Chemical Engineering (and Materials Science and Engineering) at Michigan State University

S. Patrick Walton,
Robert Y. Ofoli,
Jane L. DePriest,
Laura A. Seeley

The Engineering Building at MSU.

Michigan State University (MSU) was founded in 1855 as the Agricultural College of the State of Michigan. Since then, it has been renamed five times, finally becoming Michigan State University in 1964. Throughout its history, MSU has served as a model land-grant institution. In one form or another, chemical engineering has been a part of that history since 1912 (Table 1). Thus, 2012 represents 100 years of chemical engineering at Michigan State University.

As in many programs, chemical engineering emerged from chemistry, officially joining the Division of Engineering as the Department of Chemical Engineering in 1931. During World War II, the department was rechristened the Department of Chemical and Metallurgical Engineering, beginning an intermittent pairing of chemical engineering and materials that would culminate in 2001 with the merger of two programs to form the current Department of Chemical Engineering and Materials Science (ChEMS).

The current faculty count stands at 32, including three University Distinguished Professors. The faculty has received numerous awards and honors, including NSF CAREER Awards, a Department of Energy PECASE Award, University Distinguished Faculty Awards (University-level), Withrow Teaching Excellence Awards (College-level), and Withrow Research Scholar Awards (College-level). Also included among the faculty ranks are nine Society Fellows (three of the American Institute of Chemical Engineers, and one each of the American Institute of Chemists, the Society of Plastics Engineers, ASTM International, the American Ceramic Society, ASM International, and the American Physical Society). The department has positioned itself and established its research priorities to address critical 21st century challenges in energy and sustainability, nanotechnology and materials,

and biotechnology and biomedical engineering. In addition, the department has a long-standing focus on research in engineering education.

Since its inception as a joint department in 2001, ChEMS has grown significantly in many ways. The total number of faculty has increased by over 60%. Total research expenditures are roughly $11,000,000, and the faculty publication rate is averaging more than 150 papers per year. ChEMS programs currently enroll 98 Ph.D. students and eight Master's students. A significant portion of research funding is derived from ChEMS department participation in major research centers, including the Composite Materials and Structures Center; the Center for Revolutionary Materials for Solid State Energy Conversion (Department of Energy); and the Great Lakes Bioenergy Research Center (Department of Energy).

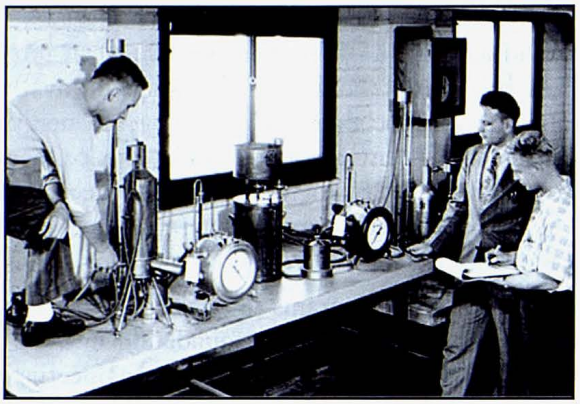
ACADEMIC PROGRAMS

The Department operates two fully ABET-accredited programs, Chemical Engineering (ChE) and Materials Science and Engineering (MSE). Together, the two programs serve approximately 100-120 students per year, with consistent growth in enrollments in recent years. To supplement the core curricula, each program offers a number of concentrations (*i.e.*, specializations) that allow students to tailor their programs according to interest. For the ChE program, the available concentrations are biochemical engineering, bioenergy, biomedical engineering, environmental, food science, and polymer science. For the MSE program, the available concentrations are biomedical materials, manufacturing engineering, metallurgical engineering, and polymeric engineering.

It is the mission of our programs to educate students to become innovative engineers with a foundation in mathematics, physics, chemistry, life sciences, and engineering. Faculty members excel in research and teaching of chemical processes, materials evaluation and design, and biotechnology. Students enjoy access to outstanding laboratories for unit operations, biochemical engineering, composite materials processing, and characterization of metals, ceramics, and polymers. Our students routinely go on to careers in automotive, aerospace, manufacturing, pharmaceutical, design and construction, paper, petrochemical, food processing, specialty chemicals, microelectronics, electronic and advanced materials, polymer, business services, biotechnology, environmental, and safety industries.

TABLE 1
Department Milestones

1912	Chemical engineering courses are administered jointly by the Department of Chemistry and the Division of Engineering.
1918	The first four undergraduates in the formal engineering chemistry option receive bachelor's degrees in chemical engineering.
1929	MSU's Department of Chemistry expands to become the Department of Chemistry and Chemical Engineering.
1931	Department of Chemical Engineering splits from the Department of Chemistry and Chemical Engineering and joins the Division of Engineering as a degree-granting program.
1933	First female engineering graduate—Ethel V. Lyon—receives bachelor's degree in chemical engineering.
1941	Department of Chemical Engineering becomes known as the Department of Chemical and Metallurgical Engineering.
1949	Department of Chemical and Metallurgical Engineering splits to form two separate departments—the Department of Chemical Engineering and the Department of Metallurgical Engineering.
1962	The Department of Metallurgical Engineering and the Department of Applied Mechanics merge to form the Department of Metallurgy, Mechanics, and Materials Science (MMM).
1982	Blue-Green Seminar Series inaugurated between Departments of Chemical Engineering at MSU and University of Michigan.
1983	Center for Composite Materials and Structures established.
1988	MSU Board of Trustees approves permanent status for the Composite Materials and Structures Center.
1991	Center on Low-Cost, High-Speed Polymer Composites Processing established—the first National Science Foundation research center in the college.
1992	Department of Metallurgy, Mechanics, and Materials Science (MMM) becomes Department of Materials Science and Mechanics (MSM).
1992	First Symposium Day held.
1999	Johansen-Crosby Lectureship in chemical engineering education inaugurated.
2001	Department of Materials Science and Mechanics reorganized; materials science faculty and programs merged into existing chemical engineering department. Official name becomes Department of Chemical Engineering and Materials Science. Martin Hawley named first chairperson.
2003	Biomedical Engineering Laboratory opened.
2004	First ChEMS Research Forum held.
2007	Great Lakes Bioenergy Research Center established.
2009	Center for Revolutionary Materials for Solid State Energy Conversion established.



In this 1947 photo, M.F. Obrecht (in suit), assistant professor of chemical engineering, shows two students in the Fuels Laboratory how to test the heat value of commercial natural gas. To the right, taking data, is Thomas Christiansen from Manistee, Mich. Operating the equipment (on table, left) is Edwin Johansen Crosby of Flint, Mich. Crosby endowed the Johansen-Crosby Professorship in the Department of Chemical Engineering at MSU shortly before his death in December 1991.

Department Heads/Chairpersons			
CHEMICAL ENGINEERING		METALLURGICAL ENG.; METALLURGY, MECHANICS, MATERIALS SCIENCE; MATERIALS SCIENCE & MECHANICS	
1918–1930	Arthur John Clark	1948–1949	R. L. Sweet
1931–1936	H. S. Reed	1949–1964	Austen J. Smith
1936–1940	H. E. Publow	1964–1965	William A. Bradley, acting
1940–1948	Clyde C. DeWitt	1966–1971	Donald J. Montgomery
1948–1949	J. W. Donnell	1971–1974	Robert W. Summitt
1949–1950	Austen J. Smith	1974–1975	William A. Bradley, acting
1950	David F. Smith	1975–1978	Robert W. Summitt
1951–1952	R. W. Ludt, acting	1978–1979	George D. Mase, acting
1952–1961	C. Fred Gurnham	1979–1984	David L. Sikarskie
1961–1963	Austen J. Smith, acting	1985–1998	Kalinath Mukherjee
1963–1977	Myron H. Chetrick	1998–2000	Nicholas J. Altiero
1977–1995	Donald K. Anderson	2000–2001	Bruce E. Dale, acting
1995–2001	Bruce E. Dale		
Department Merger to Department of Chemical Engineering and Materials Science			
2001 – present		Martin C. Hawley	

STUDENT ORGANIZATIONS

The student chapter of the American Institute of Chemical Engineers (AIChE) sponsors activities that create opportunities for students to network with industry professionals (many of them recent MSU ChEMS graduates), enhance their academic work, and contribute to the community through volunteer work. Key educational activities include Symposium Day (see below), facilitating attendance at national and regional AIChE conferences, open meetings that enable industry professionals to discuss life in the "real world" and interact with students, and sponsored activities to introduce freshmen and sophomores to chemical engineering.

The Materials Science and Engineering Society (MSE Society) focuses on programming to support students in a variety of ways. These include help in finding permanent jobs, internships, and co-operative opportunities; providing opportunities for students to network with industry personnel; enabling access to tutoring for underclassmen; and organizing social events to help create a sense of community among students.

The student chapter of the International Society of Pharmaceutical Engineers (ISPE) is committed to helping its members improve their technical abilities. It fosters many programs to promote networking among students and practicing pharmaceutical manufacturing professionals. The group is involved in several community improvement activities, including tutoring of students in Lansing-area elementary schools.

Other professional organizations in which ChEMS students have participation on various levels include Omega Chi Epsilon (ΩXE, the honor society for chemical engineering) and the Biomedical Engineering Society (promotion of biomedical engineering education and professional opportunities among all students in the college).

AWARDS AND COMPETITIONS

The department is proud of the awards and recognition received by our students. For instance, in the last five years, ChEMS students have been awarded six NSF graduate research fellowships and eight honorable mentions. In addition, the ChE program has one of the nation's best records in the annual AIChE design competition (Tables 2 and 3). MSU students have been recognized in this competition in 30 of the last 43 years, an outstanding achievement. This recognition underscores the commitment of our department and the MSU College of Engineering to a design-oriented education.

CORPORATE INTERACTIONS

The department sponsors two unique activities that allow our undergraduate and graduate students to interface with corporate representatives. The first of these is our annual

TABLE 2
Record in AIChE Annual Design Contest - Individual

1968	3rd Place – Carl L. English
1969	1st Place – Jerome Trumbley; 2nd Place – Jon Branson
1970	Honorable Mention – Steven R. Auvil
1971	1st Place – Allen G. Croft
1972	3rd Place – Tim O. Bender
1973	3rd Place – Mike Murry
1974	1st Place – Larry J. Clink
1975	Honorable Mention – Barbara R. (Kreger) Engerer
1976	3rd Place – Alan D. Schmidt
1979	1st Place – Thomas W. Calhoun
1980	1st Place – Susan J. Barrett; 3rd Place – Thomas Bartos
1981	Honorable Mention – Timothy S. VanLente
1982	1st Place – Ray Murphy
1983	3rd Place – Dennis P. Stocker
1987	Honorable Mention – Scott E. Booth 1989 1st Place – Daniel W. Manson
1991	3rd Place – John M. Gilleo
1992	Honorable Mention – Michelle Hohlfeld
1993	1st Place – Martin Heller
1994	Honorable Mention – Jennifer Jewett Antwerp
1995	1st Place – Jeff VanderLaan
1996	2nd Place – Rick Sprague; 3rd Place – John Pauli
1997	3rd Place – Brian Nowak
1999	1st Place – Casey Preston
2000	2nd Place – Brian Wall
2001	2nd Place – Jessica Okonowski
2005	1st Place – Benjamin Koenigsknecht
2006	3rd Place – Heather Schultz
2010	1st Place – Philip Lehman
2011	1st Place – Nathan W. Hanna; Honorable Mention – Nathaniel C. McIntee-Chmielewski

TABLE 3
Record in AIChE Annual Design Contest - Team

1999	Honorable Mention – Joseph Avore III and Joseph Campbell
2000	1st Place – D. Borowski and T. Maliszewski
2006	1st Place – Stephen Shaw and Matthew Yedwabnick
2007	Honorable Mention and Safety Award– Katherine Geer and Joseph Skuza
2010	1st Place – Christopher Gelinas and David Hasselbeck

Symposium Day. The second, primarily focused on graduate students and research activities, is the annual ChEMS Research Forum.

Symposium Day is organized annually by the student chapter of AIChE and the MSE Society. The event provides students with exposure to how the chemical process industry (CPI) functions, through presentations by industry professionals on process design, control, optimization, and safety. The program also promotes face-to-face interactions with industry professionals and faculty from MSU and other universities, and enhances students' ability to compete successfully for internships and full-time jobs by establishing early ties with CPI professionals. Symposium Day was held for the 21st year in 2012 and has been a key educational experience for the students who organize it as well as those who attend the function. It is also a unique opportunity to bridge our two academic programs, bringing chemical engineering and materials science students together to interact with CPI professionals and faculty members. The ChEMS department considers the event an essential part of our students' education; thus all chemical engineering and materials science classes are canceled for the day, allowing all students to attend.

The annual Research Forum is an opportunity for faculty members and graduate students from the department to give oral and poster presentations of their work to an audience of internal and external attendees. The Forum is generally organized with sessions focused on the principal research themes of the department: energy and sustainability, nanotechnology and materials, and biotechnology and biomedical engineering. The event also features presentations by distinguished industrial and academic professionals. Recent presenters have come from Ford, Stryker, Kimberly-Clark, ExxonMobil, Pfizer, MIT, DTE Energy, Sandia National Labs, Dow Chemical, Mississippi State University, Coca-Cola, BioMarin Pharmaceutical, Idaho National Laboratory, Northern Technologies, and MSU's National Superconducting Cyclotron Laboratory.

LECTURESHIPS AND SEMINARS

The department supports two special seminars each year, in addition to its regular seminar series. The Johansen-Crosby Lecture was endowed by **Edwin Johansen Crosby**, a former MSU student and faculty member at the University of Wisconsin-Madison. The lecture is dedicated to supporting chemical engineering education and is given annually by distinguished contributors in this area. This provides faculty members (and graduate students thinking of academic careers) an opportunity to discuss the state of chemical engineering education and explore visions of the future of education for the discipline.

The Blue-Green Seminar is an annual seminar held jointly with the Department of Chemical Engineering at the University of Michigan. The event involves a visit to one school that

includes a presentation by the speaker, followed by dinner and a poster competition featuring work by graduate students from both universities. The speaker then visits the other school the following day. MSU and UM alternate hosting the presentation and dinner. The choice of speaker is also a shared responsibility, with one school choosing the speaker from a list of candidates provided by the other. This seminar fosters relationships between the faculty members and graduate students of the two schools and has been a tradition for 30 years.

The department further facilitates cross-disciplinary interactions through its participation in MSU's Science at the Edge seminar series. This series, which also is coordinated by colleagues from Physics and Astronomy, Mathematics, Computer Science, Biochemistry and Molecular Biology, and Microbiology and Molecular Genetics, brings in nationally recognized pioneers in research that merges theories and techniques across disciplines.

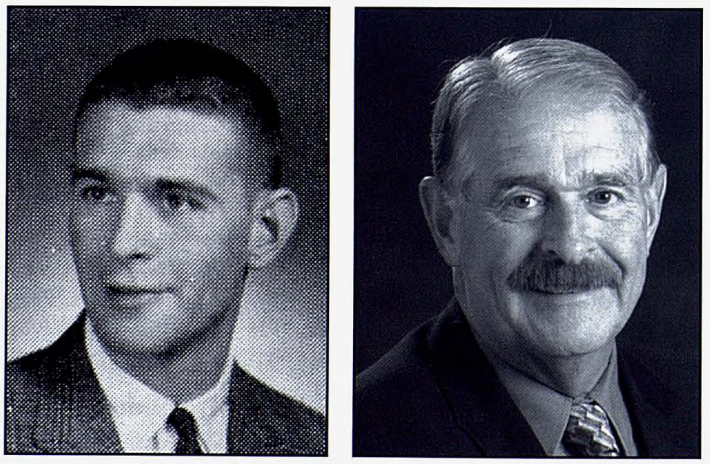
List of Faculty and their Research Areas	
Melissa Baumann	Biomaterials, bone tissue engineering, ceramics processing
Kris Berglund	Fermentation for value-added products, distilled beverage technology
Thomas Bieler	Materials properties, electronic heat sink materials, metal composites
Carl Boehlert	Titanium alloys and composites, intermetallics, electron microscopy
Daina Briedis	Bioengineering, engineering education, assessment
Scott Calabrese Barton	Catalysis and transport in electrochemical energy systems
Eldon Case	Ceramics, bioceramics, thermoelectrics, brittle materials processing
Christina Chan	Diabetes, Alzheimer's disease, tissue engineering, and systems biology
Martin Crimp	Ordered intermetallic alloys, high temperature materials, TEM, SEM
Bruce Dale	Biomass conversion, value-added agriculture, life cycle assessments
Lawrence Drzal	Polymer composite materials, nanomaterials, nanocomposites
David Grummon	Shape-memory materials, thermoelastic transformations
Martin Hawley	Carbon nanotube synthesis, electromagnetic processing of materials
David Hodge	Biofuels and biochemicals, chemical pretreatments, modeling
K. Jayaraman	Processing of polymer blends and polymer nanocomposites
Wei Lai	Advanced materials for fuel cells, batteries, and supercapacitors
Andre Lee	Structure-property relationships of inorganic-organic hybrid polymers
Ilsoon Lee	Molecular self-assembly, functional thin films, polymer interfaces
Carl Lira	Thermodynamics of complex systems, adsorption, simulations
James Lucas	Microstructure characterization of alloys and composites
Richard Lunt	Solar energy production and utilization, organic electronics
Dennis Miller	Chemicals from renewable feedstocks, thermochemical conversions
Donald Morelli	Thermoelectric materials, transport properties of solids
Ramani Narayan	Biodegradable polymer systems, natural-synthetic copolymers
Jason Nicholas	Solid oxide fuel cells, nanostructured composites, Perovskites
Robert Ofoli	Colloids, biosensors, nanocatalysis of biorenewables to chemicals
Charles Petty	Solid-fluid separations, turbulent transport phenomena
Jeff Sakamoto	Thermoelectric materials, batteries, nerve repair technology
K Subramanian	Mechanical properties of metals and ceramics, lead-free solders
S. Patrick Walton	Nucleic acid engineering, biotechnology, RNAi, education
Tim Whitehead	Protein engineering, anti-virals, production of fuels and chemicals
R. Mark Worden	Nanostructured biomimetic interfaces, biochemical engineering

MARTIN C. HAWLEY – 50 YEARS AT MSU

The current chairperson of the ChEMS Department is **Martin C. Hawley**. Of the 100 years of chemical engineering at MSU, Professor Hawley has been a part of 50. Hawley received his bachelor's degree in chemical engineering from MSU in 1961, subsequently earning his Ph.D. in 1964 and joining the department faculty. In 2001, he was named the first chairperson of the then-new Department of Chemical Engineering and Materials Science.

Hawley originally planned on going into veterinary medicine, until he discovered that it would take more than four years. So, he explored other opportunities during his freshman year and eventually looked into chemical engineering. "I liked math, chemistry, and physics, and my advisor said there would be good jobs in that field with a bachelor's degree. It seemed like a natural thing for me to do."

As an undergraduate, Hawley became involved in a research project sponsored by Upjohn. By the end of his four years at MSU, Hawley had decided to go for a Ph.D., spurred on by his undergraduate research project. "I never had it in my mind



Martin C. Hawley: 50 years at MSU.

The department's faculty. Top Row (from left): Melissa Baumann, Kris Berglund, Thomas Bieler, Carl Boehlert, Daina Briedis, Scott Calabrese Barton, Eldon Case, Christina Chan. Second Row: Martin Crimp, Bruce Dale, Lawrence Drzal, David Grummon, Martin Hawley, David Hodge, K. Jayaraman, Wei Lai. Third Row: Andre Lee, Ilsoon Lee, Carl Lira, James Lucas, Richard Lunt, Dennis Miller, Donald Morelli, Ramani Narayan. Bottom Row: Jason Nicholas, Robert Ofoli, Charles Petty, Jeffrey Sakamoto, K.N. Subramanian, S. Patrick Walton, Timothy Whitehead, R. Mark Worden.

that I would stay here. Four years became 50 years," he says. "I really followed what I liked to do. It was a matter of discovery of both the field and the profession."

Hawley is proud of the students he has mentored over the years and the department's award-winning tradition in the AIChE competition. He has taught the capstone design course (and hence has selected MSU's submissions to the competition) for more than 40 years. Looking back, Hawley would not do anything differently. "The best job in the world is being a professor, and I got to do that in a field filled with new and significant challenges to better the world."

SUMMARY

The ChEMS Department at MSU is excited to enter its second century, leading the way in cutting-edge research and high-caliber undergraduate and graduate education. We envision continuing to grow the faculty to meet the demand for degrees in chemical engineering and materials science and engineering and to broaden our research portfolio. We look forward to contributing to the solution of the problems of today and tomorrow, through an innovative, design-oriented education. ❐

The annual ChEMS Research Forum.