ChE department

Chemical Engineering at . . .

OKLAHOMA STATE UNIVERSITY

◀ ***Theta Pond, on the path between classes and housing.***

▼ ***Design groups. Left to right: Seniors Jill Petersen, Melissa Hayes, Sally Gerhold, Ting Chung, Mike Hill, and T.J. Crowell collaborating on process design homework.***

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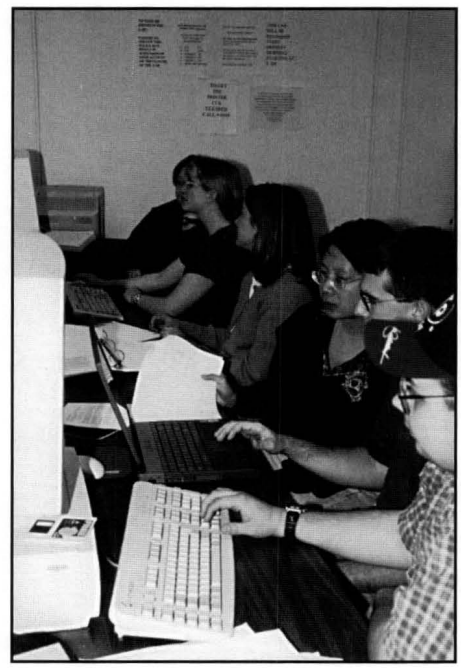


Quality in education has been a defining value in the School of Chemical Engineering at Oklahoma State University (OSU) since its inception in 1917. Developing students who will ultimately benefit their community has a different tone from simply challenging students on their ability to memorize facts and calculation procedures. While competency in the fundamentals of chemical engineering science and methodology remains important, developing people who are creative and effective within a team environment, who manage their own growth, and who make good things happen is the goal at OSU.

The school also has a mission to develop new knowledge and tools for engineering. This vision guides the graduate research program where students and faculty work closely together to both create and discover.

Students' first-place awards in national team design championships, their outstanding student-chapter awards, national scholarships, and performance on the Fundamentals of Engineering Exam are all testaments to the fact that human resource development is working at OSU.

STRENGTH IN THE TEAM

"I continue to be impressed with the collegiality of the faculty," says Dr. Karen High, whose specialty is optimization. This is a theme expressed by many of the faculty. In Jan Wagner's words, "What attracted me to OSU was the professionalism of the faculty throughout the college. They pull together." Jan's interest is safety and management of change. Kinetics expert Gary Foutch recalls the "candor, fun, mentoring, and support of the senior faculty. Decisions are made for the best interest of the School, not for individuals."

Mutual support among the faculty expresses the value that all benefit when any one individual has success. And whether cooperation is on research or on continuous improvement, the synergism and balance from partnerships makes the final result better. Collaboration is a value: it is a way of interacting with other people, and it carries over from the faculty to the undergraduate and graduate programs as well. Respect between faculty and students, and respect between students is important to the maximization of student learning and research performance.

Even while struggling to make sense of lab data, senior Melissa Hays recalls that "OSU followed through with a personal interest in me when I was seeking a college, and throughout my time here, I have always felt that the chemical engineering faculty care for and respect the students." Jake Dearman, also a senior, adds, "The main reason that I came here was because the campus was friendly and caring. Faculty want to see the students grow personally and professionally, and that atmosphere is conducive to learning." To integrate students into the program, all engineering students enroll in ENGR1111, where they are led by a faculty mentor, learn about engineering and about the values and attitudes promoted at OSU, and are encouraged to participate in school activities.

Chemical engineering is a difficult curriculum with a significant challenge—it must prepare students to use a complicated technology for the good of society. At OSU, students work in teams to help each other solve complex problems and to encourage each other through the personal ups and downs of the program. The faculty's open-door policy affirms the importance of the student's learning activity. Even the arrangement of faculty offices—suites off of one reception area—engenders a common team mission: "All for one, one for all."

The activities of the Student Chapter of the American Institute of Chemical Engineers and of Omega Chi Epsilon (the ChE honorary) also enhance student/faculty interaction. Events include formal speaker meetings, drop-in pizza dinner, golf tournaments, picnics, and service activities that integrate students and faculty. In fact, the AIChE Student Chapter has earned a National Outstanding Chapter Award for three of the past four years.

But it's not just a party. While it is fun, it is also hard work.

QUALITY

OSU was named "Best College Buy" by Institutional Research and Evaluation, Inc., in their *Student Guide to America's 100 Best College Buys: 1999.*

"As a former OSU student, I was familiar with the quality of the program and its potential for growth. I knew that I'd have many talented colleagues with whom I could associate in my research area of thermodynamics. I also felt a sense of loyalty and commitment to OSU," reflects Rob Robinson, Regents Professor, Amoco Chair, and former School Head. Long before the new EC 2000 criteria, the School established a tradition of continuous assessment, including feedback from an Industrial Advisory Committee, and experienced frequent revision of the priorities that guided its goals and objectives.

Chronology of Events

School of Chemical Engineering
Oklahoma State University

1890 Oklahoma Agricultural and Mechanical College (A&M) established

1907 Oklahoma Territory granted Statehood

1909 First chemical engineering course within Department of Chemistry

1917 Chemical Engineering BS Degree plan granted

1921 First BS ChE graduates

1938 AIChE Student Chapter granted

1947 Chemical Engineering moves from Chemistry to the Division of Engineering

1948 Policy: Each engineering student will take a course from each engineering program

1951 ChE Ph.D. program approved

1953 First ChE Ph.D. granted

1957 A&M becomes Oklahoma State University

1964 Omega Chi Epsilon (Mu Chapter) ChE Scholastic Honorary chartered

1964 Industrial Advisory Committee established

1966 Phillips Lecture Series in ChE Education started

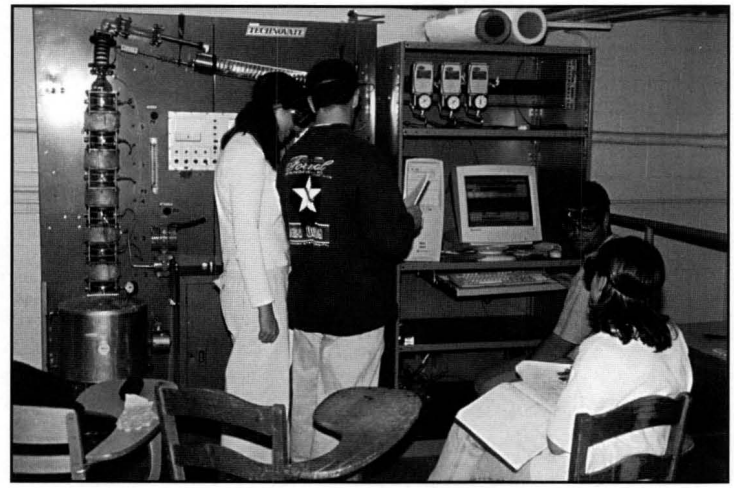
1984 Pre-medical BS option started

1993 Environmental Engineering BS option started

While competency in the fundamentals of chemical engineering science and methodology remains important, developing people who are creative and effective within a team environment, who manage their own growth, and who make good things happen is the goal at OSU.

The department has been very fortunate to have the Phillips Petroleum Company as a co-sponsor of the Phillips Lecture Series in Chemical Engineering Education, an annual lecture at Oklahoma State University now in its 33rd year. Speakers have established themselves as leaders in education, and reprints of their lectures are distributed nationally. "My first awareness of Oklahoma State University," recounts Russ Rhinehart, School Head and Bartlett Chair, "came as a result of the lecture pamphlets. I was preparing for a new career in academe, and the stimulating lectures generated respect for the School."

Of course, the program is ABET accredited.



Unit Operations: Tamika Killian, Chad Smith, Mike Dickenson, and Sally Gerhold as operators on a computer-controlled distillation.

"Unit Operations Lab is fun!"—the often-heard sentiment describes the students' team apprenticeship on distillation, reaction, heat exchange, refrigeration, absorption, and fluid-flow processes. In the classroom, the concepts are isolated and idealized so students can learn the fundamentals of chemical process behavior, but since the behavior is neither ideal nor isolated in real process equipment, students are also taught how to deal with such complexity before they are released to practice their profession. With professors taking the role of "coaches" and students the role of team "players," the Unit Operations Laboratory is a place where active mentoring shows the students how to apply the fundamentals to the real world. Features include "360" evaluations, student ownership of experimental design, and conversion of lab findings into business decisions.

Process Design and Economics is also a practice-oriented course. Two full-time professors manage the course and coach the student teams. The Celanese Chemical Company provides an annual design challenge, and their engineers evaluate the students' oral and written presentations as well as the technical work.

BALANCE

"Balancing fundamentals with practice, as well as research with education were important attributes to me when I was looking for a school," says School Head Russ Rhinehart. Emeritus Professor and heat-exchanger expert Ken Bell notes, "The program has always emphasized the practicality of technology in both teaching and research." The career experience of chemical engineering faculty at OSU averages five years of full-time practice. The result is that they understand how engineers need to work and they integrate that knowledge into their classes.

This balance can be credited to former Head, and Emeritus Professor Robert N. Maddox, who initiated the Phillips educational lectures as well as the Industrial Advisory Committee (IAC) in the '60s. The role of the IAC is to "provide advice and council to the faculty of the School of Chemical Engineering. All areas of operation will be open to criticism and suggestion." Those values remain important today.

This experience also shapes the graduate research program (where about half of the funding is industrial), which includes three industrially sponsored consortia. Gary Foutch, Regents Professor and Kerr-McGee Chair, leads a group concerned with ultrapure water. "The Ultrapure Water Group is a consortium that has existed for eight years now. The eight companies in the group represent nuclear power, microelectronics, domestic water, and the Navy nuclear program. The primary research focus is to develop accurate models that will predict the performance of contaminant removal from water where the concentrations of interest are at the parts-per-trillion level. Students in the group frequently have the opportunity to work in the industry as co-ops."

Centers are created to enhance industrial and academic research-and-development collaborations. The newest is the Measurement and Control Engineering Center (MCEC), a joint collaboration with the University of Tennessee, Knoxville, the US National Science Foundation, and twenty com-

panies to explore and guide the practicable application of advanced techniques for process automation. OSU participants include four professors and five graduate students. Led at OSU by Dr. Karen High, it includes sponsorship of work by Russ Rhinehart in nonlinear control and management automation, Rob Whiteley in fault detection, Gary Yen (Electrical and Computer Engineering) in computer perception, and Karen's work in optimization in process design and control.

Jan Wagner and Marty High lead the downhole corrosion consortium. One product from this consortium is a Windows software package that can predict the location and rate of corrosion in both sweet and sour natural gas wells. The project not only aims to solve the practical problem of corrosion in the petroleum industry, but also involves the fundamental study of fluid mechanics, thermodynamics, corrosion kinetics, and mass transfer.

Certainly, one of the leading indicators of either industrial or academic success is the student's ability to understand and apply fundamentals. Evidence of this competence is demonstrated by student performance on the Fundamentals of Engineering (FE) Exam, administered nationally by the NCEES. It is a comprehensive test of competence in engineering material, and passing it is the first step toward becoming registered as a professional engineer. For the past five years, OSU chemical engineering students have consistently shown a 92% pass rate on the exam. Nationally, the pass rate for chemical engineering graduates is 83%. OSU's

TABLE 1
Faculty • Oklahoma State University School of Chemical Engineering

Gary L. Foutch, Ph.D., P.E., Kerr-McGee Chair and Regents Professor
Ph.D., Chemical Engineering, University of Missouri-Rolla, 1980
Ultrapure Water Processing, Reaction Kinetics and Reactor Design
National Fulbright Scholarship Selection Committee

Khaled A.M. Gasem, Ph.D., R.N. Maddox Professor
Ph.D., Chemical Engineering, Oklahoma State University, 1986
Thermodynamic and Transport Studies, Equilibrium Calculation Algorithms, Process Design and Simulation
Integrated Petroleum Environmental Consortium co-founder and liaison to the US Congress

James E. Halligan, Ph.D., Professor, System CEO, OSU President
Ph.D., Chemical Engineering, Pennsylvania State University
People, Development

Karen A. High, Ph.D., Associate Professor
Ph.D., Chemical Engineering, Pennsylvania State University, 1991
Optimization, Kinetic and Reactor Modeling, Environmental-Based Process Design and Optimization, Parallel Optimization
Director AIChE Division 10 (Computing and Systems Technology)

Martin S. High, Ph.D., P.E., Associate Professor
Ph.D., Chemical Engineering, Pennsylvania State University, 1990
Equations of State for Polymer Solutions, Diffusion of Polymer Molecules, Downhole Corrosion Rates

Arland H. Johannes, Ph.D., P.E., Professor
Ph.D., Chemical Engineering, University of Kentucky, 1977
Interfacial Mass Transfer, Mathematical Modeling, Heterogeneous Catalysis and Energy Conversion Systems, Hazardous Waste Disposal, Fluidized Bed Reactors

Randy S. Lewis, Ph.D., Associate Professor
Ph.D., Chemical Engineering, Massachusetts Inst. of Technology, 1995
Biomass Conversion to Liquid Fuels, Drug Delivery, Artificial Organs, Biomaterials
Past National Student Chapters Committee Chair of the AIChE, Member of the National AIChE Career and Education Operating Council

R. Russell Rhinehart, Ph.D., Edward E. Bartlett Chair and School Head
Ph.D., Chemical Engineering, North Carolina State University, 1985
Nonlinear and Statistical Methods in Process Optimization and Control
Editor-in-Chief of ISA Transactions, General Chair of the 2002 American Control Conference

Robert L. Robinson, Jr., Ph.D., P.E., Amoco Chair and Regents Professor
Ph.D., Chemical Engineering, Oklahoma State University, 1964
Equilibrium Behavior, Design of Solvents for Extractive Distillation, Equation-of-State Representations, Adsorption
Director of the National Technological University ChE program, Fellow AIChE

Alan Tree, Ph.D., Associate Professor, Interim Associate Dean for Research
Ph.D., Chemical Engineering, University of Illinois, 1990
Polymer Science and Engineering, Flow-Induced Crystallization, Melt Rheology

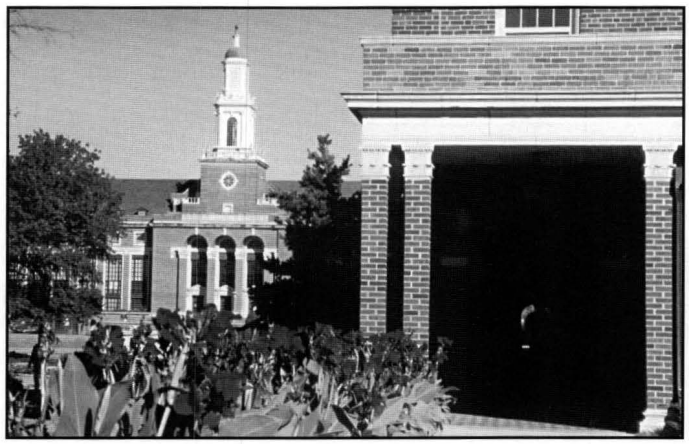
Jan Wagner, Ph.D., P.E., Professor
Ph.D., Chemical Engineering, University of Kansas, 1976
Process Safety, Process Design, Phase Equilibria and Equations of State
Member AIChE/CCPS SACHE Committee and editor of SACHE News

James Robert Whiteley, Ph.D., P.E., Associate Professor
Ph.D., Chemical Engineering, Ohio State University, 1991
Advanced Process Control, Artificial Intelligence Applications in the Process Industries

Kenneth J. Bell, Ph.D., P.E. Regents Professor Emeritus
Ph.D., Chemical Engineering (Physics minor), Univ. of Delaware, 1955
Fluid Dynamics, Heat Transfer, Heat Exchangers
AIChE Fellow, 1978 AIChE Donald Q. Kern Award, 1999 AIChE HT&EC Division Award

Robert N. Maddox, Ph.D., Sc.D., P.E. Leonard F. Sheerar Distinguished Professor Emeritus, Head Emeritus
Ph.D., Chemical Engineering, Oklahoma State University, 1955
Gas Processing
Sc.D. honors causa University of Arkansas 1991; 1985 GPA Hanlon Award; 1994 AIChE Founders Award

Marvin M. Johnson, Ph.D., Adjunct Professor
Ph.D., Chemical Engineering, University of Utah, 1956
Kinetics and Catalysts
AIChE Fellow; 1985 National Medal of Technology Recipient; 1994 National Academy of Engineering inductee



◀ *Edmond Low Library, center of the OSU campus.*

Students, faculty, and alumni enjoy a pre-game picnic. University President Jim Halligan talks with Professors Karen and Marty High. ▼

sustained 92% pass rate is one clear indication of excellence in both students and faculty.

Fundamentals are important, but engineers have to integrate fundamentals, apply them, and devise a solution that meets all of the criteria for goodness. Perhaps one indication of excellence here is OSU's record of accomplishment in the National AIChE Student Design Contests. In the five-year history of the team contest, Oklahoma State student teams have won first place twice. Since 1953, they have also received many honorable mentions and first-place awards for the individual design contest.

As stated earlier, collegiality was an initial attraction for Dr. Jan Wagner, but he goes on to say, "The most enjoyable thing now is the work ethic and values of the students. We have high expectations, and the students meet them." Professor "AJ" Johannes seconds this; "Warm weather, low taxes, and friendly, honest people were the initial attraction to Oklahoma State. But, it is the hard-working honest students that make every day a joy."

GRADUATE RESEARCH

The School emphasizes basic research, and here, too, there is a practice-relevant component. "I was attracted to OSU by the expertise in processing, process development, and the practice orientation in phase behavior," says Khaled Gasem, Maddox Professor. One of OSU's premier graduate research programs has been that of Professors Khaled Gasem and Rob Robinson in their experimental findings and equation-of-state development for the thermodynamic behavior of multicomponent phase equilibrium. Their U.S. Department of Energy-funded research on carbon dioxide sequestering in coal beds has the dual purposes of reducing CO_2 in the air while enhancing natural gas production. They are also developing techniques for using molecular simulation software to "design" specialty solvents for extractive distillation, and have demonstrated industrial success. Their work has a strong experimental component and employs about a dozen graduate and undergraduate students.

Randy Lewis, Associate Professor, has collaborative bio-technology research projects with several departments, each with experimental credibility. He is exploring novel routes to use bacteria to generate liquid fuels from renewable resources, developing mathematical models for analysis of drug delivery, analyzing immune response molecules and their role in the dysfunction of an artificial pancreas, and developing biomaterials that control local nitric oxide levels and prevent platelet adhesion on implanted materials. Randy's primary funding has come from the National Institutes of Health and the Department of Energy. He is also the advisor to the award-winning Student Chapter, one of the prime reasons for its success.

Can you make a bridge smart enough to take heat from the ground to prevent freezing when the surface is wet? "Yes," according to Associate Professor Rob Whiteley, who is collaborating with civil, mechanical, and technology professors on a DOT-sponsored project. Rob and his students are responsible for the artificial intelligence that reacts to weather forecasts and underground conditions and manages the ground-source heat pumps. Rob is a regular winner of college and university teaching awards.

Martin High ("Dr. Marty") and Alan Tree have a shared interest in the fundamentals of polymer kinetics and thermodynamics. "The long, chain-like nature of polymer molecules allows them to crystallize under certain flow conditions, resulting in structures with superior mechanical properties. Part of our NSF funding has been used to support experimental and theoretical efforts that extend classical crystallization theory to account for flow-induced behavior," says Alan, presently Interim Associate Dean for Research. In addition, the team of High, Tree, and High are exploring the applicability of strong-acid polymer catalysts for the synthesis of liquid organic molecules from gases.

Research on particle properties and size development is led by Professors "AJ" Johannes and Gary Foutch. They are using computational fluid dynamics programs and kinetic models of interfacial mass transfer and chemical reaction to improve the design of reactors.

We have forty graduate students, averaging about four per faculty member, and each faculty member has externally sponsored research. All graduate students are supported, and 60% are PhD candidates. The faculty backgrounds and research interests are shown in Table I.

ATTRACTIVENESS OF THE AREA

"I sought a place where I could build a future for both my career and my family. OSU gave me collaborative faculty, and Stillwater gave me a great place to live," says biomedical expert Randy Lewis. He notes that the quality of life in Stillwater, a town with about 35,000 permanent residents, has the flavor of a small town but is only a little over an hour from either Tulsa or Oklahoma City. With a temperate climate and located in the rolling hills of "green country," there are four balanced seasons and many local recreational opportunities. Ken Bell adds, "The beauty of the campus originally attracted me to OSU, and the recent upgrades in the Student Union gardens and Theta Pond have made it even better."

There are 250 undergraduates who have declared chemical engineering as their major. About one third of them are female, about 15% are from minority groups, and about 20% are from outside of the state. These statistics allow everyone to have an extended family of diverse individuals. Upper-level class sizes are about 35; thus, with a faculty size of eleven, the student-to-faculty ratio is relatively low.

With about 19,000 students on the Stillwater campus, OSU is large enough to offer a broad variety of classes and a wide range of student activities: Big XII athletics, cultural events, international student societies, intramural events, recreational outings, and study groups. The "engineering floors" in the dorms provide both social and academic support activities for the students.

OPPORTUNITIES

For freshman and Phillips Scholar Christy Petersen, "Opportunities made the program attractive." She should know. Her older sister is a senior, and her oldest sister and brother-in-law are recent graduates, all from chemical engineering at Oklahoma State. "The program prepares students for a broad range of careers. Carl is in law school, Tracie is enjoying her industry assignments, and Jill is looking at medical school. Within chemical engineering we have the bioengineering, premedical, and environmental options. And, while on campus, there are many activities that allow us to explore our potential." Hosting the 1999 National AIChE Annual Student Conference in Dallas, Texas, was a major activity that engaged about 50 of our students.

One of the special features of the College of Engineering, Architecture, and Technology is that all students are in a "common" curriculum for their first two years. Once they qualify academically, they are admitted into the School that offers a degree in the major of their choice. Courses in the common engineering curriculum include computer programming, statics, thermodynamics, fluid dynamics, strength of materials, electrical circuits, and materials science. Faculty from separate Schools team-teach most of these courses, and their content is controlled by the faculty from all disciplines that require the courses. This means that chemical engineering students get a multidisciplinary perspective in their general engineering courses, and as a result, they have subsequent career flexibility. Course management by an oversight committee maintains a balanced structure, curriculum content, and high academic standards. This broad and quality-monitored experience contributes to diverse career opportunities for the students.

Students have to qualify for acceptance into the School of Chemical Engineering. Making the "grades" in the first two years is a prerequisite to taking the upper level chemical engineering courses. It is a significant challenge, and the feeling is that the student-faculty family is an important contributor for promoting academic scholarship and encouragement.

Undergraduates can be involved in research if they wish to explore outside of the classroom. Recently, Nellie Bruce, a junior, received a Wentz Scholarship to develop an artificial kidney experiment that will be used for the newly developed biomedical engineering course. Nellie is the fourth of her siblings to choose engineering at OSU and the third in chemical engineering. Dipesh Pokharel received a Wentz Scholarship to study the effects of nitric oxide (NO) on smooth muscle-cell growth. Dipesh developed the experimental apparatus that delivers controlled and predictable amounts of NO to a culture dish containing smooth muscle cells. Cell growth is monitored during NO exposure. Phoebe Brown, recipient of a national Morris Udall Scholarship, is evaluating a method for automatic identification of steady state in multivariable processes. Since most processes generate noisy data, the method is statistically based. Phoebe is testing the multivariable method on data from the Unit Operations Lab distillation column.

MAGIC?

Chemical engineering at OSU uses the same textbooks as other universities. It is accredited by the same rules. It has the same best students. It has the same inadequate operating budget. It has the same web and library access. So—what is the reason for its success? If not magic, then it must be a shared commitment to human development and a focus on getting results in the real world.

We invite you to enjoy a visit to our web pages at http://www.cheng.okstate.edu. ❐