

ChE at...

Vanderbilt University

M. DOUGLAS LEVAN

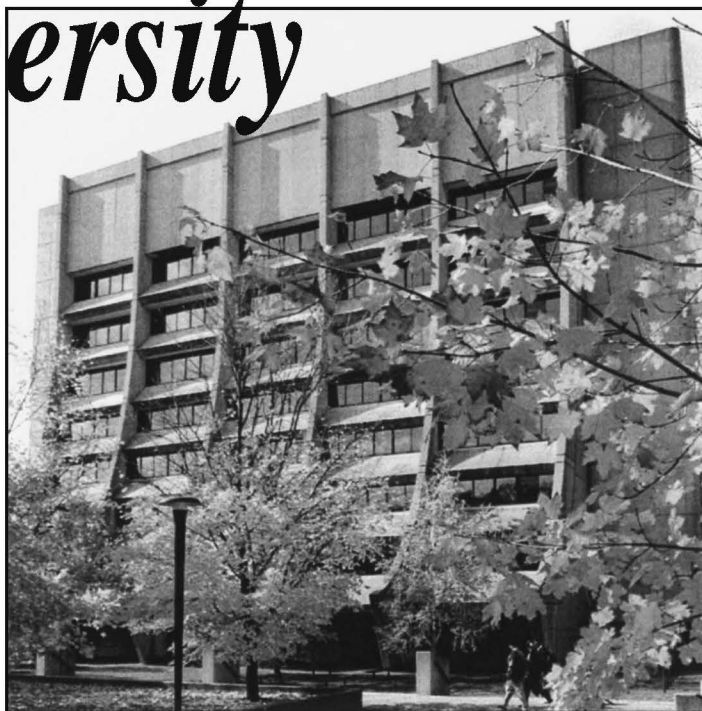
Vanderbilt University • Nashville, TN 37235

Like our discipline, the Department of Chemical Engineering at Vanderbilt University is experiencing a significant expansion beyond its traditional roots toward advanced materials, bioengineering, and other product and application areas. To respond to changes in the field and to take a strong leadership role in research developments in the future, the Department has concentrated on building expertise through faculty recruitment, revising both undergraduate and graduate curricula, and cultivating ambitious interdisciplinary research thrusts. The University's established world-class research prominence in medicine, biology, and environmental studies augments its advantages in reaching its future goals.

VANDERBILT UNIVERSITY

Established in 1873, Vanderbilt University has a long-standing tradition for academic excellence. Cornelius Vanderbilt, "The Commodore," contributed approximately one million dollars of his personal fortune to build a university that could help repair the post-Civil-War rifts among geographical areas of the nation. The University continues to cultivate a tradition of collegiality, interdisciplinary teamwork, and cohesion.

The University, now a national arboretum, is located on 330 park-like acres one and one-half miles from downtown Nashville. It has ten schools, which provide a full range of undergraduate, graduate, and professional programs. There are four schools with undergraduate programs: the School of Engineering, the College of Arts and Science, Peabody College (education), and the Blair School of Music. The Graduate School confers MA, MS,



Olin Hall, home of Chemical Engineering at Vanderbilt.

and PhD degrees. The PhD is offered in 39 disciplines. In addition, there are schools of medicine, nursing, management, law, and divinity. Vanderbilt has about 1,900 full-time faculty members and a diverse student body with 6,200 undergraduates and 4,300 graduate and professional students.

Vanderbilt's Chancellor, Gordon Gee, joined the University two years ago after having been President of West Virginia University, the University of Colorado, Ohio State University, and Brown University. Changes have been occurring throughout the University. A residential college system for undergraduates is being strongly considered, and graduate research is an area of considerable focus. The Board of Trust, the University's governing body, has contributed significant funds for several new interdisciplinary research initiatives.

Nashville is called the "Athens of the South" and "Music City



Nashville from across the Cumberland River.

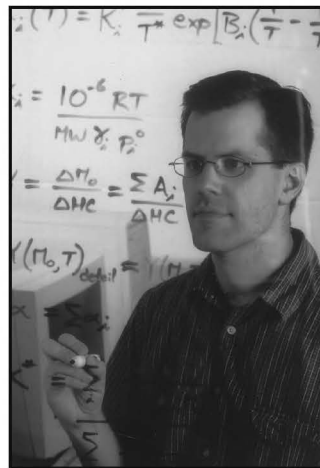
USA” and is the capital of Tennessee. The city and surrounding area support a wide range of activities with performing arts and museums, professional sports teams, and many outdoor activities. Nashville is one of the South’s major focal points for banking, healthcare, insurance, publishing, and entertainment. The Nashville area is home to more than a dozen colleges and universities. Vanderbilt is a major contributor to the intellectual life of Nashville.

THE SCHOOL OF ENGINEERING

In 1874, the year following the founding donation by Cornelius Vanderbilt to the University, engineering was announced as one of ten schools within the Department of Philosophy, Science, and Literature. Engineering classes began in 1879 in drafting, surveying, applied mechanics, structures, water supply, sanitary engineering, and mechanical power. The first Bachelor of Engineering degree was awarded in 1880. Engineering was organized as a department in 1886 and became a school again in 1915, when departments were renamed schools and schools were renamed departments.

Graduate work in the School of Engineering began with chemical engineering. An MS program in chemical engineering was approved in 1943, and the first two MS degrees were awarded in 1946. The first PhD program in engineering to be approved by the Graduate School was in chemical engineering in 1962. The first PhD conferred in engineering went to a chemical engineering student in 1964.

Kenneth F. Galloway joined Vanderbilt in Fall 1996 as Dean of the School of Engineering and Professor of Electrical Engineering. Dean Galloway restructured the School by consolidating some departmental administrative structures. The School now has five Departments: Biomedical Engineering, Chemical Engineering, Civil



Professor Bowman

and Environmental Engineering, Electrical Engineering and Computer Science, and Mechanical Engineering. The Department of Electrical Engineering and Computer Science also offers a degree in Computer Engineering. The School also offers degrees through programs in Engineering Science, Management of Technology, and an Interdisciplinary Program in Materials Science.

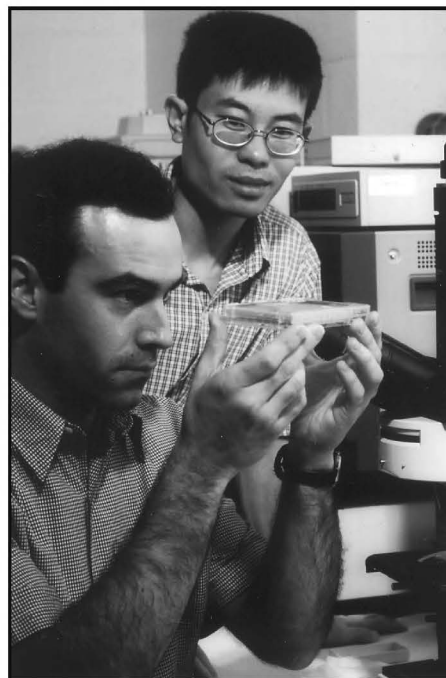
Dean Galloway encouraged growth of research programs. Sponsored research activity within the School has more than doubled since 1996, and research expenditures currently average \$300,000 per faculty member.

The Dean also began a vigorous program of fund raising to improve facilities within the School. A new centerpiece of the School, Featheringill Hall, was formally dedicated in September 2002. It has a large three-story atrium and many areas for small-group interactions. Undergraduates throughout Vanderbilt have voted it the best building on campus.

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▲ *Vanderbilt's Chemical Engineering Class of 2003.*
Professor Balcarcel with PhD candidate Yuansheng Yang. ►



THE DEPARTMENT OF CHEMICAL ENGINEERING

A Chemical Engineering Program was first announced at Vanderbilt in 1903 as a joint program between engineering and chemistry. A Department of Chemical Engineering was established in 1938 with the first head appointed in 1939.

The Department has had seven Chairs. The early ones were Roy S. Hanslick (1939-1941), E. E. Litkenhous (1941-1961), and W. Dennis Threadgill (1961-1972). E. E. Litkenhous had influence far outside the field of chemical engineering; in 1930, while still an undergraduate at the University of Louisville, he developed a system for rating athletic teams and predicting the outcome of a sporting event based on a "points spread"—this basic system is still in use today.

The School was reorganized in 1972 into a grid system with John A. Roth as Chairman of the Division of Chemical, Fluid, and Thermal Sciences, which was comprised of chemical engineering and mechanical engineering; Thomas M. Goldbold (1972-1975) was Director of the Chemical Engineering Program. In 1975, the School returned to a normal departmental structure.

Recent Chairs have been W. Dennis Threadgill (1975-1980), Karl B. Schnelle, Jr. (1980-1988), Thomas M. Godbold (Acting Chair, 1988-1989), Tomlinson Fort (1989-1996), and M. Douglas LeVan (1997-present).

The current home of the Department is Olin Hall, a gift of the Olin Foundation, which opened in 1974. The building is occupied by the Department of Chemical Engineering, most of the Department of Mechanical Engineering, and much of the Interdisciplinary Materials Science Program. The Department occupies approximately 20,000 square feet,

including space for a high-bay undergraduate unit operations laboratory.

The Department provides an intimate environment for undergraduate and graduate students. Each faculty member cares a great deal about education and student welfare. Classes are small and are all taught by faculty members. Advising is done face-to-face with faculty members.

We have many distinguished alumni. Our graduates hold positions of major responsibility in large corporations, in small entrepreneurial and consulting firms, and in federal and state government agencies. Some PhDs continue their research in post-doctoral positions or enter the teaching profession.

CURRENT FACULTY

M. Douglas LeVan joined the Department as Chair in 1997. At mid-year, the tenured/tenure-track faculty was all tenured and consisted of Professors Robert J. Bayuzick, Kenneth A. Debelak, Tomlinson Fort, M. Douglas LeVan, John A. Roth, Karl B. Schnelle, Jr., and Robert D. Tanner. Each had well over 15 years of university teaching experience. We also had two experienced research faculty, Professors William H. Hofmeister and Ales Prokop. A clear opportunity existed to hire new faculty.

Three research thrust areas were identified: materials, bioengineering, and environmental engineering. All are interdisciplinary and important at Vanderbilt. We sought (and continue to seek) candidates who can contribute fundamentally and broadly to one or more of these focus areas. We also sought faculty with indications of excellent teaching ability.

ties; at Vanderbilt, teaching performance is a strong consideration in promotion and tenure decisions.

Beginning in January 1998, we added four faculty at the assistant-professor level: Frank M. Bowman (Ph.D., California Institute of Technology, 1997) has research interests in atmospheric chemistry and gas-aerosol transport; G. Kane Jennings (Ph.D., Massachusetts Institute of Technology, 1998) works on surface modification and experimental molecular engineering; Bridget R. Rogers (Ph.D., Arizona State University, 1998) focuses on nucleation and microstructure evolution of thin films and microelectronic materials processing; and R. Robert Balcarcel (Ph.D., Massachusetts Institute of Technology, 1999) who studies biological cell life cycles, metabolism, and apoptosis for recombinant therapeutic protein production, cancer therapies, and environmental sensing. All of our new faculty have established significant external funding for their research programs. Professors Bow-

man and Rogers have won NSF CAREER awards. Professor Jennings won the School's teaching award last year.

Our newest faculty member is Peter T. Cummings, who joined us in August 2002 as the John R. Hall Professor of Chemical Engineering. This chaired position was endowed by the Ashland Foundation in honor of John R. Hall, a graduate of the Department, former Chairman and CEO of Ashland, Inc., and recent President of the Board of Trust of Vanderbilt University. Prof. Cummings is acknowledged as an international expert in molecular simulation and computational nanoscience and nanoengineering. He has retained his role at Oak Ridge National Laboratory as Director of the Nanomaterials Theory Institute within the Center for Nanophase Materials Sciences.

Current departmental faculty are listed in Table 1. The special team-teaching role of Professor Julie E. Sharp deserves

TABLE 1
Current Chemical Engineering Faculty at Vanderbilt University

■ **R. Robert Balcarcel**

Assistant Professor (PhD, Massachusetts Institute of Technology)
Biotechnology and bioengineering; mammalian cell cultures; cell life cycles; pharmaceutical production

■ **Robert J. Bayuzick**

Professor (PhD, Vanderbilt University)
Solidification; nucleation; evolution of microstructure; microgravity science; physical metallurgy; containerless processing; oxide superconductor processing

■ **Frank M. Bowman**

Assistant Professor (PhD, California Institute of Technology)
Air pollution; atmospheric chemistry mechanisms; gas-aerosol transport; modeling complex chemical reaction systems

■ **Peter T. Cummings**

John R. Hall Professor (PhD, University of Melbourne)
Computational nanoscience and nanoengineering; molecular modeling of fluid and amorphous systems; computational materials science; parallel computing

■ **Kenneth A. Debelak**

Associate Professor (PhD, University of Kentucky)
Development of plant-wide control algorithms; intelligent process control; activity modeling; effect of changing particle structures in gas-solid reactions; environmentally benign chemical processes; mixing in bioreactors

■ **Tomlinson Fort**

Centennial Professor, Emeritus (PhD, University of Tennessee)
Capillarity; insoluble monolayers/L-B films; adsorption; contact angles and wetting; polymer interfaces; spreading on liquid surfaces; fine particles; flow in porous media

■ **William H. Hofmeister**

Research Associate Professor (PhD, Vanderbilt University)
Materials science and engineering; nucleation and solidification kinetics; microgravity science; high-speed thermal imaging; biological applications of materials science

■ **G. Kane Jennings**

Assistant Professor (PhD, Massachusetts Institute of Technology)
Surface modification; experimental molecular engineering; corrosion inhibition; microelectronics processing

■ **M. Douglas LeVan**

Centennial Professor and Chair (PhD, University of California, Berkeley)
Fixed-bed adsorption; adsorption equilibria; adsorption processes (pressure-swing adsorption, temperature-swing adsorption, adsorptive refrigeration); process design

■ **Ales Prokop**

Research Professor (PhD, Czechoslovak Academy of Sciences)
Bioengineering; bioartificial liver and pancreas; cell encapsulation and immunoisolation devices; biocompatible nanotechnology; protein recovery

■ **Bridget R. Rogers**

Assistant Professor (PhD, Arizona State University)
Nucleation and microstructure evolution of thin films; fundamentals of thin film processing for microelectronic applications (mass transport, kinetics, and effects of substrate topography on CVD, sputter deposition and etch processes)

■ **John A. Roth**

Professor (PhD, University of Louisville)
Chemical reactor design; industrial wastewater treatment; sorption processes; chemical oxidation for waste treatment; hazardous waste management; electrochemistry

■ **Karl B. Schnelle, Jr.**

Professor (PhD, Carnegie Mellon University)
Turbulent transport in the environment; control of toxic emissions and SO₂ and NO_x from coal fired boilers; solution thermodynamics; applications of process simulation to microcomputers; supercritical extraction applied to soil remediation

■ **Julie E. Sharp**

Associate Professor of the Practice of Technical Communication (PhD, Vanderbilt University)
Written and oral technical communications; technical reporting; Kolb learning style theory in engineering education

■ **Robert D. Tanner**

Professor (PhD, Case Western Reserve University)
In situ bubble fractionation of excreted proteins from growing baker's yeast; selective protein recovery from a semi-solid air fluidized bed fermentation process; bubble and foam fractionation of proteins.

mention. A practice was started by Professors Debelak and Roth of developing written communication skills in design and laboratory courses through the team-teaching efforts of an expert in technical communications. Their efforts won an ASEE best paper award in 1983. Dr. Sharp has been involved with the Department as the expert in technical communications since 1982. Each semester she co-teaches the undergraduate laboratory courses, where she instructs

students in written and oral communications, and in addition she teaches two sections of a technical communications course for the School, for which she serves as coordinator. She is active within the ASEE and regularly publishes her research on learning styles. She has been instrumental in the consideration of Kolb learning styles within the School of Engineering. Her efforts have won praise from alumni and ABET.

In addition to those shown in Table 1, five faculty currently have secondary appointments in the Department. Professors Todd D. Giorgio, Thomas R. Harris, K. Arthur Overholser, and Robert J. Roselli (all former faculty in the Department of Chemical Engineering) have their primary appointments in the Department of Biomedical Engineering. Professor David S. Kosson has his primary appointment in the Department of Civil and Environmental Engineering.

In addition, the Department is fortunate to have the services of staff members Margarita Talavera, Mary M. Gilleran, Anita K. Patterson, and Mark V. Holmes.

UNDERGRADUATE PROGRAM

The undergraduate program in chemical engineering was accredited by the Engineers' Council for Professional Development (ECPD) in 1952. Accreditation by the Accreditation Board for Engineering and Technology (ABET) followed beginning in the 1980s as ECPD was replaced. The most recent accreditation visit occurred in October 2001.

The undergraduate curriculum was revised for the 1998-1999 academic year and again for the 2002-2003 academic year. Both of these curricula are on our website. The changes for 1998-99 were made to present material in a more logical order, to change computer languages, and to increase efficiency. We retained a 3-hour engineering economy course, but collapsed two 3-hour senior design courses into a single 4-hour capstone course. Graduation requirements were reduced to 128 hours.



Professor Rogers with BS/MS student Virginia Wahlig.

The changes for the current academic year involved improving the structure of our thermodynamics sequence, eliminating engineering courses (but not physics courses) in statics-dynamics and electrical circuits, and adding flexibility. We are now teaching all of thermodynamics, not relying on the Department of Chemistry. We are also increasing the exposure of our sophomores to simulation; instead of teaching just Aspen, we now also apply additional

programming and numerical problem-solving methods to chemical engineering problems.

The new open curriculum makes it easy for students to minor or pursue their own chosen direction. There are six humanities-social science electives spread uniformly throughout the curriculum. We have moved all technical and open electives into the junior and senior years, and as a result, students have a technical elective each semester of the junior and senior years plus two open electives in the senior year. The Department encourages minors in environmental engineering, materials science and engineering, and management of technology; these require 15 hours. Students also minor in chemistry, mathematics, economics, etc. The Department is offering a new concentration in biotechnology that requires 13 hours. Additionally, a special, intensive program leads to a dual degree in chemical and biomedical engineering.

For the last four years, the School of Engineering has offered elective seminar courses to entering freshmen. The Department has participated heavily, offering several courses. Our regular offering, however, has been the course "Frontiers in Chemical Engineering," which has been team-taught every year by our assistant professors based on their research interests. (This course is the subject of an article published in this issue of *Chemical Engineering Education*.)

Our undergraduates have research opportunities also. Each year many of them work side-by-side with graduate students in our research laboratories. In the summers, external and School support has been available to provide research experiences for undergraduates.

We have an active AIChE student chapter with a long history. A Chemical Engineering Club, formed in 1936, became the Tau Alpha Tau Society in 1940 and then the Vanderbilt Chapter of the American Institute of Chemical Engineers in 1947. Students participate in a wide variety of activities, including Rube Goldberg competitions. Last year eight under-

graduates attended the AIChE Student Conference in Puerto Rico. For the 2002 Annual AIChE Meeting, the Department supported a trip for 12 undergraduates to attend.

GRADUATE PROGRAM AND RESEARCH

A majority of our graduate students are PhD students. Most are supported in their first year as teaching assistants, although some support for new students as research assistants is usually available. After the first academic year, almost all students are supported as research assistants from research grants for the duration of their studies. Some multi-year “topping” awards are also available.

Graduate course requirements were changed for the 1999-2000 academic year and again for the 2002-2003 academic year. For 1999-2000, we revised our graduate core course requirements, moving to a more research-oriented chemical engineering science core. For 2002-2003, we reduced coursework requirements for PhD students and made some modifications to our core course structure. We now offer six core courses: applied mathematics for chemical engineers, thermodynamics, transport phenomena, chemical kinetics, simulation, and separation science and engineering.

An MS student must take 24 hours of coursework, a graduate school requirement. This includes five core courses. A thesis is required. (The Master of Engineering, an advanced professional degree, is offered by the School of Engineering.)

We require a PhD student to take a minimum of 30 hours of coursework beyond the bachelor's degree. This includes the six core courses. Many students take more than 30 hours of coursework, but this load is designed to allow students to spend the majority of their studies on original research for the dissertation. PhD students work with their research advisor under the guidance of a PhD committee towards fulfilling all requirements for the degree.

Research laboratories within the Department are equipped for experimental and computational investigations of materials, bioengineering, environmental engineering, adsorption and surface chemistry, chemical reaction engineering, and process modeling and control. Interdisciplinary research opportunities exist with researchers in other departments in the School of Engineering, the natural sciences, and medicine. Our faculty participate in the Interdisciplinary Program in Materials Science and in an NSF-sponsored Engineering Research Center for Bioengineering Educational Technologies. We also participate in two new University-supported interdisciplinary research initiatives—the Vanderbilt Institute for Nanoscale Science and Engineering (VINSE) and the Vanderbilt Institute for Integrative Bioengineering Research and Education (VIIBRE). Activities are currently developing within the Vanderbilt Institute for Environmental Risk and Resources Management (VIERRM).

We currently have an annual Tis Lahiri Memorial Seminar, named after a former graduate student and supported by an endowment. This seminar has an educational flavor. Recent speakers include H. Scott Fogler, Richard M. Felder, Phillip C. Wankat, Ronald W. Rousseau, John M. Prausnitz, Edward L. Cussler, and Arthur W. Westerberg.

We also have an active Chemical Engineering Graduate Student Association (ChEGSA) that represents graduate student interests and sponsors a variety of social events. They have had great leadership and help the Department in many ways.

OUR FUTURE

The Chemical Engineering Department has changed considerably in the last six years. Nine of the fourteen full-time faculty members listed in Table 1 were not in the Department in late 1996. We have been working toward improved undergraduate and graduate curricula and expanding our research activities. The changes will continue.

Our curricula and research programs reflect the broadening of the chemical engineering profession from its chemical and petrochemical heritage toward advanced materials, bioengineering, environmental concerns, and other application-based and product areas. Vanderbilt University as a whole is strong in biological research, with a world-class research hospital; this creates broad opportunities for collaborative research on biologically related topics.

We seek advice on our programs in many ways. A principal avenue is through our Departmental External Advisory Committee. We also seek advice from alumni and corporate friends through a newsletter, “The Catalyst,” edited by Professors Schnelle and Sharp. The Chair has formed an Undergraduate Student Council, which provides him with advice on the undergraduate program, and he serves as advisor to ChEGSA.

Essentially all Departments want to improve not only their rankings but also their quality and visibility. We are certainly no exception. We have been working on improvements from all angles. We recognize the many opportunities that we have at Vanderbilt.

Information: More information on the Department is available at <http://www/vuse.vanderbilt.edu/~cheinfo/che.htm>. Questions should be directed to cheinfo@vuse.vanderbilt.edu.

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Reference: Jacobs, D., “102 Years: A Story of the First Century of Vanderbilt University School of Engineering,” Vanderbilt University Alumni Association, Nashville, 1975.

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