008) in chemical engineering from the University of Illinois. His current work focuses on engineering microalgae for the production of natural products and biofuels. He is also a licensed professional engineer.

Associate Professor **Daniel Crunkleton** is an alumnus of the department, receiving his B.S. in 1995. After his undergraduate studies, he attended the University of Florida as a NASA Graduate Student Research Fellow, receiving his Ph.D. in 2002. Following a post-doctoral appointment at Vanderbilt University, Crunkleton joined our department in 2003. While serving as full-time faculty, he attended law school at the University of Tulsa, and obtained his J.D. in 2008. He is also a registered professional engineer, and is the director of the Alternative Energy Institute at the University of Tulsa. His areas of research interest are alternative energy, algae biofuels, and computational fluid dynamics.

Geoffrey Price, professor and department chair, joined the faculty as chairman in 2000. He holds a B.S. from Lamar University (1975) and Ph.D. from Rice University (1979), both degrees in chemical engineering. Prior to his appointment in his current capacity, he served on the chemical engineering faculty at Louisiana State University - Baton Rouge for more than 20 years, and is emeritus professor there. He is a Fellow of the AIChE and his research interests are in heterogeneous catalysis, particularly zeolite catalysis. Current work is focused on catalytic conversion processes applied to the production of biofuels.

Laura Ford, associate professor, joined our faculty in 1999, while completing her Ph.D. in chemical engineering at University of Illinois at Urbana-Champaign the same year, and where she also obtained an M.S. in 1997. Her undergraduate degree is from Oklahoma State University (1993). Her research is on the dry etching of metals and photovoltaic alloys, studying the kinetics of the etching reaction under low vacuum conditions. The effects of oxidant, temperature, total pressure, and surface treatment have been studied. Ford is also an investigator in the University of Tulsa Hydrates Flow Performance joint industry project, where she studies the remediation and prevention of hydrate plugs.

Christi Patton Luks began her academic career in the department in 1997 as senior lecturer. She now holds the position of applied associate professor. Luks has a B.S. in chemical engineering from Texas A&M University (1981), an M.S. in applied mathematics from the University of Tulsa (1988), and a Ph.D. in chemical engineering from the University of Tulsa in 1992. She studies innovations in chemical engineering pedagogy and effective ways to blend technology with learning. She has received numerous teaching awards at the University of Tulsa including the most prestigious, university-wide Outstanding Teacher Award. She works actively with Engineers Without Borders, Society of Women Engineers, American Society for Engineering Education, American Institute of Chemical Engineers, and numerous other organizations.

Professor **Keith Wisecarver** has expertise in the general area of multiphase reactor design and modeling, multiphase flows with reaction, and computer-aided process design, particularly as applied to petroleum refining and other energy processes. The main thrust of his current research is in the field of delayed coking, a petroleum refining process that uses high-temperature thermal cracking to convert the heaviest cuts of crude oil to lighter fractions such as gasoline, diesel, and gas oil, plus petroleum coke. He is co-principal investigator for the Tulsa University Delayed Coking Project (TUDCP), a research consortium of 19 energy-related companies. Wisecarver holds B.S. (1979), M.S. (1983), and Ph.D. (1987) degrees from Ohio State University. He is also a licensed professional engineer.

Kerry Sublette is the Sarkeys Endowed Professor of Environmental Engineering. In addition to his primary appointment in chemical engineering, Sublette also has a joint appointment in the Geosciences Department. He holds a B.S. in chemistry from the University of Arkansas, an M.S. in biochemistry from the University of Oklahoma (1974), and both an M.S.E. (1980) and Ph.D. (1985) in chemical engineering from the University of Tulsa. His research interests include bioremediation of petroleum hydrocarbons, restoration of soil ecosystems, ecological indicators of soil restoration, remediation and restoration of brine-impacted soil, and subsurface microbial ecology of groundwater impacted by hydrocarbons and chlorinated hydrocarbons. He has been a faculty member in the department since 1986.

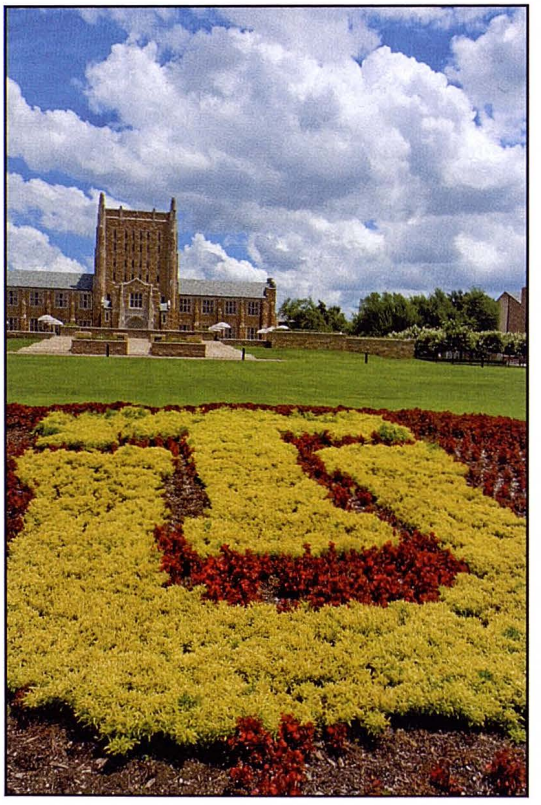
The longest-serving member of the faculty is Frank Manning, mentioned previously. Manning came to the University of Tulsa in 1968 as department chair after a successful academic appointment at the Carnegie Institute of Technology (now Carnegie-Mellon) from 1959-68. Manning was born in Barbados, and studied in Canada at McGill University where he earned a B. Eng. degree in 1955. He also holds M.S.E (1957), A.M. (1957), and Ph.D. (1959) degrees from Princeton University. The AIME awarded him the R.W. Hunt silver medal for a Transactions of the Metallurgical Society paper in 1969. His current interests are in oilfield processing of crude oil, natural gas, produced water, and natural gas plants. He is currently revising his two books, *Oilfield Processing of Petroleum: Vol. I – Natural Gas* and *Vol. II – Crude Oil*, which have been well received by industry and adopted as

The TU experience . . .

Engineers Without Borders in Contani, Bolivia, installing a solar heating system. Left to right: ChE student Jasmine Htoon (the "T" in "TU"), ChE student Tsebaot Lemma, local professional and sponsor Jon Taber, ChE student Weston Kightlinger, Engineering Physics student Tim Brown, ChE student Sarah Edenfield, ChE faculty sponsor Christi Luks, and ChE student Philip Goree (the "U" in "TU").

Christina Bishop Jackson, Chemical Engineering Ph.D. student (now alumna) using a scanning electron microscope to study nanostructured battery electrolyte materials.

Congressman John Sullivan (in pink tie) visits the algae-to-fuels project in the Chemical Engineering Department. Left to right: Professor Geoffrey Price, Associate Professor Daniel Crunkleton, Sullivan, and congressional staffer Richard Hedgecock.



McFarlin Library on the University of Tulsa campus.

texts worldwide. Manning has won five teaching awards at TU and also the Outstanding Teaching Award from the Midwest Section of ASEE (1999). He is a professional engineer licensed in Oklahoma and Pennsylvania.

UNDERGRADUATE PROGRAM

The Educational Objectives adopted by the faculty of chemical engineering are:

> *"to provide a foundation for successful chemical engineering careers in the petroleum, natural gas, chemicals, alternative energy, environmental, materials, or biotechnology industries, and for graduate studies in chemical engineering or related fields such as medicine, law, and business administration."*

The curriculum has evolved over the years, but would be considered a traditional program for chemical engineers. Option programs (discussed in more detail below) allow students to specialize in areas of personal interest.

The B.S. curriculum is a minimum of 131 hours of total coursework and it is built upon the Tulsa Curriculum, which is required of every undergraduate student at the University of Tulsa. The Tulsa Curriculum requires all students to complete 6 hours in aesthetic inquiry and creative experience, 12 hours in historical and social interpretation, 7 hours in scientific investigation, and 6 hours of writing. Mathematics proficiency is also required by the Tulsa Curriculum.

Highlights of the chemical engineering program include emphasis in computer-aided design, which we base on HYSYS simulation software. The curriculum includes two courses in process control, two senior-level laboratory courses, and traditional instruction through a capstone plant-design course. In addition to many electives that students select to satisfy the Tulsa Curriculum, students choose two senior-level engineering electives, two upper-level advanced chemistry electives, an advanced math elective, and a senior-level advanced science elective. These elective courses can be used by students according to their individual interests, or students can choose an option program that focuses coursework in one of four areas.

Option Programs

In addition to a general option where students have the widest flexibility to choose elective courses according to their own interests, we offer options in:

- *Petroleum Refining*
- *Environmental Engineering*
- *Materials*
- *Pre-Med*

As of this writing, the chemical engineering faculty have approved a business option and we are awaiting approval from campus curriculum committees for this to become an official offering. Students completing the business option (assuming it is approved) will have all the background required for direct entry into the University of Tulsa's M.B.A. program without having to take any remedial courses.

Undergraduate Laboratory Facilities

In 2003, thanks to generous support by an alumnus, a faculty member, and the College, the department added a Honeywell Process Control system—originally based on Plantscape, but now upgraded to Experion process control software—to the unit operations laboratory. **Art Roslewski**, retired engineer from Honeywell Corporation, comes in part-time to help students and to design control algorithms and process diagrams that are similar to those used in industry. The lab was remodeled when the Honeywell system was added so that the process control system resides separately in a "control room." Existing experiments, such as fluid dynamics and heat transfer experiments, were integrated into the process control system where it was feasible, and new experiments have been added. In particular, the laboratory now sports a 6" diameter by 10' high packed absorption column made of glass so that students can observe the column dynamics and flooding phenomena, and a 3" diameter by 12' high continuous distillation column with 11 theoretical trays. Among the wide range of other experiments are those focusing on heat transfer, fluid mechanics, and process control.

In 1991, the Chemical Engineering Department was the first department at the University of Tulsa to have its own departmental personal computer laboratory. Four alumni provided the startup funding and requested that the lab be named after Paul Buthod, who is now an emeritus professor. Our advisory board, many of whom were students of Buthod's, helped design the lab and provided additional funding. Generous support from local industries and alumni helps keep the computing lab furnished with the latest computing hardware.

Study Abroad

The University of Tulsa has a very active study-abroad program, and chemical engineering students can take advantage of these programs. We accept transfer credit from international universities from dozens of countries given in numerous languages. Academic advisors help students choose courses and schedules that fit each student's needs and career goals. Currently, 15 - 20% of our students have participated in study abroad, and the percentages are growing rapidly.

Undergraduate Research/ TURC Program

The Tulsa Undergraduate Research Challenge (TURC) is a campus-wide program that enables undergraduates to conduct research with University of Tulsa faculty, and students in chemical engineering often take advantage of this program. Students, working with a faculty mentor, prepare a short proposal and submit it to the TURC program. The number of successful proposals varies from year to year, but the success rate is generally extremely high. Students receive financial support for supplies and for student wages through the TURC program to conduct original research work that can lead to publications. Overall,

TURC scholars have brought prestige to the University of Tulsa by winning an incredible 104 nationally and internationally competitive scholarships, including Goldwater Scholarships, National Science Foundation Fellowships, Truman Scholarships, Department of Defense Fellowships, Udall Scholarships, Phi Kappa Phi Fellowships, Fulbright Scholarships, and British Marshall Scholarships.

TABLE 2
University of Tulsa AIChE Student Chapter ChemE Car History from 2000-2010

Date	Competition	Place	Award
Spring 2000	Mid-American Regional	St. Louis, MO	1st competition
Spring 2001	Mid-American Regional	Norman, OK	1st poster, 2nd competition
Spring 2002	Mid-American Regional	Iowa City, IA	1st poster, 3rd competition
Fall 2002	National	Indianapolis, IN	2nd poster
Spring 2003	Mid-American Regional	Lawrence, KS	3rd competition
Spring 2004	Mid-American Regional	Tulsa, OK	2nd competition, 2nd poster, most creative car
Fall 2004	National	Austin, TX	1st competition
Spring 2005	Mid-American Regional	Manhattan, KS	4th competition
Summer 2005	International	Glasgow, Scotland	1st competition
Fall 2005	National	Cincinnati, OH	2nd poster
Spring 2009	Mid-American Regional	Columbia, MO	3rd poster, most creative car
Spring 2010	Mid-American Regional	Ames, IA	2nd competition, 3rd poster

Student Organizations and Activities

The AIChE Student Chapter at the University of Tulsa has been very active and well organized for many years. Currently, Ty Johannes is the faculty advisor. AIChE generally sponsors annual trips to the AIChE Meeting and to the Midwest Regional student meeting. AIChE officers arrange for a speaker luncheon roughly every two weeks during the semester.

The AIChE ChemE Car Team has been one of the most successful teams in the nation, winning not only the national competition, but also the first international competition in 2005. The AIChE students also help sponsor an annual high school ChemE Car competition. A listing of the ChemE Car Team awards is given in Table 2.

A chapter of Omega Chi Epsilon, the chemical engineering honor society, was chartered at TU in April 2004. Christi Patton Luks is the faculty advisor. This group assists the department and college with recruiting and retention efforts. The chapter was responsible for the creation of ENS Ambassadors who give tours to college visitors. They also host study breaks during final exams and have helped build up a resource library for students in the Buthod Computer Lab.

Chemical engineering students are also active in other campus organizations including Tau Beta Pi, Society of Women Engineers (SWE), National Society of Black Engineers (NSBE), and American Chemical Society (ACS).

The University of Tulsa Student Chapter of Engineers Without Borders-USA (EWB) is advised by Luks and Ford. The chapter was started in 2006. EWB students have worked on several projects, including designing and building a kiln for a local Girl Scout camp and making water filtration pots from the Potters for Peace design. Recently, students and faculty advisors have been working in a village in the altiplano of Bolivia. With the Oklahoma East professional chapter, EWB has built eco-latrines (self-composting outhouses) for the village, which had fewer than five toilets of any kind when we started. The current project is designing a solar-heated shower and sink and an education program to encourage better handwashing in the community.

COMBINED BS/MS PROGRAM

Often called the 4/1 program, the combined Bachelor's-Master's degree program allows students to earn a B.S. and a Master of Engineering in chemical engineering (non-thesis master's degree) in five years. Students complete the regular coursework for the B.S. degree with the exception that some of the advanced engineering and science elective credit in the B.S. program are taken as graduate courses that are offered for outstanding students for undergraduate credit. These courses are then also counted as credit toward the Master's degree. Students in the combined B.S./M.E. program may either take a project course as part of the degree requirements, or pass the Master's comprehensive exam during their final semester of the combined program. The Master's comprehensive exam is a subset of the Ph.D. qualifying exam.

GRADUATE PROGRAM

The Department of Chemical Engineering at The University of Tulsa has offered a Master's degree program since 1939 and a Doctoral degree program since 1967. The department has a strong tradition in the energy and environmental fields, but has also diversified to offer research opportunities in materials engineering, biochemical engineering, advanced modeling and simulation, alternative energy, surface science, and catalysis.

Our current research focuses on modern experimental approaches and state-of-the-art computational studies. Our experimental approach to research allows investigation of fundamental phenomena as they are applied to "real world" problems, thereby enhancing our interactions with industry. Our computational studies address a wide range of complex

problems in multiple time and length scales, ranging from multiphase flow models to complete energy supply chains, hence helping to catalyze solutions to complex societal challenges. Graduate study in chemical engineering at the University of Tulsa offers a dynamic environment for challenging and stimulating research, and at the same time provides a close interaction between faculty and students.

Curriculum and Unique Features

Students may begin any program in either the fall or spring semester. The four core classes required for all programs cover fluid mechanics, thermodynamics, reaction kinetics, and heat and mass transfer at an advanced level. Electives offered recently include surface science, petroleum microbiology, environmental engineering, petroleum refinery design, natural gas plant design, catalysis, biochemical engineering, combustion engineering, and advanced process optimization.

The Doctor of Philosophy degree provides students with an opportunity to reach a critical understanding of basic scientific and engineering principles underlying their field of interest, and to cultivate their ability to apply these principles creatively through advanced methods of analysis, research, and synthesis. The doctoral degree is awarded primarily on the basis of research. Each student selects a research topic and advisor during the first semester of the graduate program and, in consultation with the research advisor, forms an advisory committee. A Ph.D. qualifying exam must be completed satisfactorily. After completing the qualifying exam, the student must submit and defend a research proposal on the intended dissertation topic. After completion of the research activity, the student will write a dissertation on the results of the research, and defend the dissertation before the advisory committee.

The Master of Science degree is a research-oriented program that requires the completion of a Master's thesis and defense of the thesis in front of the advisory committee. Twenty-one hours of coursework (including 12 hours of chemical engineering core courses) and 9 credit hours of research are required for the completion of this program.

The Master of Engineering degree is a non-thesis professional degree that can usually be completed in 12 to 18 months. The Master of Engineering degree is a good option for students who do not have a chemical engineering undergraduate degree and students who are more interested in advanced coursework than in research work. Twenty-seven hours of coursework (including 12 hours of chemical engineering core courses) are required for this program, as well as a 3-hour master's project, supervised by a chemical engineering faculty member.

Students who have not earned a Baccalaureate degree in chemical engineering are usually required to complete a series of undergraduate-level chemical engineering courses before formal admission into the graduate program. The specific course requirements are determined based on the undergraduate coursework completed by the student, and decided on an individual basis.

Facilities

The Department of Chemical Engineering operates modern, fully equipped research laboratories with a wide range of specialized and unique experimental equipment. Keplinger Hall provides comfortable and modern laboratories and classrooms. Analytical instrumentation available within the department includes gas chromatography, GC-MS, high-pressure liquid chromatography, mass spectrometry, x-ray diffraction, microbalance, catalytic and non-catalytic reactor systems, high-vacuum surface science equipment, and numerous other pieces of equipment for experimental research. TU's Chemistry Department is also housed in Keplinger Hall, and this facilitates a close collaboration between the two departments, resulting in the availability of further sophisticated instruments including NMR, SEM, Raman, and LC-MS. State-of-the-art computer facilities including commercial process simulators are available in the Paul Buthod Chemical Engineering Computer Laboratory and in graduate computing laboratories.

North Campus Research Center

In addition to traditional laboratories described above, the University of Tulsa also has pilot plant scale facilities at a 10-acre site two miles north of the main campus known as North Campus. Of particular interest to chemical engineering at North Campus is a Special Projects building and Hydrates building. Chemical engineering faculty are involved in delayed coking, catalysis, and hydrates research using much larger scale equipment than is generally available on college campuses. The Hydrates project includes a 3 inch diameter, 160 ft long, 1500 psi flow loop, a 50 ft long clear pipe jumper facility, and a direct electric heating dissociation facility. The Special Projects building has about a 10,000 ft^2 footprint with 24-foot-high space indoors with full indoor climate control. Equipment that the Chemical Engineering Department houses in the building includes two one liter high-pressure stirred catalytic reactor systems and the Delayed Coking facility. The Delayed Coking facility includes a 2 gallon batch reactor, a 10 gallon coker for studying foaming from 850 to 950 °F, and a micro coker.

Tallgrass Prairie Ecological Research Station

The University of Tulsa and The Nature Conservancy (TNC) jointly operate The Tallgrass Prairie Ecological Research Station in the Tallgrass Prairie Preserve northwest of Tulsa. Equipped with laboratories, classrooms, library and computer facilities, and overnight housing, the research station supports a wide range of ecological research projects conducted by scientists and engineers from all over Oklahoma and the world who come to the Preserve to take advantage of this unique 40,000-acre living laboratory. TU's participation in the Research Station began through the Department

of Chemical Engineering with a wide range of remediation projects related to oil and gas exploration and production on the Preserve. The need for a support facility within the Preserve was quickly apparent and a joint TU-TNC fund-raising campaign was launched that raised $2.4 million and saw the opening of the research station in 2004.

COMMUNITY OUTREACH

High School ChemE Car Competition

The department hosts a modified ChemE Car Competition for area high school students every spring. The high schoolers build a car powered by and stopped by a chemical reaction, and the competition is to see which team can get its car to stop the closest to a target distance announced just before the race. They may use commercial batteries and their cars do not carry a variable water load like in the AIChE national competition. The competition brings in an interesting mix of students, from 20 advanced placement chemistry students from a metro school to five students in basic chemistry at a rural school. The competition is intended as a recruiting tool for both chemical engineering as a profession and for the University of Tulsa, and some of the students have never been on a college campus before the event. The competition has been running for nine years with 89 teams total competing.[1]

Brownie Day

To promote science and engineering to the community, Luks brings 150 second- and third-grade Brownie Girl Scouts onto campus each semester for a day of math and science fun. With assistance from several departments, the students learn about science and engineering. The student AIChE chapter teaches the students about polymers through role playing where the students are assigned to be either a monomer or a cross-linker, then they make Gluep, a viscoelastic goo made from white glue and borax. The college students prod the girls to brainstorm engineering solutions to the manufacture of large batches of Gluep. The Brownies rotate through other hands-on activities where they learn the importance of designing a Lego™ bridge that is "on time, on budget, and on spec," visit a chemistry laboratory, experience statistics with M&M™ candies, and more. More than one young woman in our program today was first introduced to engineering at Brownie Day 10 years ago!

EXTRACURRICULAR

The University of Tulsa's Chemical Engineering faculty is a talented, dynamic group with a variety of research interests from biofuels and other alternative energy resources to directed evolution and zeolites. But this diverse bunch enjoys life outside the classroom just as much as they do inside:

- *Geoffrey Price and his sons are huge baseball fans, cheering for the Houston Astros and the LSU Tigers. Around Keplinger Hall, he's known for his extensive and colorful collection of neckties, most of which are provided by his wife who also is a Ph.D. chemical engineer.*
- *Frank Manning is in his office by 7:30 a.m. seven days a week (though he is sometimes "late" on Sundays) and enjoys following cricket worldwide, thanks to the Internet.*
- *Selen Cremaschi was a competitive ballroom dancer during graduate school. In fact, her husband was her dance partner before he became her life partner, and the two still hit the dance floor once a week at a local studio.*
- *Kerry Sublette cleans up nicely but is most at peace in a pair of jeans in the field working on his environmental projects.*
- *Dan Crunkleton apparently functions without sleep. The dedicated researcher is adjusting to life with a newborn baby at home and still manages to exercise every day.*
- *Christi Patton Luks is known as a scientist and mentor beyond Keplinger. A Girl Scout leader for 18 years, she also teaches a science class at her church and stirs up her own soap and cosmetics at home.*
- *Laura Ford is a Gregorian chant teacher and likes to commute to work by bike. Both activities may provide much-needed "recharging time" to Ford, who's busy raising five children with her husband who is a chemical engineer, too.*
- *Tyler Johannes maintains one of the neatest offices in the department and also kept order on the basketball court and baseball diamond, officiating games to help pay his way through college.*
- *Keith Wisecarver relishes foreign foods—Chinese, Japanese, Thai, and Indian—when he's out at a restaurant; but even when he's home, he cooks up a mean curry and can roll sushi like a pro.*

SUMMARY

Chemical Engineering at the University of Tulsa is a vibrant, accomplished group of students and faculty operating in concert for the educational benefit of students and the advancement of mankind through innovation, research, and ingenuity. The low student-to-faculty ratio fosters the close interaction of students and faculty, and excellent departmental and university resources add to the experience of all students. Best of all, the Chemical Engineering Department at the University of Tulsa is a close-knit community enjoying the university environment in an open and friendly manner.

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