The University of Kansas
School of Engineering

Aerospace Engineering

Architectural Engineering

Chemical and Petroleum Engineering

Civil Engineering

Electrical and Computer Engineering

Engineering Physics

Mechanical Engineering

1891 100 *years of* KU engineering *excellence* 1991

1891 **100** *years of*
KU engineering
1991 *excellence*

Table of contents

Introduction

Carl E. Locke, Dean of the School of Engineering

Special Annual Events

Harold F. Rosson, Associate Dean of the School of Engineering

The relation between the activities of the School of Engineering and the needs of society

Aerospace Engineering
Architectural Engineering
Chemical and Petroleum Engineering
Civil Engineering
Electrical and Computer Engineering
Engineering Physics
Mechanical Engineering

Resumés of the historiees of the various departments of The School of Engineering

Aerospace Engineering
Architectural Engineering
Chemical and Petroleum Engineering
Civil Engineering
Electrical and Computer Engineering
Engineering Physics
Mechanical Engineering

Epilogue

Dean of the University of Kansas School of Engineering

Carl E. Locke

The School of Engineering is celebrating the centennial anniversary of its establishment as a school. This coincides with the 125th anniversary of the University of Kansas. Engineering has been an integral part of the university's history, so it is appropriate that these two celebrations coincide. In 1873 the first four graduates of the university completed their studies and one of these, Murray Harris, received a degree in civil engineering. Engineering has been at KU since its beginning.

Engineering education began in Kansas at KU and therefore the School of Engineering is the oldest engineering school in the State. Chancellor Fraser came to Kansas from Pennsylvania State College, a land grant institution, partially because the regents of that school would not consider beginning engineering education at Penn State. The agricultural interests thought that education under the Morrill Act, which established the land grant institutions, should be confined to agricultural education and not be involved in engineering education. Chancellor Fraser did not find the same reluctance at the University of Kansas, but the same type thinking prevailed in the State of Kansas.

Engineering programs were offered from the very beginning of the University and continued for twenty years prior to the formal organization of the School of Engineering. On April 2, 1891 the Board of Regents passed the following resolution: "On motion, voted that a School of Engineering, as recommended by the faculty (said school to include the present Department of Civil Engineering and the Department of Electrical Engineering) be established." The first dean of the School of Engineering, Frank Marvin, was then chairman of the civil engineering department. His father, James Marvin, had been the third chancellor of the university.

This brief introduction to the history of the School of Engineering only describes how the school was begun. A more complete description of the history and the role the various deans and chancellors played is available in the History of the School of Engineering, published in 1989. In addition to giving the history of the school, each departmental history is given along with the history of several degree programs that have since been discontinued. Alumni and friends of the School of Engineering should find the book very interesting and informative. It is available for purchase from the Dean's Office for $25.

The School of Engineering, after a recent program review, has been given a specific mission by the Regents. This mission in the review report states that the School of Engineering at the University of Kansas should emphasize graduate education and research without degrading the undergraduate program. This charge from the Regents did not cause a dramatic change in the direction of the school because that has been the way the school had been moving for a number of years. Research is a vital part of the school and is also a major and critical factor in graduate education. Research at a university should involve graduate students and therefore is a vital part of the teaching mission of the institution. At KU, graduate students are heavily involved in the research programs and are vital to their success.

We are working very hard to maintain the quality of the undergraduate programs and think the research programs help in this effort. The research programs allow the faculty members to maintain an up-to-date perspective on the undergraduate courses. In addition, several undergraduate students work on the research projects which allow them to gain an understanding of the research process and augment the knowledge they receive in their undergraduate program.

The methods and tools for numerical calculations used by engineering have changed dramatically during the last 12 to 15 years. Engineering students from the beginning until the early 1970s were known for using the 'slip stick' (slide rule). 'Slide Rule' accuracy was a well known term which symbolized a reasonably close estimate. In the early 1970s the hand-held, electronic calculator was made available, but initially was so expensive not all students could afford to own one. In less than five years, however, all students had one and there was no longer any question that they could be used on all examinations. These devices allowed the students to do more complex calculations faster and more accurately. We are now in the midst of another revolution in how students do calculations. The introduction to the personal computer in the early 1980s have made an even more powerful tool available for faculty and students. The devices available at the present time are priced at a level that a few students can afford one, but a few can. In addition, the size of the computers are such that they can not be easily carried into the classroom. Progress is being made rapidly on the lap-top, and notebook computers so that in the near future all students may be expected to have a computer in the classroom. When this occurs, the methods of instruction and testing will need to be changed dramatically to fully utilize this powerful tool. We are studying how we should integrate the computer into the curriculum and how we should change our teaching methods to best use these new tools.

This brochure is meant to commemorate our centennial year but is not intended to recount the history of the school or each department. A brief description of the activities of the school and each department at this important point in our history is given. Activities of each department are outlined. Our hope is that this brochure will inform you of where we are in this centennial year. It should also serve as an historical document for those who come later. Our intent here is to transmit the flavor of the School of Engineering at this important juncture in our history.

Dean Carl E. Locke meets with Kathryn Lancaster, public relations assistant. Their goal is to ensure that the university, the state, and the nation know that this is the centennial year of The University of Kansas School of Engineering.

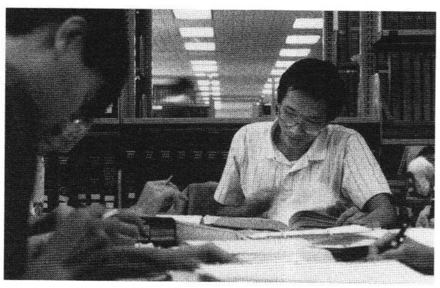
School of Engineering

Annual Events

In addition to the normal routine operations of the School, a number of special events occur each year:

Career Fair

Each September, the School of Engineering Office of Career Services coordinates a career fair specifically for engineering students. The fair features invited corporate and graduate school representatives who visit informally with students throughout the day. The fair is normally scheduled in the same week with a similar fair at Kansas State University and with a KU School of Business fair. This allows the representatives the opportunity to be present at all three fairs over a reasonably short period of time. The fair has grown annually with 81 occupied booths this last September. This is the kick-off for the interview season which begins immediately thereafter.

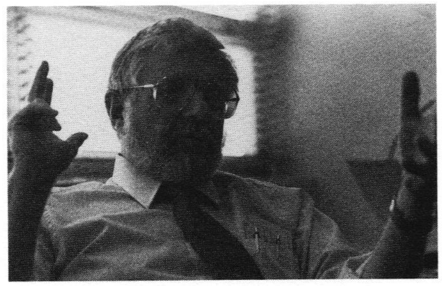


Specialists in information transfer at work.

High School Day

For the past several years the School of Engineering has sponsored a High School Competition day which has taken place in early November. We provide both an academic and a 'fun' design contest. In the morning, the students may take examinations in mathematics and chemistry or physics. There is a system wherein the attending high schools win points with first, second and third place winners. Although individual high scores are recognized, it is the *schools* that win. Then in the early afternoon, the design competition takes place. Recent assignments have been to produce a rubber band powered vehicle to climb a pole as high as possible, a mouse trap powered vehicle to carry a specified weight as far as possible, and a balsa wood bridge to withstand maximum load per unit weight of bridge. This part of the event seems to evoke the most enthusiasm, or at least the most cheering. Typically, the larger high schools win the academic competition and the small rural high schools win the design competitions.

This event has become more and more popular and was most recently attended



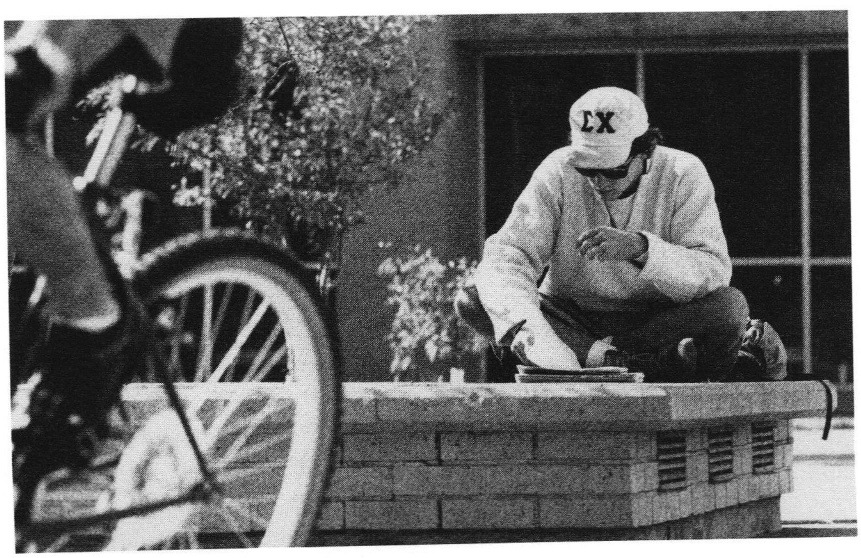
An associate dean at work. (who? me?)

by 393 students representing 30 schools. Because of the growing number of attendees, there have been some operational problems, but we intend to solve them and to make the day better each year.

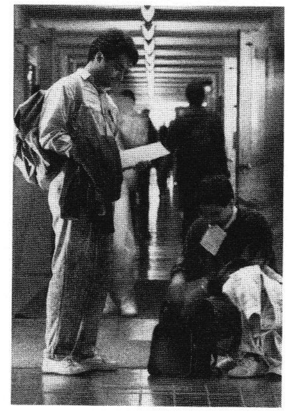
Engineering Exposition

The oldest annually occurring event is the Engineering Exposition. In earlier times it was traditionally held at the same time as the Kansas Relays. However, when the calendar change to an earlier beginning of the academic year took place, there was too little time between the Exposition and final examinations. Since then, the Exposition has vacillated between autumn and mid-winter.

The event is produced by the several student professional societies and coordinated by the Engineering Student Council. The displays usually are in keeping with an overall theme. Theoretically, the displays are produced entirely by the students although faculty have been known to be involved as consultants. Not having the Exposition along with the Relays has reduced the popularity of the event with the general public.



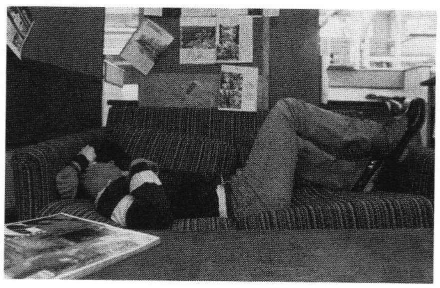
Studying can occur anywhere.



An exercise in group dynamics

SWE Day

For the past few years the Society of Women Engineers has sponsored a high school visitation day where high school women together with their teachers, counselors, and some parents, have been invited to campus to learn about opportunities, challenges, and problems facing women as professional engineers. There is an introductory plenary session, followed by small group meetings with representatives from the different engineering departments and from industry. Most recently, the event has been coincident with the Friday of Engineering Exposition. The day has been remarkably successful, having grown from about 25 women from 7 schools in 1987 to 164 women from 20 schools in 1990.



Senior design projects take a lot out of engineering students.

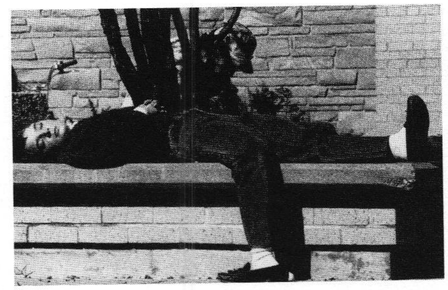
Minority Symposium

The annual Minority Engineering Symposium was initiated fifteen years ago by the Minority Engineering Program at KU. It was designed to provide current information concerning engineering opportunities to students considering or pursuing an engineering career. It combines symposium sessions describing opportunities and programs with a mini-career fair exclusively for minority students.

The format of the symposium has remained much the same over the years except that within the past five years, the engineering minority programs at Kansas State University and Wichita State University have been included. During this time, the number of corporate participants has increased to almost seventy. During the 1990 symposium, a separate on-campus program for precollege students was added.

Distinguished Engineering Service Awards Banquet

The Advisory Board to the School of Engineering in 1980 established the annual Distinguished Engineering Service Awards to honor persons with ties to KU who have made outstanding contributions to engineering and to society. The Service Award is the highest honor bestowed by the School of Engineering. The awards are presented at a banquet held at the time of the annual meeting of the Advisory Board in May. All members of the faculty and their spouses are invited to attend and it is a most pleasant affair. For the one-hundredth anniversary celebration, the banquet will be expanded to include alumni and friends.

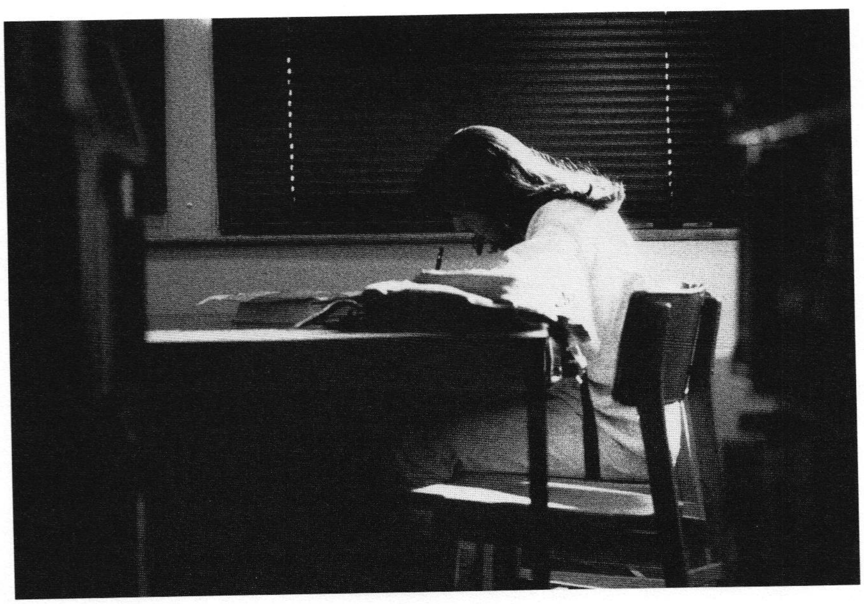


Recharging solar batteries.

Engineering Awards and Recognition Ceremony

Beginning in 1987, a new tradition was established. On Commencement day, a special ceremony is held in honor of all graduating engineers. At this time, a number of awards are presented to outstanding students and faculty. Each graduate is recognized individually and receives a 'remembrance' presented by their chairperson and by the dean. The remembrance is a polished wood block with a brass plate on which are engraved the seal of the university and the graduate's engineering major. A similar ceremony is held at the end of the fall semester for summer and fall graduates, except that no awards are made at the fall ceremony. Attendance of students, family, and friends has indicated that the ceremony is valued and appreciated.

The Enginering Library provides a quiet spot for study.



The relation between activities of the School of Engineering and the needs of society

Professional schools have been associated with universities since the earliest days of the universities in the Middle Ages. The professional schools were established to provide special and additional education in areas thought to be of vital importance to society. The subjects treated and the locations of some prominent schools were: medicine: Salerno, Italy and Montpellier, France; law – civil and canon: Bologna, Italy; theology: Paris, France

Two of these subjects, medicine and civil law, because of their obvious importance to society, continue to be associated as professional schools with universities in many countries. The other two, canon law and theology, closely related to religious matters, have essentially disappeared from the universities. Over the years, other subjects have become important to society and worthy of professional treatment in a university environment. One of these is engineering.

The first schools of engineering were established in France in the middle of the seventeen hundreds and the subjects taught initially were concerned with military subjects – roads, bridges and fortifications – although the students were all well schooled in mathematics, chemistry, physics and mechanics. The graduates were employed by the government and were regarded as military engineers. By the end of the seventeen hundreds France had established polytechnic schools for teaching engineering. Some of the professors in the French military and polytechnique schools produced works that bedevil engineering students today – Laplace, Lagrange, Fourier.

In the United States, the first school that taught engineering subjects was the Military Academy at West Point (established 1802). The first school, which exists today, that taught civil engineering was Rensselaer Polytechnic Institute, and it awarded the first U.S. engineering degree in 1835. The institutes of technology and the schools of engineering that were established in the U.S. after the middle of the eighteen hundreds were primarily concerned with educating young men to carry out the engineering work associated with technological developments.

The second chancellor of the University of Kansas, John Fraser (1868-1874), was the person who initiated engineering education at the University. He had taught mathematics and mechanics at a school in western Pennsylvania before the Civil War and later served four years in the Union Army. He was thoroughly familiar with the importance of engineering and was determined to include engineering education in the KU programs of study. In this endeavor he was successful.

By the end of the century, five engineering programs existed at KU and were within the School of Engineering, which was established in 1891. These programs were: civil engineering (1871), electrical engineering (1887), chemical engineering (1895), and mechanical and mining engineering (1899). Each of these programs and the others to follow were designed to provide the technological education needed by the country. A few of the programs were terminated when the need for their specialized knowledge ceased or when they were combined with other disciplines.

The sections which follow immediately contain accounts of the technological contributions that the presently-existing departments have made and are making.

Aerospace Engineering

Excellence in Design by design

Department Mission and Philosophy

As the Department of Aerospace Engineering starts its fiftieth year, it continues to have as it mission: 1) the preparation of students for careers in aerospace analysis, design and development, 2) the participation in the development of new technology and 3) service to the aerospace engineering profession. To achieve this mission the department has designed and implemented a comprehensive demanding curriculum taught by experienced faculty who are active in teaching and research.

Department Status

The department is ranked eighth nationally among undergraduate programs and 28th among graduate programs in the 1989 Gourman report. Seniors have won top honors in the AIAA/General Dynamics Aircraft Design Competition for team aircraft design and individual student design competitions sponsored by the AIAA/United Technologies and Pratt Whitney. (See Table 1). Faculty and students also are active in funded and unfunded research. The results of this research are presented at national professional meetings and appear in the professional journals.

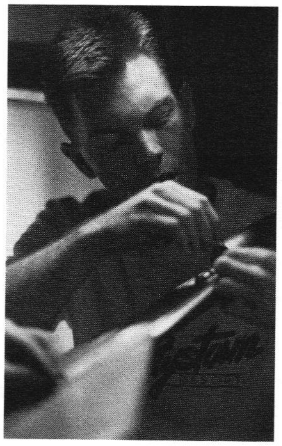
Undergraduate Curriculum

The undergraduate curriculum is a demanding program that includes a strong foundation in mathematics, basic sciences, and engineering sciences during the first two years. At least two courses in aerodynamics, structures, propulsion, and flight mechanics are taken in the last two years. They are supplemented with required courses in computer graphics, aerospace materials and practices, and instrumentation. This comprehensive foundation is an excellent preparation for the study of vehicle design. Design is taught as a set of two senior design courses. The first course focuses on aircraft preliminary design. The students then choose between an aircraft, spacecraft or engine installation as the focus of their second design course.

Graduate Programs

The department offers a comprehensive selection of graduate level courses that support

Aerospace Engineering graduate student run wind tunnel tests to determine the influence of forebody shape on vortex flow.



An Aerospace Engineering student prepares a generic flight model for wind tunnel tests.

education through the doctoral degree. These courses cover all the major subdisciplines in aerospace engineering, including vehicle design. In addition to the standard Masters of Science and Doctors of Philosophy degrees, KU offers Masters and Doctors of Engineering degrees. These degrees are design and management-oriented. They require one half of the program to be in a technical area, like aerodynamics, propulsion or flight dynamics, with a second half devoted to design and management. Internships in industry or at a government laboratory are required in both of these programs.

Faculty

The department has a very experienced and highly qualified faculty. The faculty averages fourteen years of teaching and nine years of industry or government experience. The faculty are all involved in teaching and research.

The current members of the Aeronspace Engineering faculty are:

David Downing, Sc.D., Massachusetts Institute of Technology, 1970. Chairman and Professor of Aerospace Engineering. Dr. Downing joined the department in 1981 and has been chairman of the department since August 1988. His areas of teaching and research are in advanced flight control, display and instrumentation systems. He has had professional experience at NASA's Electronic Research Center and NASA's Langley Research Center.

Saeed Farokhi, Ph.D., Massachusetts Institute of Technology, 1981. Associate Professor of Aerospace Engineering and Director of the Flight Research Laboratory. Dr. Farokhi has taught in the department since 1984. He specializes in propulsion and fluid mechanics. His professional experience includes working for four years as a design and development engineer and project leader in the Gas Turbine Division of Brown, Boveri, and Co. in Baden, Switzerland.

Eddie Lan, Ph.D., New York University, 1968. Professor of Aerospace Engineering. Dr. Lan has been at the University of Kansas since 1968 teaching and conducting research in theoretical and applied aerodynamics, flight dynamics and applied mathematics.

James Locke, Ph.D., Old Dominion University, 1988. Assistant Professor of Aerospace Engineering. Dr. Locke has been with the department since 1988. His areas of interest are in structures and materials. Dr. Locke's previous professional experience was as a structural dynamics engineer at LTV Aerospace Corporation and at NASA Langley Research Center.

Jan Roskam, Ph.D., University of Washington, 1965. Ackers Distinguished Professor of Aerospace Engineering and Graduate Advisor. Dr. Roskam has been with the department since 1967. He specializes in aircraft design, aerodynamics, aircraft stability and control, automatic flight control systems, transportation and applied mathematics. He has had 12 years of professional experience with Aviolanda Co. in Holland, Cessna Aircraft Company, and the Boeing Company in Wichita and Seattle.

Howard Smith, Ph.D., Oklahoma State University, 1968. Professor of Aerospace Engineering. Dr. Smith has been with the department since 1970 teaching aircraft structures, crash-worthiness and biomechanics of bone and hard tissue. Dr. Smith has had 21 years of structures experience with Boeing in Wichita.

Ammon Andes, M.S., California Institute of Technology, 1933. Professor Emeritus. Professor Andes joined the department in 1946. His teaching and research interests were in the area of propulsion, engine technology and thermodynamics. He has three years and 19 summers of engineering experience with aircraft and engineering organizations such as Convair (General Dynamics), Boeing, McDonnell-Douglas, Westinghouse, General Electric, Martin and NASA. He retired in May, 1976.

Vincent Muirhead, A.E., California Institute of Technology, 1949. Professor

Emeritus. He came to the department in 1961. His teaching and research interests are in the areas of theoretical and applied aerodynamics and aerodynamic testing. Professor Muirhead retired from the Aerospace Engineering Department at KU in May, 1989.

Research

The department is engaged in an active and diverse research program that enriches the education of undergraduate and graduate students. Operating through the Flight Research Laboratory in the Center for Research Incorporated, the faculty and students have been involved in a wide range of research in the areas of computational fluid dynamics, fluid physics and turbulence, applied aerodynamics, aeroacoustics, structural mechanics and materials, flight dynamics and control, flight testing and biomechanics.

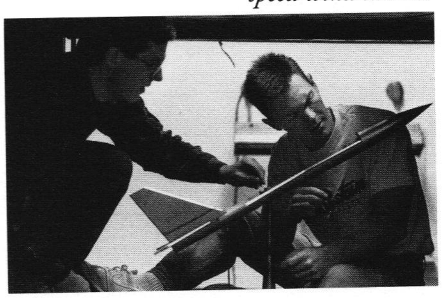
Examples of recent projects include identification of aerodynamic models for maneuvering aircraft, a finite element formulation for the buckling and vibration of heated anisotropic plates, ride quality augmentation systems, ultralight structural testing, the aerodynamics of thrust vectoring, design of control systems for departure/spin prevention, fighter agility metrics, high angle-of-attack aerodynamics of airplane configurations, and hydrodynamic stability analysis of a swirling jet. This research has been funded by NASA's Ames, Dryden, Langley, and Lewis Flight Centers, the FAA, Boeing, General Dynamics, General Electric, the Kansas Technology Enterprise Corporation, and the Aeronautical Research Laboratory in Taiwan.

Service

The faculty actively participates in numerous professional societies including AIAA, SAE, ASME, IEEE and ASEE. The faculty has served on professional society technical committees, government advisory committees and special panels.

The department is involved in thirteen short courses covering topics in aerodynamics, structures and materials, airplane design, flight control, propulsion and flight testing. These courses are presented at KU and at public locations throughout the world. Recent courses have been given in England, Italy, Holland and Australia.

Aerospace Engineering graduate students install a generic fighter model in a low speed wind tunnel.



What's Next?

The department is committed to continue the excellence of the current program always evolving to keep pace with changes in the profession and adding improvements as opportunities develop. One recent example of an opportunity was the negotiation of a KU/Wichita State co-operative agreement. This agreement permits and encourages the use of unique facilities and expertise at the two universities by the faculties for teaching and research. This sharing of talent and resources will strengthen both universities and enrich student's educational experiences.

The department is committed to expanding its astronautic activities. The department will recruit a Distinguished Professor of Astronautics for fall 1991. Plans are underway to enhance the graduate offerings and to develop an active research program in astronautics.

TABLE 1: The University of Kansas AIAA Design Competition Achievements

United Technologies Electric Individual Aircraft Design	1981 1st & 2nd	*General Dynamics Team Aircraft Design*	1986 1st	*General Dynamics Team Engine Design*	1988 1st
	1982 1st, 2nd & 3rd		1987 1st & 3rd		1989 2nd
	1983 1st, 2nd & 3rd		1988 1st		1990 1st
	1984 1st		1989 1st & 2nd		
	1985 1st & 2nd		1990 2nd, 3rd & 4th		
	1986 1st				
	1987 2nd				
	1988 3rd				
	1989 1st				
	1990 no entries				

Architectural Engineering

The present and future of Architectural Engineering

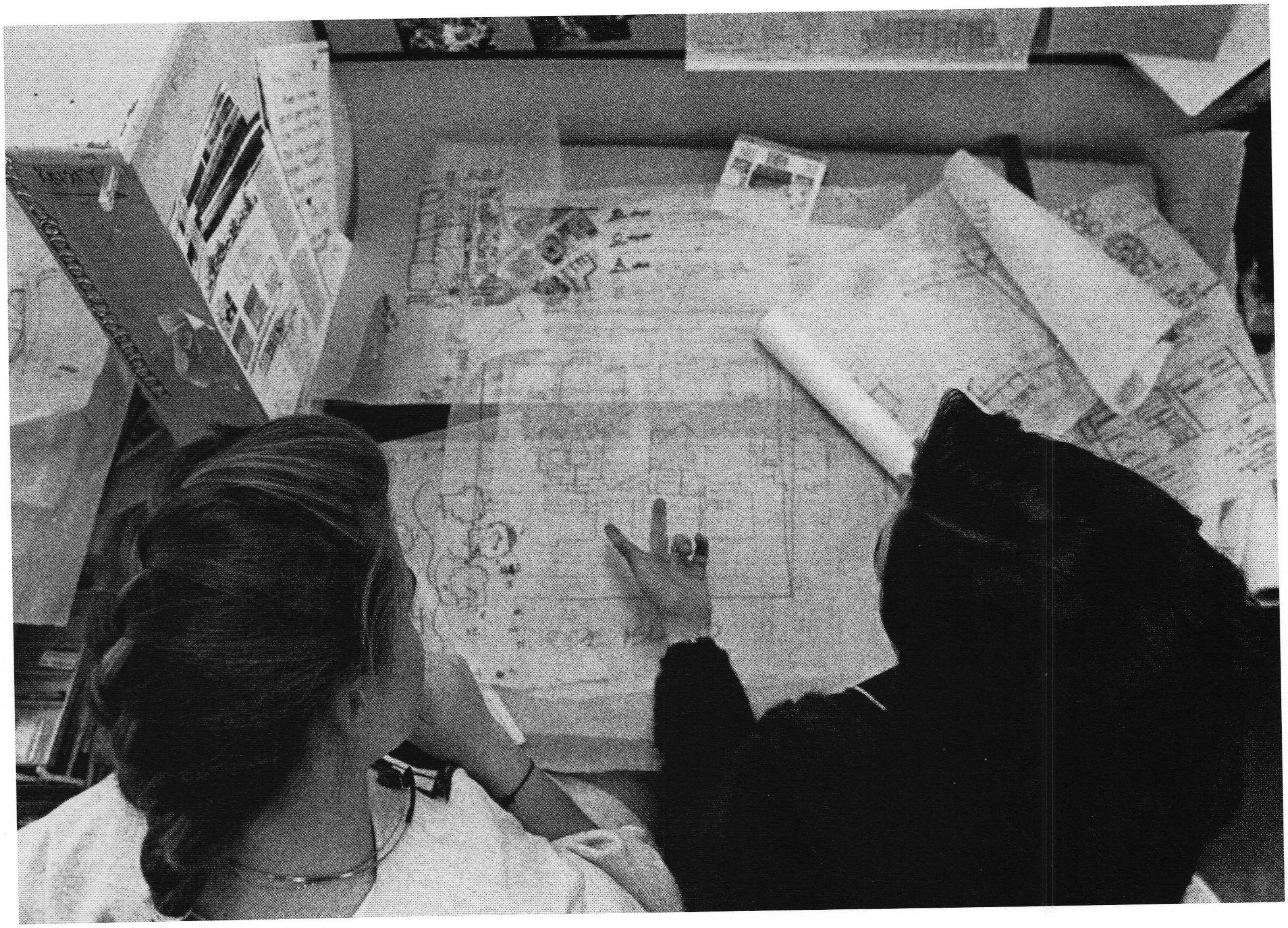
The Architectural Engineering Program was established in 1912 and has been accredited since 1937. Graduates of the program address the technological areas associated with building design and construction. These include structures; heating, ventilating and air conditioning; plumbing and piping; illumination; power systems; acoustics; and construction management. In recent years solar energy design and energy management have been added to the list.

The architectural engineering department at the University of Kansas is a small and tightly knit unit offering a diverse assortment of courses and enjoys a well-deserved national reputation.

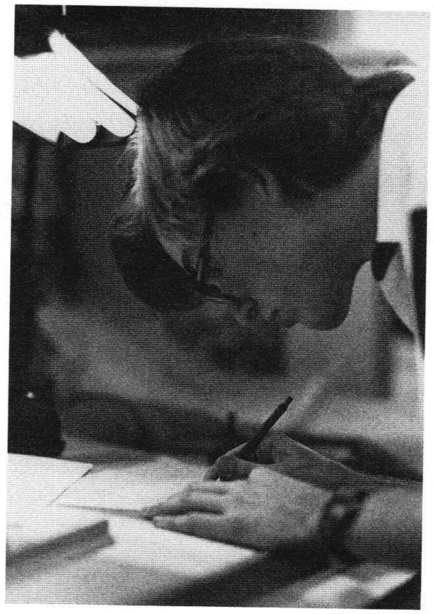
The program requires five years of study with a full complement of mathematics, basic and engineering sciences, engineering and architectural design, building technology, and architectural history. One hundred-sixty undergraduates are enrolled in the program in 1990. Since studio space is limited, only about one of four freshmen applicants is admitted. Those admitted have an ACT math score above 28.

All undergraduate students are required to complete fundamental courses in structures, HVAC, plumbing and piping, illumination, power systems, and construction management. Elective courses are offered in heating-ventilation-air conditioning, illumination, daylighting, power systems, solar energy design, acoustics, energy management, and construction management.

The faculty believe that this diversity of engineering design courses together with studies in architectural design and construction materials and methods is fundamental to comprehensive mechanical and electrical system design.



An Architectural Engineering student explains a design solution.



An Architectural Engineering student translating numbers into drawings.

In addition to providing instruction for its own majors, the department provides required instruction in structures, mechanical systems, illumination, power systems, and acoustics for architecture students. Students from electrical and computer engineering, mechanical engineering, architecture, and interior design constitute a sizeable enrollment in the elective engineering design courses.

Two capstone courses, Architectural Engineering Design Studio I and II, are required during the fifth year. These courses are supplied with fully equipped CADD stations of three work stations and a plotter each. In these courses students design the structural, mechanical, lighting, and power systems for an office building or similar structure and produce the contract documents.

With the diversity of career opportunities and the broad spectrum of technical specialties available, a modest amount of concentration is allowed. Students may elect to concentrate in structures, environmental control, illumination, or construction management.

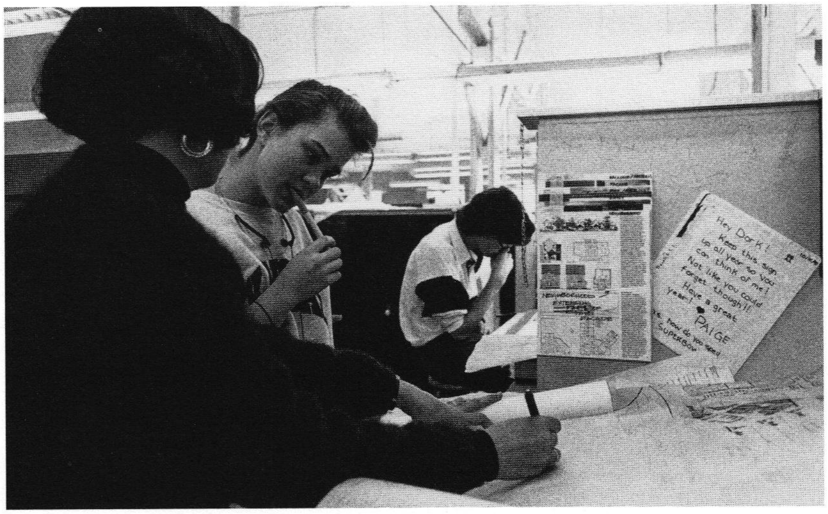
The faculty of architectural engineering is active and diverse. Each holds the doctorate degree, each is a registered engineer (one faculty member is also a registered architect), and each has significant consulting or industry experience. Three of the six departmental members are listed in "Who's Who In America". Each faculty member in the department is also active in one or more professional societies.

Each faculty member in the department has authored books, significant papers, research reports, or a combination of these. Although architectural engineering is not known for its research base, funded research is currently being conducted in the areas of energy conservation, intelligent systems for illumination, and acoustics.

The current members of the Architectural Engineering faculty are:

M. Clay Belcher, Ph.D, Missouri, 1987. Illumination and Energy Conservation.
Bezaleel Benjamin, Ph.D., London, 1965. Structural Plastics.
Thomas Dean, Ph.D., Texas, 1963. Heating, Ventilating, and Air Conditioning, Solar Energy, and Acoustics.
William Douglas, Jr., Ph.D., Missouri (Columbia), 1979. Construction Management.
Ronald N. Helms, Ph.D., Ohio State, 1971. Illumination.
Nancy L. Holland, Ph.D., Texas A&M, 1989. Construction Management.

As with any other endeavor, future developments in the program can only be speculated about. Current indications are that increased attention will be directed to indoor air quality, lifetime costs, energy conservation, and further emergence of 'smart' buildings. The department will attack these challenges as they present themselves.



Students in the Architectural engineering program must learn to contend with problems which involve multiple variables.

Chemical and Petroleum Engineering

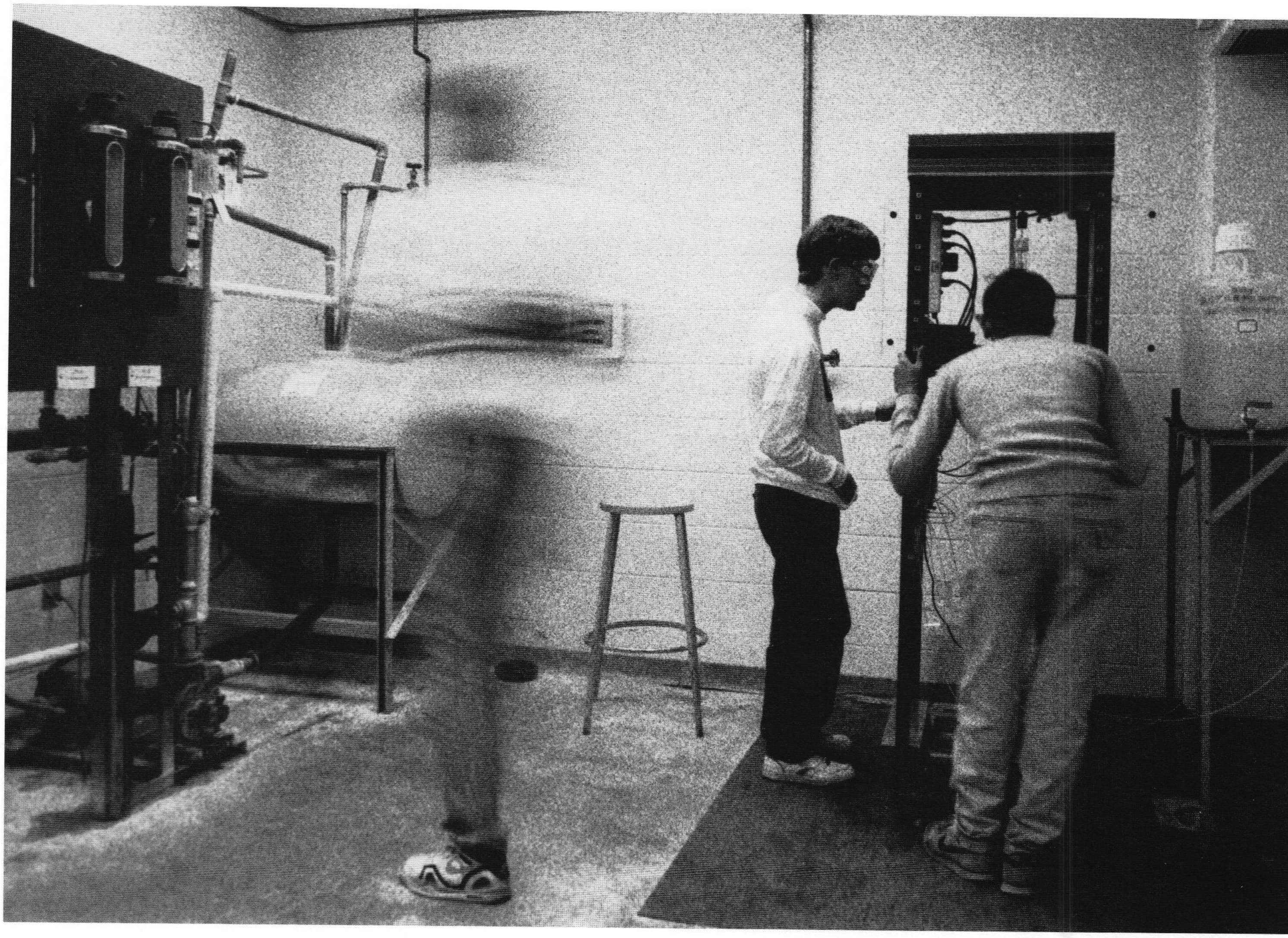
A historical perspective

A bachelor's degree program in chemical engineering was established at the University of Kansas in 1895, and the first student graduated in 1900. The program was administered by the Department of Chemistry from 1895 to 1935 and was a mixture of chemistry and engineering courses. Such an arrangement was common nationally in the early days of chemical engineering education. At KU during that period, there were no courses in chemical engineering, no faculty members with degrees in chemical engineering, and no budget. The students who earned degrees during this period were well educated, but not in chemical engineering subjects.

When the university requested in 1936 that the chemical engineering program be accredited by the Engineers' Council for Professional Development-AIChE, accreditation was refused. Steps were taken to remedy the deficiencies, and by the end of World War II, a satisfactory department was created, with adequate faculty, budget, and laboratories. The department was accredited in 1949 and has remained accredited since. A pre-med option was added in 1972. Biomedical and environmental options were developed in 1990. The first master's degree was granted in 1937, and the first doctoral degree was granted in 1951; it was the first doctoral degree in engineering ever granted at the university.

The petroleum engineering program began in 1924 with courses in petroleum technology offered as options in mechanical and mining engineering. The Department of Petroleum Engineering was established in 1937, and the first bachelor's degree was awarded in 1938. In 1948, the faculty was expanded from one to three. The bachelor's degree was accredited by the Engineers Council for Professional Development in 1949 and has remained accredited since. Both masters and doctoral degree programs were established.

In 1961 the departments of chemical and petroleum engineering were combined, and degrees were granted in both fields at all levels. In many cases the thesis work could be considered in either field. As of May 1990, 2,035 bachelor's, 434 master's, and ninety-one doctoral degrees have been awarded.



Students at work in the undergraduate Chemical Engineering laboratory.

Our graduates have excelled in all fields of endeavor. We are proud of their accomplishments.

The Chemical and Petroleum Engineering faculty

The faculty's commitment to both research and teaching has resulted in several honors and awards. Four of the faculty members are fellows of the American Institute of Chemical Engineers, and three are Distinguished Members of the Society of Petroleum Engineers. Individual faculty members have been recognized for their professional achievements. There are eleven endowed professorships in the school, and four are held by members of this department.

Our faculty members have written undergraduate and graduate textbooks. Members of the faculty have won every award for outstanding teaching for which they are eligible in the university. Since 1981, our undergraduate students have won three firsts, one second, three thirds, and one honorable mention in the American Institute of Chemical Engineers Design Contest. Other professional activities of our faculty include journal editorships, memberships on national committees, and consulting.

The members of the Chemical and Petroleum Engineering faculty are:

Kenneth A. Bishop, Professor, Ph.D., Univ. of Oklahoma, 1965. Research interests: Supercomputer applications in chemical and petroleum engineering. Improvement of the human-machine interface for computation. Transient behavior of chemical and physical processes.

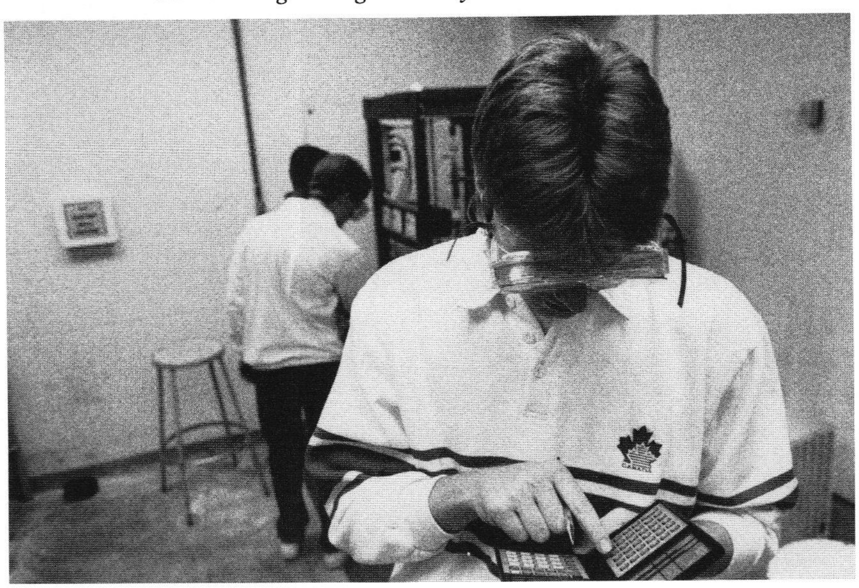
John C. Davis, Professor and Senior Scientist, Kansas Geological Survey, Ph.D., Univ. of Wyoming, 1967. Research interests: Statistical analysis of geologic and engineering data, particularly for prospect evaluation and regional resource appraisal. Computer mapping and display techniques, including automated cartography and image analysis, play a large role in this work.

Don W. Green, Conger-Gabel Distinguished Professor and Co-Director of Tertiary Oil Recovery Project, Ph.D., Univ. of Oklahoma, 1963. Research interests: Enhanced oil recovery including methods of increasing recovery from petroleum reservoirs. Techniques include micellar/polymer flooding, application of gelled polyacrylamide polymers for flow control, and carbon dioxide miscible flooding.

Colin S. Howat, Associate Professor, Ph.D., Univ. of Kansas, 1983. Research interests: Plant performance analysis, process simulation and phase equilibria thermodynamics. Recent emphasis has been interpreting formalistically plant performance data, developing statistically the relationship between process design and data base uncertainties, determining experimentally the phase equilibria of mixtures of dissimilar molecules, and developing the theory and technology for separating azeotropic, isomeric mixtures using supercritical solvents through simulation and experimentation.

Carl E. Locke, Jr., Professor and Dean, School of Engineering, Ph.D., Univ. of Texas, 1972. Research interests: Corrosion of steel in concrete. Study of pore solution composition and its effect on corrosion electrochemistry of embedded steel.

Checking data in the undergraduate Chemical Engineering laboratory.



A graduate student gathering experimental data

James O. Maloney, Professor Emeritus, Ph.D., Pennsylvania State Univ., 1941. Research interests: Undergraduate laboratory experiments to provide sequences of experiments in distillation and in extraction and adsorption. Structuring of information for improved comprehension to provide more easily grasped textbook material.

Russell B. Mesler, Warren S. Bellows Distinguished Professor, Ph.D., Univ. of Michigan, 1955. Research interests: Heat transfer and fluid mechanics, principally nucleate boiling. High-speed photography and measurement of fast transient surface temperature have been useful tools. Photography is used to study the fluid mechanics of bubbles and drops and transient surface temperature behavior to study the heat transfer.

Floyd W. Preston, Professor, Ph.D., Pennsylvania State Univ., 1957. Research interests: Numerical modeling of pore structure and quantitative description of spatial variation in petroleum reservoir properties.

Harold F. Rosson, Professor and Associate Dean, Ph.D., Rice Univ., 1958. Research interests: Development of inexpensive laboratory experiments that demonstrate theoretical engineering concepts and provide integration of engineering principles using automated data collection and microcomputer supported data analyses.

Marylee Z. Southard, Assistant Professor, Ph.D., Univ. of Kansas, 1989. Research interests: Drug transport and bioavailability enhancement, mathematical modeling of physiological transport, characterization of controlled release devices for pharmaceuticals.

Randall V. Sparer. Adjunct Assistant Professor, Senior Research Chemist, Controlled Delivery Devices Group, Merck Sharp and Dohme Research Laboratories, Ph.D., Case Western Reserve Univ., 1982. Research interests: Polymers for biomedical materials in drug delivery systems.

Bala Subramaniam, Associate Professor, Ph.D., Univ. of Notre Dame, 1984. Research interests: Kinetics and catalysis, mathematical modeling. Current projects include study of catalyst coking chemistry using supercritical reaction media, investigation of reaction schemes for reduction of NO_x emissions, modeling of selective epitaxial growth on patterned wafers and development of pharmacokinetic models for drug therapy.

George W. Swift, Deane E. Ackers Distinguished Professor and Director of Kurata Thermodynamics Laboratory, Ph.D., Univ. of Kansas, 1959. Research interests: Phase equilibria experiments on systems that have industrial importance, e.g. extractive distillation for diolefin recovery and CO_2 miscible flooding. Transient gas flow experiments to identify natural gas production problems associated with tight, lenticular, and/or fractured reservoirs.

Brian E. Thompson, Assistant Professor, Ph.D., Massachusetts Institute of Technology, 1986. Research interests: Integrated circuit fabrication and semiconductor materials processing. Specific areas include plasma modeling and plasma reactor design, plasma-enhanced chemical vapor deposition, selective and blanket deposition of refractory metal thin films.

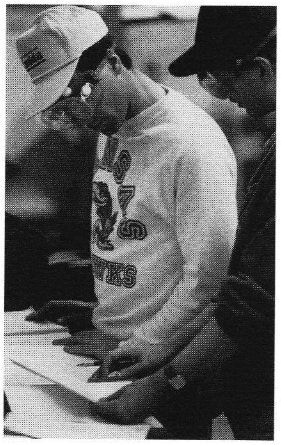
Shapour Vossoughi, Associate Professor, Ph.D., Univ. of Alberta, Canada, 1976. Research interests: Enhanced oil recovery concentrating on in-situ combustion, polymer flooding and in-situ gelation. Rheology with emphasis on polymer solutions and petroleum gels. Thermal analysis concentrating of thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) techniques applied to the combustion of crude oil to study the reaction kinetics involved. Catalytic effects of clays and grain surface area on crude oil combustion.

Computer simulation for development of computer models in the area of in-situ combustion and polymer flood.

Stanley M. Walas, Professor Emeritus, Ph.D., Univ. of Michigan, 1941. Research interests: Fluid phase thermodynamics, reaction kinetics, and process engineering.

G. Paul Willhite, Ross H. Forney Distinguished Professor and Chairperson and Co-Director of Tertiary Oil Recovery Project, Ph.D., Northwestern Univ., 1962. Research interests: Enhanced oil recovery processes involving the study of processes that have the potential of displacing oil from petroleum reservoirs. Research projects range from fundamental studies of displacement mechanisms to numerical simulation of process performance. Transport processes in porous media. Phase equilibria in liquid systems.

Students check data obtained during an experiment in the Chemical Engineering laboratory



Research

Research is an integral part of our department. Our faculty and graduate students conduct research in a broad spectrum of topics including:

Catalytic Kinetics and Reaction Engineering
Chemical Vapor Deposition Kinetics and Reactor Modeling
Controlled Drug Delivery
Corrosion
Enhanced Oil Recovery Processes
Fluid Phase Equilibria and Process Design
Nucleate Boiling
Numerical Modeling of Pore Structure
Plasma Modeling and Plasma Reactor Design
Process Control
Supercomputer Applications
Supercritical Fluid Applications

Organized research laboratories have been developed in several of the research areas.

Kurata Thermodynamics Laboratory (ktl). This facility in the Department of Chemical and Petroleum Engineering occupies a new laboratory building on the University's west campus. This building has approximately 5,000 square feet, including offices for two of the department's faculty members and six graduate students, several experimental laboratories, a well-fitted machine shop, and a standards laboratory equipped to provide calibrations (traceable to NBS primary standards) on temperature and pressure sensors.

Research activities center around phase equilibrium (vapor-liquid, vapor-liquid-liquid, liquid-liquid, vapor-solid, etc.), P-V-T studies, and transport (mainly viscosity) studies, all of which can be conducted at pressures up to 12,000 psia and at temperatures from -450° to 300° F. All of these efforts are tied closely to problems of engineering importance in chemical-related processing. To this end, personnel at KTL have developed a process simulator that relates the data acquired to end-use needs, including reservoir simulation and petrochemical plant design, using equations of state and appropriate liquid phase solution models as required. The process simulator is a mathematical model written for MSDOS microcomputer.

Research is conducted in process design applications including sensitivity analysis and formalistic analysis of plant operating performance. Extensive use of statistics integrated with unit operation calculations and data analysis procedures are employed in both of these areas to improve the mathematical tools available to process designers.

Tertiary Oil Recovery Project (torp). The TORP program is concerned with the research and development of enhanced oil recovery processes. Topics being studied include poly-

Students at KU learn the value of maintaining their equipment.

mer and gelled polymer applications, the micellar/polymer process, in-situ combustion, and the carbon dioxide miscible process. Research focuses on understanding the different process mechanisms and developing the processes for field application. Experimental work typically involves displacements in rock cores or unconsolidated porous media beds, phase behavior, and analytical methods for analyzing displacement effluents.

TORP is located in Learned Hall in the Department of Chemical and Petroleum Engineering. The facilities include those required to conduct fluid displacement experiments in porous media, analytical equipment for characterization of various fluids used in the displacements, and certain specialized equipment required in particular research projects. A microcomputer system is used for on-line data gathering, experiment control, and technical calculations.

The porous media displacement laboratory has a pressure transducer system connected to the computer and a microwave apparatus to measure liquid saturations in rock cores. Other apparatus includes precision low volume/high pressure pumps, automatic sample collectors, and constant temperature baths.

The laboratory has a broad range of devices for measuring fluid concentrations and physical properties. These include gas and high-pressure liquid chromatographs, an auto analyzer, spectrophotometer, light scattering instrument, mercury porosimeter, a spinning drop interfacial tensiometer, and two Weissenberg rheogoniometers.

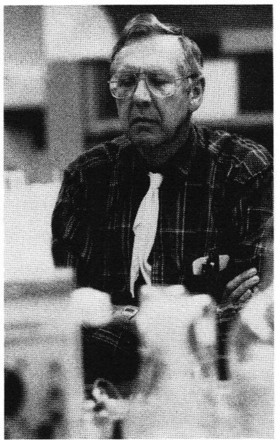
Heat Transfer Laboratory. A laboratory devoted to research on nucleate boiling was established in 1958. The early emphasis was on transient surface temperature measurement with acquisition of high-speed recording equipment for electrical signals including oscilloscopes, a storage oscilloscope, and oscilloscope camera, and a transient store.

The need to measure transient pressure during vapor explosion and bubble collapse experiments brought a variety of quartz pressure transducers and their associated electronics.

Dr. Stan McCool, at right, demonstrates computer graphing techniques.

Studies with high speed photography use a wide variety of equipment including a Fastax camera with dual streak and framing capability at framing speeds up to 8,000 frames per second, a Dynafax camera with speeds up to 35,000 frames per second, and the newest camera, a LOCAM II with speeds up to 500 frames per second and with start and stop capabilities. Strobe photography has played a role with a GR Stroboslave and an EG&G Microflash. A spectra Physics Starlight 5'mw Helium Neon Laser together with a variety of electronic timing circuits are useful for precise timing of strobe photographs.

Kinetics and Catalysis. Research in these areas mainly deals with heterogeneous fluid/solid reactions and reactors. Both traditional and non-traditional problems are being addressed. On the traditional application side, two problems of industrial interest have been the focus of recent research. The first project investigates the chemistry of coke formation in porous catalysts using a novel experimental technique that involves in situ extraction and subsequent analysis of the coke precursors using supercritical fluid reaction media. This research has application in the optimum scheduling of catalyst regeneration cycles in conventional processing.



Mike Michnick, TORP *senior scientist, waits patiently for data.*

The second project addresses the catalytic reduction of nitrogen oxide (NO_x) emissions, a major cause of photochemical smog and acid rain. Our research is aimed at developing a low temperature, sulfur dioxide resistant process for selective catalytic reduction of NO_x emissions from stationary combustion sources such as coal-fired utility boilers.

The non-traditional applications involve colloborative research and employ the basic principles of heterogeneous fluid/solid reaction engineering in the mathematical modeling of such diverse phenomena as tumor targeting by monoclonal antibodies (MAbs) and the selective epitaxial growth (SEG) of silicon in electronic materials processing. Two-dimensional models are being developed to describe MAb penetration in tumors and to predict SEG rates as a function of process variables, viz. pressure, temperature and bulk gas composition. Our goal is to gain a better understanding of the physicochemical processes underlying these phenomena, and thereby aid in a rational approach to practical application.

The Kinetics and Catalysis research laboratory is located in Learned hall and is equipped with experimental facilities for studying the kinetics of fluid-solid catalytic reactions involving multiple species such as in the catalytic cleanup of flue gas from stationary combustion sources, and with a continuous high pressure reactor unit for studying reactions under supercritical reaction conditions. A Digisorb catalyst surface area and pore volume analyzer, a Fisher chloride titrator, a Hewlett-Packard gas chromatograph, a Beckman chemiluminescent NO_x analyzer and a Beckman infrared CO analyzer support current analytical needs.

Biomedical Engineering Research. This interdisciplinary research area was established in 1989. Our research is concerned with design and characterization of devices for controlled release, and simulation of physiological transport phenomena. Topics under current study include the design of biocompatible and biodegradable devices for controlled pesticide release, study of osmotic pumping devices, and investigation of drug uptake by malignant tumor tissue.

The laboratory is located in Burt Hall. Also, other experimental study is conducted at $Inter_x$, a research facility of Merck, Sharp and Dohme, Inc., located on West Campus. We collaborate with a number of researchers in other disciplines, including the Department of Pharmaceutical Chemistry and the Department of Nuclear Medicine (Medical Center - Kansas City).

Plasma Processing Laboratory. A laboratory devoted to studies of plasma processing reactors for the semiconductor industry and other applications has been set up in Burt Hall. The lab has a custom designed plasma system comparable to single wafer systems used in industry. The basic equipment required to produce the plasma includes a gas manifold with mass flow meters for mixtures of gases, a capacitance namometer and butterfly exhaust valve for pressure measurement and control, and a mechanical vacuum pump for pumping to the operating pressures of 0.1 to 10 Torr. In order to have the greatest flexibility, the plasma is powered from up to three combined voltage waveforms amplified by an ENI broadband amplifier for frequencies from 10 kHz to 20 MHz. The primary analytical tool of the lab is currently a Phillips high-speed (250 MHz sampling rate) digitizing oscilloscope. The electrical impedance of the discharge measured with the scope is analyzed to give the concentrations of two types of reactive species: electrons and positively charged ions. A Zenith 386 system is used for control and data acquisition as well as for analyzing experimental data.

Strengths

Our department is committed to the development of students into professional colleagues. Our undergraduate programs in both chemical and petroleum engineering are strongly rooted in mathematics, sciences, engineering sciences, and engineering design. We attempt to maintain a first-rate curriculum that has laboratory and design components integrated with fundamentals to produce engineering practitioners, not just theorists. We recognize the importance of written and oral communication skills in professional development and promote growth in these areas through our curricula. Particular emphasis is placed on teaching, and our faculty has consistently been recognized for superior teaching. Faculty members are internationally recognized for contributions to research. Several faculty consult regularly with industry. Our faculty develop the technology of the future through research and engineering practice.

The Future

Chemical engineers are involved in the conversion of raw materials through chemical and physical processes into products that are useful to our society. Potential applications of chemical engineering principles continue to develop in emerging technologies such as biotechnology, electronic materials processing and disposal of hazardous wastes. While maintaining our strengths in the traditional areas, we shall continue to diversify our curricula to produce engineers trained in these emerging technological areas.

Our country is strongly dependent on hydrocarbons for transportation, heat and chemical feedstocks. Petroleum engineers are involved in all phases of drilling, exploration and production of oil and natural gas. There are many opportunities for petroleum engineers to contribute to our society through development of energy resources from new and existing reservoirs.

A flurry of activity is characteristic of our undergraduate laboratory.

Civil Engineering

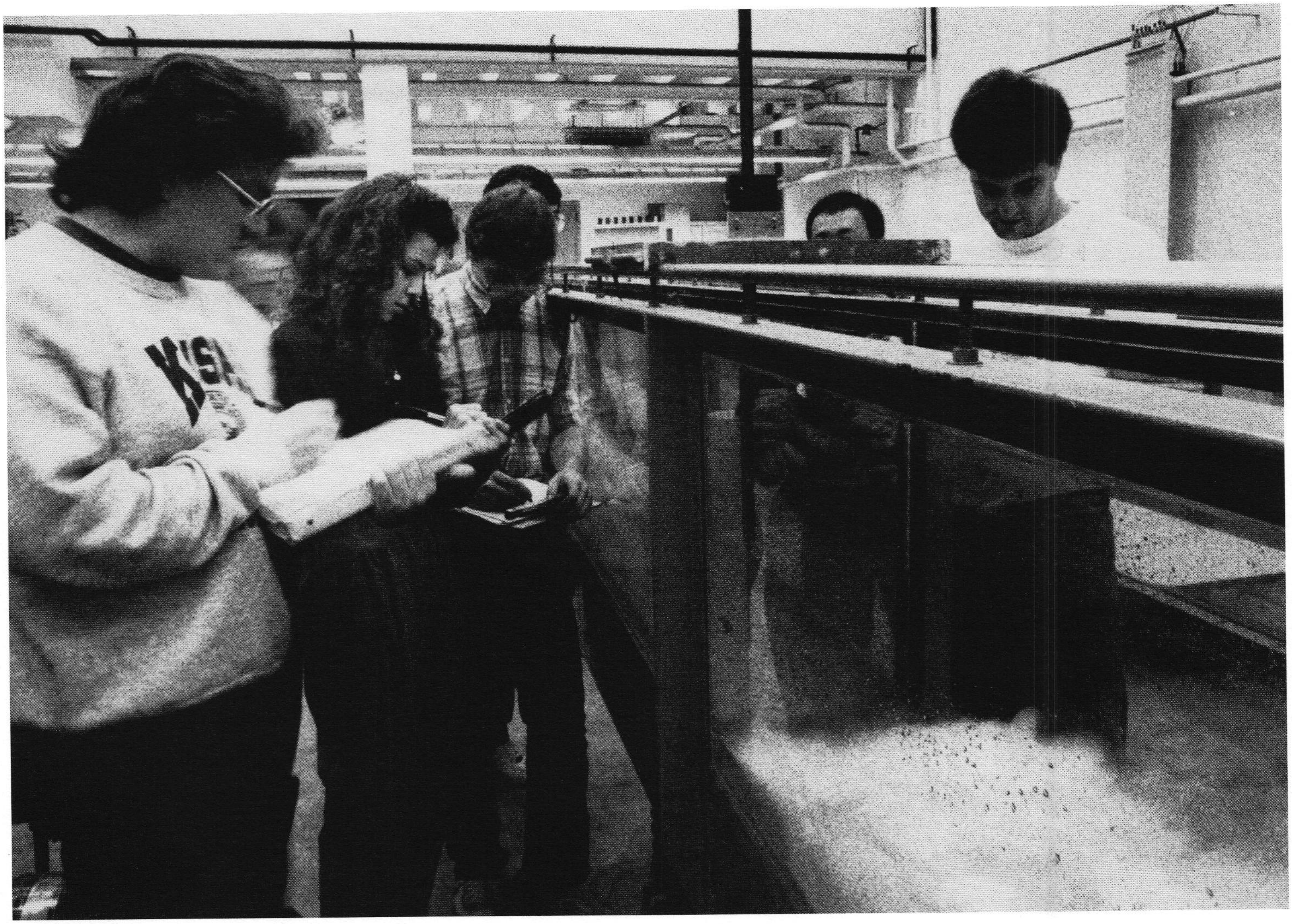
A People Serving Profession

Civil Engineering is a shortened version of 'civilian engineering', in contrast to the original military engineer in Roman times. The civil engineering profession has a long and distinguished history of serving the public and the private needs of society through the design and construction of buildings, bridges, highways, airports, water and wastewater treatment plants, dams and reservoirs. The complexity of civil engineering projects has produced several technical subdisciplines. Civil Engineering at the University of Kansas reflects this diversity with teaching and research in environmental, water resources and fluid mechanics, structures and solid mechanics, engineering materials, construction, transportation, and geotechnical engineering.

Students, faculty, staff, and alumni of the KU Department of Civil Engineering continue a tradition of excellence in education, basic and applied research, and professional achievement and service. KU civil engineering students are career-oriented with a strong sense of commitment and societal responsibility. This perspective mirrors the professional accomplishments of KU civil engineering alumni. A dedicated faculty and staff enjoy working with both undergraduate and graduate students. An experienced faculty, seasoned by working with local, national and international research organizations and consulting firms and recognized by several appointments to the National Academy of Engineering, blend the practice and research of civil engineering to form an exciting and contemporary learning environment. Classes remain fairly small and the faculty maintain an 'open-door' policy. We expect the strength of the Department – namely, people: past, present and future – will be maintained well into the next century.

Areas of Civil Engineering

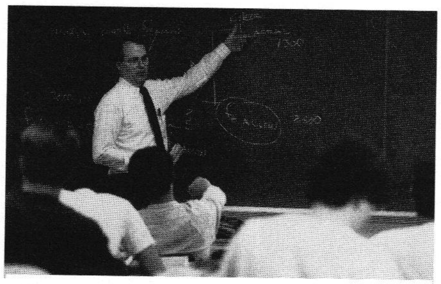
The undergraduate curriculum prepares the student to either enter professional practice upon graduation or to begin graduate studies in engineering or another discipline. Undergraduate students are not allowed to specialize, but receive broad exposure to the fundamentals of environmental, geotechnical, structural, transportation, and water resources engineering. Specialization in these subjects occurs at the graduate level.



The complexity of open - channel fluid flow can be observed easily in a laboratory experiment using a hydraulic flume.

Environmental. The University of Kansas has been involved with environmental teaching and research associated with public health since 1895. Engineering solutions were found to protect public drinking water supplies and to prevent further contamination of natural water systems in response to typhoid fever and cholera epidemics during the late 19th century. In the 1950's, air pollution control and solid waste management were added to traditional water pollution concerns reflecting a more complete understanding of the total natural and human modified environment. The newest challenge is to assess the public health risk of life-time exposure to various compounds found in air and water in minute or trace concentrations and to develop technology to reduce any unacceptable danger.

Thus, the environmental health graduate program focuses on science and its application through engineering. The research conducted to study anaerobic digestion, drinking water quality, industrial waste pretreatment and treatment, volatile organic chemicals in ambient air, and atmospheric deposition, continues to have regional, national and international importance.



Competent professional practice is based on an in-depth understanding of structural code requirements and their technical basis.

The members of the Environmental faculty are:

Carl E. Burkhead, Ph.D., Kansas, 1966. Industrial waste treatment, environmental monitoring, chemical principles.

Dennis D. Lane, Ph.D., Illinois at Urbana-Champaign, 1976. Air pollution, physical principles.

Glen A. Marotz, Ph.D., Illinois at Urbana-Champaign, 1971. Air quality, air quality monitoring, toxic air pollutants, hydrometeorology.

Ross E. McKinney, N. T. Veatch Distinguished Professor, Sc.D., MIT, 1951. Wastewater treatment, solid waste management, biological principles.

Stephen J. Randtke, Ph.D., Stanford, 1977. Water treatment, water quality.

Water Resources and Fluid Mechanics. Water resources/fluid mechanics instruction and research involves the study of hydrology, hydraulics, fluid mechanics, groundwater, contaminant transport, local and regional scale system analysis, planning and water policy formulation. Specific research topics include flood forecasting, 3-reservoir operation, groundwater quality modeling, analysis of scour, sill-flow analysis, agricultural runoff induced nonpoint source pollution processes, groundwater dispersion analysis, and wetlands hydrology. Since many of these topics involve environmental dispersion processes, the environmental engineering faculty are frequently co-investigators sharing research leadership with the water resources group.

The members of the Water Resources/Fluid Mechanics faculty are:

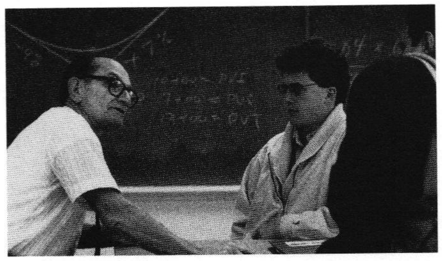
Ernest E. Angino, Ph.D., Kansas, 1961. Rock-water interaction, hazardous waste materials, energy materials, marine pollution, water quality.

Bruce M. McEnroe, Ph.D., Kansas, 1983. Hydraulics, hydrology, water resources engineering, stormwater management, groundwater.

A. David Parr, Ph.D., Iowa, 1976. Hydraulics, geohydrology, surface water hydrology, dispersion processes, aquifer thermal energy storage.

Ernest C. Pogge, Ph.D., Iowa, 1966. Water resources engineering design, hydraulic structures, fluid mechanics, surface water models, groundwater modeling, flood frequency, surface water hydrology.

Yun-Sheng Yu, Sc.D., MIT, 1960. Experimental and theoretical fluid mechanics, applied hydraulics, application of optimization techniques in water resources systems analysis.



The essence of KU civil engineering education is a passing on to a new generation the science and art of professional practice by mentors who have preceeded them.

KU Transportation Center (KUTC) Organized in 1977, the KUTC is a multi-disciplinary research unit devoted to transportation research, technical assistance and technology transfer. KUTC is supported by a combination of federal, state, and local government funds and is active in studies concerning rural public transportation, traffic engineering and highway safety, regional science and transportation planning, transportation investment strategies, and the application of microcomputer technology. A new cooperative research program, K-TRAN, funded by the Kansas Department of Transportation will strengthen and expand the existing program by integrating the transportation research resources of KDOT, KU, and Kansas State University. Technology transfer includes publishing of several national and international transportation newsletters, sponsoring short courses and seminars, and managing a video tape loan library. These activities are primarily designed for municipal, township, and county government personnel.

Transportation and Geotechnical Engineering. The KU instructional and research programs of geotechnical and transportation engineering have always been interconnected. Although a comprehensive set of traditional soil mechanics and foundation engineering graduate courses are taught, the majority of geotechnical research (e.g. chemical soil stabilization, in-situ soil property measurements) has primary application in highway and airfield pavement design and construction.

Transportation research activities address transportation corridor analysis, traffic distribution characteristics, human factor studies of driver capability,

The measurement of brittle fracture and fatigue properties of steel alloys requires state-of-the art testing equipment and electronic sensing devices pavement management system enhancement, and the evaluation of high-tech pavement roughness and distress detection devices.

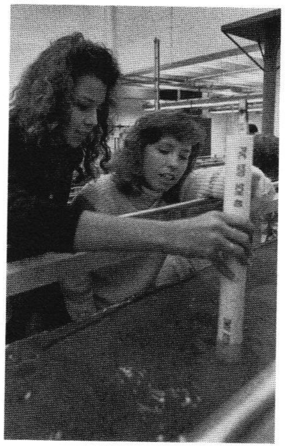
The members of the Transportation/Geotechnical faculty are:

Joe Lee, Ph.D., Ohio State, 1971. Traffic flow theory, traffic control, transportation planning, system analysis, transportation design.

Roy J. Leonard, Ph.D., Iowa State, 1958. Geotechnical engineering, tunnels, earth dams, foundations.

Raymond K. Moore, Ph.D., Texas at Austin, 1971. Geotechnical engineering, transportation engineering, materials.

Thomas E. Mulinazzi, Ph.D., Purdue, 1973. Traffic engineering, highway engineering, surveying, airport and railroad planning and design.



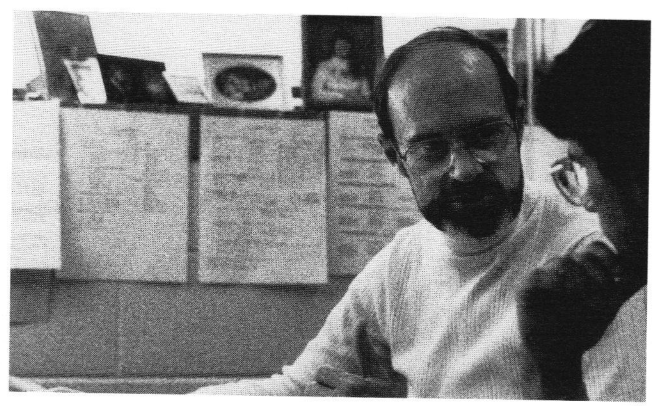
Laboratory exercises are a major component of the civil engineering undergraduate curriculum at KU.

Structures and Solid Mechanics. Civil engineering projects require either a structural system that is in harmony with the environment (e.g., a bridge or dam) or with architectural function and esthetics (e.g., inhabited buildings). Structural design requires the selection of materials and structural dimensions for safe and serviceable performance. Solid mechanics provides the theoretical background leading to the analysis and design procedures of individual members and structural systems. Engineering materials must be developed and tested to insure long-lasting, durable performance under a myriad of load and environment conditions. Structural engineering research often results in structural analysis software developments involving finite element analysis and computational mechanics. Structural materials research has focused on studies of plain and reinforced concrete behavior and the fracture and fatigue of metals. The dynamics of structural response to seismic excitation are being studied to improve structural design and building performance. Expert systems, artificial intelligence, computer-aided design and structural optimization are other emerging new technologies being developed at KU.

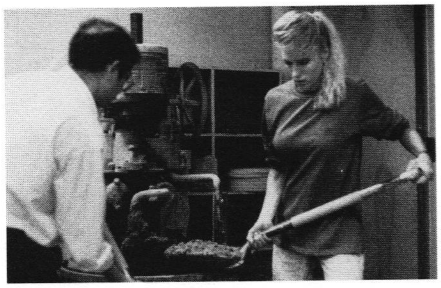
The members of the Structures and Solid Mechanics faculty are:

David Darwin, Deane E. Ackers Distinguished Professor, Ph.D., Illinois at Urbana-Champaign, 1974. Structural engineering, engineering materials, reinforced concrete design and analysis, plain concrete, composite construction, finite-element analysis, earthquake engineering, experimental studies.

John T. Easley, Ph.D., Kansas, 1964. Structural mechanics, theoretical and experimental stress analysis.



Academic and professional counseling between civil engineering faculty and students on an individual basis is an ongoing KU tradition



An understanding of proper concrete mix design requires 'hands-on' laboratory preparation of trial mixtures.

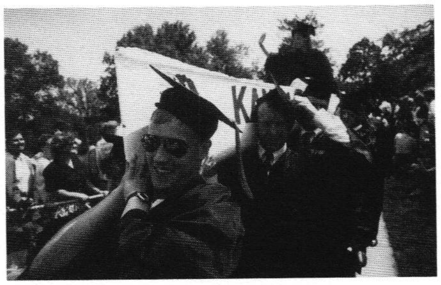
Carl E. Kurt, Ph.D., Oklahoma State, 1969. Inspection, analysis, and rating of highway bridges, structural steel design, fatigue of steel connections, lateral-torsional buckling of crane girders, microcomputer applications, thermoplastic pipe behavior and design.
Steven L. McCabe, Ph.D., Illinois at Urbana-Champaign, 1986. Structural dynamics, structural analysis and design, earthquake engineering, structural mechanics, reinforced concrete design analysis, finite element analysis, fatigue.
W. M. Kim Roddis, Ph.D., MIT, 1989. Expert systems, artificial intelligence, structural design, infrastructure maintenance, bridge fatigue, engineering ethics.
Stanley T. Rolfe, Albert P. Learned Distinguished Professor, Ph.D., Illinois at Urbana-Champaign, 1962. Fracture mechanics, fatigue, fracture control plans for structures, structural mechanics.
Francis M. Thomas, Ph.D., Illinois at Urbana-Champaign, 1969. Structural mechanics, stress analysis, vibrational analysis, and structural dynamics.

Off Campus Programs

KU civil engineering has offered evening graduate courses in Kansas City at the Regents Center for over 30 years and in Topeka at the Capitol Complex for almost 10 years. The evening programs have been designed to permit graduate engineers to develop additional professional skills and to learn the latest in new civil engineering technologies. In addition, certain on-campus graduate courses are scheduled during the early evening and on Saturday mornings to provide additional opportunities for working graduate engineers.

The Future

The future is difficult to predict, but civil engineering will always be a profession in demand. Major national challenges such as rebuilding our reducing environmental infrastructure, managing dwindling resources and reducing environmental degradation will require the ingenuity of civil engineers working with other disciplines and professions. The civil engineering tradition as a *"people serving profession"* established during the past one hundred years will be enhanced in the next century as the new set of challenges will test our abilities to serve society.



Graduating Civil Engineering students carrying a concrete canoe, a traditional design project in the Civil Engineering department.

Electrical and Computer Engineering

The Role of the Electrical Engineer and the Computer Engineer

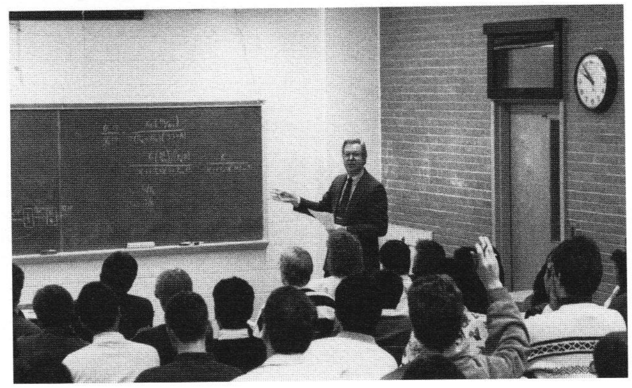
The basis of today's electrical engineering profession and its close ally computer engineering is the harnessing of electrical energy and information to serve the needs of society. The understanding of electrical phenomena began in the 18th century when such people as Benjamin Franklin and Alessandro Volta laid the experimental groundwork for the significant advances of the next century made by such great scientists as Ampere, Faraday, and Ohm. Once current, charge, and resistance were understood, it was left to the brilliant English physicist James Clerk Maxwell to unify the theories and predict the existence of electromagnetic waves which along with Morse's telegraph opened up the new field of communications engineering. Fleming's development of the vacuum tube launched the field of electronics.

By the middle of the 20th century, computers were starting to make their impact on the world of technology and ultimately our everyday lives. Electrical engineers played a dominant role in the development of the computer because it is fundamentally a complex electronic machine. But as the computer field advanced, the information processing aspect of computers and the engineering of the software itself took on a new larger dimension. Thus was born computer engineering.

The impact of electrical and computer engineers on today's society is immense. A sampling of the products designed, produced, operated, and maintained by electrical and computer engineers include: radio, television, telephones, computers (ranging from microprocessor chips to high-speed super-computers), aircraft avionics, space vehicle electronics, automobile electrical and electronic systems, home appliances and music equipment, medical electronic equipment, electronic games, military communications, radar, mobile radio, data processing systems, computer communications networks, instrumentation devices, manufacturing support systems, and computer aided design systems. Truly much of what makes the 20th century what it is is due to the talents of the electrical and computer engineers.

The field of electrical engineering can be divided into four disciplines which, along with computer engineering, form five important broad areas of specialization. The four electrical en-

Electronic instruments allow students to 'see' high speed electrical signals.



Professor Rowland addresses a class of electrical and computer engineering undergraduates on control systems.

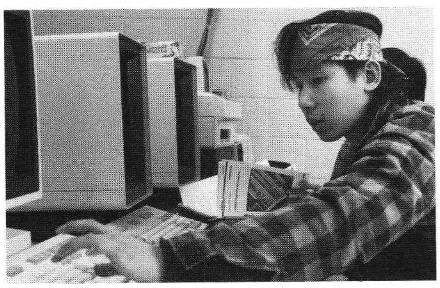
gineering areas include: electromagnetics; signals, systems, and control; electrical circuits and electronics; and energy conversion and transmission. Each of these five areas plays an important role in serving mankind.

Electical and Computer Engineering at The University of Kansas

Electrical engineering began at the University of Kansas in 1887, four years before the formation of the School of Engineering in 1891, and awarded its first degree in 1890. By May 1990, 3,463 people had received the bachelor of science in electrical engineering degree. In addition, 628 MS degrees and 135 Ph.D degrees had been awarded. Computer engineering was formed in 1985 as an outgrowth of the computer option within electrical engineering. In recent years, KU has focused on four of the five disciplines within electrical and computer engineering.

Electromagnetics

The basis of all electrical engineering lies in the theory of electromagnetics. Even though other equally strong disciplines have developed within the profession, electromagnetics remains a dominant force, and the University of Kansas is a nationally renowned leader in the field. The academic program was planned with the aid of an advisory board of distinguished industrial and government radar engineers.



Students turn computer engineering theory into practice in the micro-computer laboratory.

The principal electromagnetics laboratory is the Microwave Engineering Laboratory in Learned Hall where students study the principles of wave transmission, antennas, device design and microwave measurements.

The research focus in this field is concentrated in the Radar Systems and Remote Sensing Laboratory (RSL) located in Nichols Hall, which has been recognized as a world leader in radar research for over 20 years. RSL studies the development and application of microwave systems for remotely sensing the atmosphere and the surface of the earth. Recent research grants involve studies of radar backscatter from sea ice and the use of radar to remotely sense clouds.

The members of the Electromagnetics faculty are:

Kenneth R. Demarest, Associate Professor; Ph.D., Ohio State, 1980. Microwave engineering, radar, electromagnetic theory, antennas.

Siva Prasad Gogineni, Associate Professor; Ph.D., Kansas, 1984. Radar systems, microwave engineering.

Richard K. Moore, Black and Veatch Professor of Electrical and Computer Engineering and Director of RSL; Ph.D., Cornell, 1951. Radar remote sensing, radio wave propagation, communications systems, antennas, radar imaging and backscatter systems.

Richard G. Plumb, Assistant Professor; Ph.D., Syracuse, 1988. Electromagnetics, radar systems.

Hillel Unz, Professor; Ph.D., California (Berkeley), 1957. Electromagnetic theory, antenna arrays, plasma propagation, acoustic waves, applied mathematics.

Signals, Systems, and Control

As electrical systems became more complex, the discipline of systems engineering began to emerge. At its most fundamental level, the systems engineer uses the power of mathematics including integral transform theory, probability and stochastic processes, analysis, topology, modern algebra, and state variable theory to design systems. Feedback control, optimal estimation and control, communications, signal processing, signal detection, information theory, and coding are all key subdivisions of this discipline of electrical engineering which has risen to prominence in the last several decades.

The key student laboratory in this area is the Communications Laboratory located in Learned Hall. Here modern equipment allows for demonstrating and analyzing the performance of modern analog and digital communications systems such as those used in satellite communications and other applications.

KU has focused heavily on communications research and consequently has emerged as a national leader in the field. Widely acclaimed textbooks and the development of the Block Oriented Simulation System (BOSS) for performing detailed simulations on communications systems have added to this stature.

The center for communications research is the Telecommunications and Information Sciences Laboratory (TISL), located in Nichols Hall. TISL research is supported by both industry and government. Recent grants have focused on satellite communications and computer networks.

The members of the Signals, Systems, and Control faculty are:

Victor S. Frost, Associate Professor and Director of TISL; Ph.D., Kansas, 1982. Telecommunications, integrated communication networks, network performance analysis, and simulation.

Julian C. Holtzman, Professor; Ph.D., Cornell, 1967. Telecommunications and microwave remote sensing, antennas.

David W. Petr, Assistant Professor; Ph.D., Kansas, 1989. Communications, networking, digital signal processing.

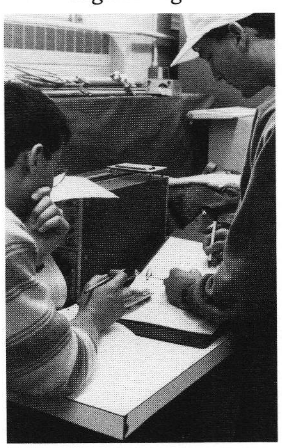
Glenn E. Prescott, Associate Professor; Ph.D., Georgia Tech, 1984. Communications theory, digital signal processing.

James A. Roberts, Jr., Professor and Chairman; Ph.D., Santa Clara, 1979. Communications, signal processing, and error correction coding.

James R. Rowland, Professor; Ph.D., Purdue, 1966. Stochastic systems modeling and analysis, control systems.

K. Sam Shanmugan, J. L. Constant Professor of Electrical and Computer Engineering; Ph.D., Oklahoma State, 1970. Telecommunications, pattern recognition, general systems theory, statistical communications theory, image processing, digital signal processing techniques.

Designing and building a complex digital system is a challenging task for electrical and computer engineering students.



Electrical circuits and electronics

The electrical circuit forms the fundamental building block of systems ranging in size from microchips to electrical distribution systems. Vacuum tube electronics revolutionized the world in the early part of the 20th century just as the vacuum tube's successor, the semiconductor transistor, revolutionized the world at mid-century. The semiconductor integrated circuit, consisting of millions of circuit elements and transistors, has allowed for building electronic systems so small that they would have been unthinkable only a few years ago. The personal computer is only one very visible result of the 'silicon revolution.'

The electronics laboratories in Learned Hall features the use of precision measuring instruments and waveform generation, display, and measurement devices. Recent research activities have included medical instrumentation systems and computer modeling of semiconductor device fabrication.

The members of the Electrical Circuits and Electronics faculty are:

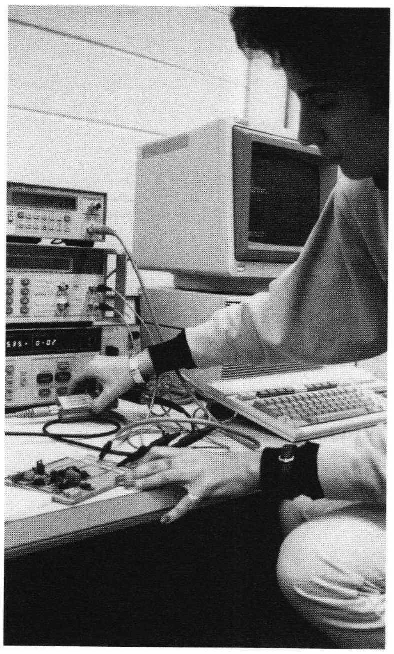
Don. G. Daugherty, Professor; Ph.D., Wisconsin, 1964. Electronic circuits for communications and control.

Harvey H. Doemland, Associate Professor; Ph.D., Illinois, 1963. Electronic circuits, pulse circuits, biomedical engineering.

Computer Engineering

The world today has been described variously as the 'Information Age,' the 'High Technology Age,' and the 'Computer Age.' Common to these and other descriptors used are the central themes of a knowledge based economy and the revolution caused by the technological advances in computers. The use of computers for information processing and storage and, most importantly, the use of computers embedded in systems ranging from games to automobiles and spacecraft, will increase even more dramatically in the future. Improvements in communications technology will make possible exchanges of information never before imagined. The proper application of computer technology, both hardware and software, will impact in a positive way the economic growth of the world.

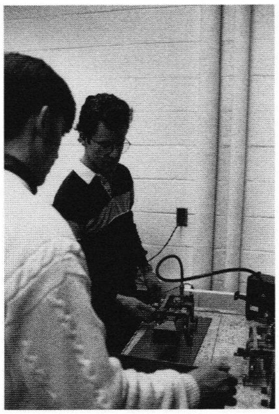
Electronic circuits, test equipment, and computers are integral components of electrical and computer engineering laboratories.



Computer engineering is an integration of aspects of electrical engineering (the use of digital electronic circuits in computers), computer science (the mathematics of computation and the theory of computer programming), and applications (the use of computers), but it is distinct from each of its precursors. To quote H. Freeman in the *IEEE Computer Magazine*, "Intrinsic to computer engineering is the concept of design as it applies to all aspects of a computer system – the hardware, the software, the algorithms used – and the application for which it is intended."

Computer engineering laboratories in Learned Hall include the Microprocessor Laboratory which concentrates on the design and programming of digital computational systems and the newly created Embedded Computer Systems Laboratory. Computer resources consist of four micro-VAXes, a VAX 11/750, a VAX Station 3900, one AT&T 3B15, two AT&T 3B2-400's, two AT&T 3B2-300's, twenty AT&T 3B1's, and a Sun 2/170 in Learned Hall. Research facilities at Nichols Hall feature several Sun workstations, a NCR Tower, Symbolics processor and several AT&T 3B2's.

The principal areas of computer engineering research are embedded computer systems, artificial intelligence, digital signal processing, computer communication networks, and digital systems design. The most recent research initiative, started as a collaboration between the computer engineering and communication engineering faculty, is the formation of the Center of Excellence in Computer Aided Systems Engineering (CECASE), funded by the Kansas Technology Enterprise Corporation. This is an interdisciplinary center reporting to the Vice Chancellor for Research and headed by a member of the electrical and computer engineering faculty. The development of computer aided design tools is a major research thrust of the department and of CECASE. KTEC established the center to aid in the transference of technology developed at the University of Kansas to Kansas businesses to enhance their economic development. The center is in the process of determining what services will be offered and is working with a number of Kansas businesses.



Electrical engineering students test a horn antenna in the microwave engineering laboratory.

The members of the Computer Engineering faculty are:

Swapan Chakrabarti, Assistant Professor; Ph.D., Nebraska, 1986. Computer graphics, Electro-magnetic scattering from rough surfaces, digital signal processing, computer vision.

Raymond H. Dean, Professor; Ph.D., Princeton, 1968. Digital control, system modeling, artificial intelligence.

Joseph B. Evans, Assistant Professor; Ph.D., Princeton, 1988. Communications, signal processing, VLSI design.

Julian C. Holtzman, Professor and Director of CECASE; Ph. D., Cornell, 1967. Computer aided systems design tools.

Tag Gon Kim, Assistant Professor; Ph.D., Arizona, 1988. Computer engineering, artificial intelligence, modeling simulation, software engineering.

Gary J. Minden, Associate Professor; Ph.D., Kansas, 1982. Digital systems, microprocessors, artificial intelligence.

Dale I. Rummer, Professor; Ph.D.., Kansas, 1963. Design of digital systems, design of microprocessor-based systems, computer-aided design tools.

Costas Tsatsoulis, Assistant Professor; Ph.D., Purdue, 1987. Artificial intelligence, expert systems.

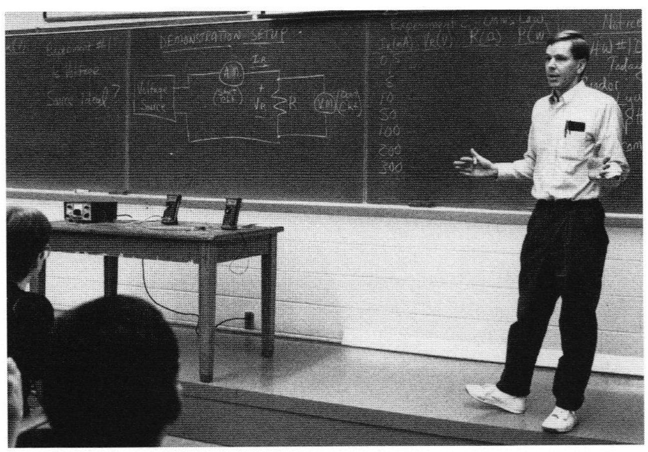
Off-Campus Programs

The electrical and computer engineering department has offered graduate courses at the Regents Center in Johnson County serving the Kansas City metropolitan area.

Strengths

The following faculty have written books: Moore, Rowland, Rummer, Unz, Shanmugan, and Daugherty. Professor Moore is a member of the National Academy of Engineering. Professors Moore and Shanmugan are Fellows of the IEEE. The following faculty have had significant full-time industrial experience: Petr, Shanmugan, Moore, Holtzman, Roberts, Dean, and Minden; the other faculty have had significant sabbaatical and/or summer industrial experience. All of the faculty hold the Ph.D. degree. New research funding awarded in the first quarter of fiscal year 1991 totaled $585,000.

The real strength of the department is in the quality of the students produced. Companies that hire our students return again citing the exceptional quality of the KU graduates. Our strength also comes in our commitment to the people of Kansas, fostering technological advancements and economic growth through our research and centers of excellence such as CECASE. Electrical and computer engineering will continue to play the strong role in the advancement of technology to serve the state and nation that it has in the past.



Professor Petr demonstrates basic electrical circuits to a sophomore electrical and computer engineering class.

Engineering Management

Background Purpose

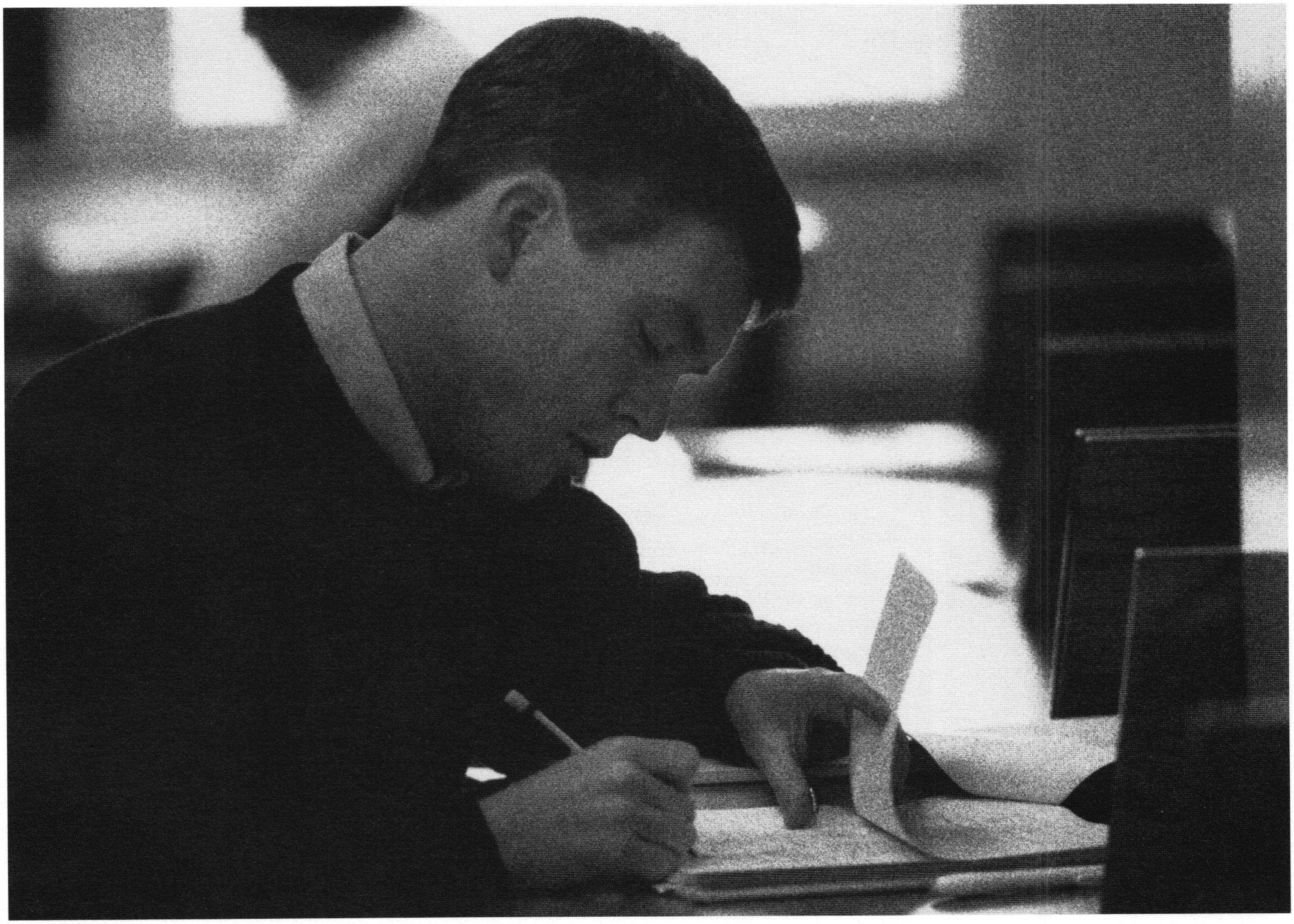
Increased competitiveness in the marketplace and a need to make progress toward the elimination of the trade and service deficit, have increasingly turned the attention of business and industry toward technology as the source of new products and improved productivity in both manufacturing and service delivery. Issues dealing with technological innovation and incorporating technological change into company strategies must be addressed by today's manager.

Continuing surveys indicate that between 40% and 50% of engineers in the twenty five to forty five age bracket hold some form of engineering management responsibility. The scope and complexity of their responsibilities has changed dramatically in the past 10 years. If these engineer managers are to meet the challenges of a more efficient use of natural resources, improved design and safety requirements, a more effective management of human resources for improved productivity and to do so with an increased knowledge and awareness of environmental issues and an added emphasis on total quality in operations, they will need increased education and training in the management of technology. It is precisely this need that led to the development of the Master of Science Program in Engineering Management in 1982 by the School of Engineering.

The Master of Science degree program in Engineering Management provides education and training that prepares engineer managers to more effectively manage technology-based operations. The program provides a special managerial perspective, one that combines an existing in depth engineering education with a substantial input of managerial knowledge in planning, organizing, controlling, finance, simulation, business development and leadership.

The Master of Science degree program in Engineering Management requires 39 credit

Research and understanding of project requirements are an integral part of the Engineering Management program at KU.



hours broken down as follows:

- Core Courses *23 hours*
- Elective Courses *12 hours*
- Field Project *4 hours*

Case studies and a field project allow practical application of the knowledge gained in the courses. All of the courses required to complete the degree program are offered in the evening at the University of KansasRegents Center, 99th and Mission, Overland Park, Kansas. The courses are taught by a blend of full time faculty and practicing professionals.

Engineering Physics

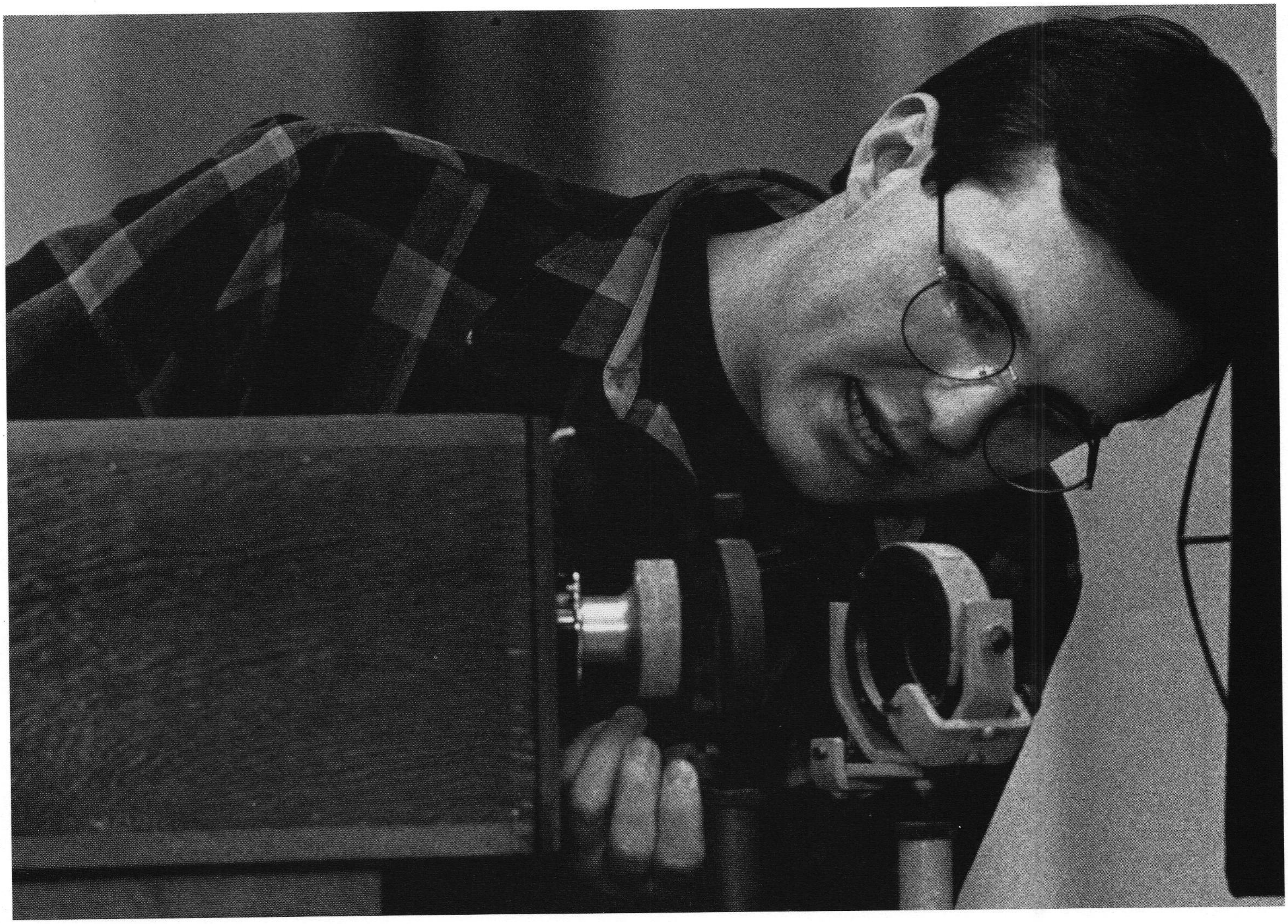
The role of the engineering physicist is to facilitate the flow of new developments from the laboratory to their application in the marketplace.

Engineering physics, sometimes called engineering science or applied physics, is not one of the traditional fields of engineering, and the roles assumed by graduates are consequently quite diverse. The education of an engineering physicist, comparable to that of a physics major, combines a strong background in physics, mathematics, and chemistry with a strong program in one or more of the traditional engineering fields. While many of the graduates go on to graduate studies in physics or engineering, most are employed by companies with a major commitment to high-technology research and development or in government laboratories. For such employment, their background has given them a knowledge of the physics fundamental to today's technologies and an insight into future technologies. Their engineering background has provided an awareness of the application of these technologies in the real world.

A recent survey of KU graduates of the engineering physics program reflected a diversity of careers. Respondents included three professors, a physician, several in branchs of the armed forces, several in government laboratories, and many in positions associated with engineering, like General Dynamics.

Curriculum

The engineering physics degree program is unique at KU in that it is administrated by the faculty of the Department of Physics and Astronomy in the College of Liberal Arts and Sciences. It is subject to approval by the faculty of the School of Engineering, and the degree is awarded by that school. The degree curriculum is divided into two components: a common core required by all students and a choice of one of four engineering design options: Aerospace, Control, Digital, and Energy. It is regarded rightfully as a difficult major. The students must compete in their physics and math courses with many of the best students in the college, and with other engineers in their engineering courses. For the good students there are compensations. They have the opportunity to learn from two excellent faculties in the Department of Physics and Astronomy and of the School of Engineering. While all engineering students take the introductory sequence in physics, these courses are taught in large sections. The major remains in the department for the smaller, more personal upper-division



At work in the Optics Laboratory.

courses and laboratories where there is the opportunity to become better acquainted with the faculty.

While most of the physics faculty are involved in areas of basic research, they represent a variety of backgrounds and interests, which often include topics associated with engineering applications.

The members of the Engineering Physics faculty are:

Students at work in an Electrical Measurements class using an oscilloscope.

R. G. Ammar, Professor and Department Chairman, experimental elementary particle physics, detection and analysis of high energy subatomic particle interactions, electronic detectors, study of the properties of quarks and leptons.

T. P. Armstrong, Professor and Higuchi Research Award winner, theoretical and experimental space plasma physics, analysis of solar wind interaction with planetary magnetospheres, detection of charged particles on the Voyager, Galileo, and Ulysses interplanetary space probes and on Earth satellites, detector design for several of these missions.

P. S. Baringer, Assistant Professor, experimental elementary particle physics, detector design and computer control for high energy experiments, collaborator with Ammar.

R. C. Bearse, Professor and Associate Vice-Chancellor for Research, Graduate Studies, and Public Service, experimental nuclear physics, detection of trace elements with nuclear techniques, safeguards against loss of radioactive materials.

T. E. Cravens, Associate Professor, theoretical and experimental space plasma physics, interaction of the solar wind with Earth's magnetosphere and upper atmosphere, collaborator with Armstrong.

J. W. Culvahouse, Professor, experimental solid state physics, magnetic interactions in solids, nuclear magnetic resonance, computational physics.

J. P. Davidson, Professor, theoretical nuclear physics, stellar atmospheres, stellar nucleosynthesis, aircraft propellor design.

R. E. P. Davis, Professor, experimental elementary particle physics, detection of high energy subatomic particles, collaborator with Ammar.

J. Enoch, Associate Professor, theoretical plasma physics, magnetic confinement of plasmas for nuclear fusion, interaction of solar wind particles with surfaces in space.

R. J. Friauf, Professor, experimental and theoretical solid state physics, color centers, diffusion of ions in alkali halides, interaction of particles with surfaces in space.

N. Kwak, Professor, experimental elementary particle physics, electronic detection of high energy charged particles, collaborator with Ammar.

D. W. McKay, Professor, theoretical elementary particle physics, field theory, particle astrophysics.

A. L. Melott, Associate Professor, theoretical astrophysics, cosmology, evolution of the early Universe, galaxy formation, computational physics.

H. J. Munczek, Professor, theoretical elementary particle physics, field theory.

F. W. Prosser, Professor and Department Associate Chairman, experimental nuclear physics, heavy-ion nuclear physics, nuclear structure, detector development.

J. P. Ralston, Associate Professor, theoretical elementary particle physics, field theory, particle astrophysics.

S. J. Sanders, Associate Professor, experimental nuclear physics, heavy-ion nuclear physics, detector development, nuclear structure, computational physics.

R. C. Sapp, Professor, experimental solid state physics, low temperature physics, magnetic interactions in solids.

S. Shandarin, Visiting Professor, theoretical astrophysics, cosmology, evolution of the early Universe, galaxy formation, computational physics.

K. W. Wong, Professor, theoretical solid state physics, many-body physics, high temperature superconductivity, liquid helium.

The interests of the faculty span from modern applications of classical electromagnetism in space plasma physics through possible emerging technologies in superconductivity.

Student Research

Most of the faculty have external funding for their research and work with graduate students, but many faculty include undergraduates in their research. Professors Armstrong and Melott have published recent papers with undergraduates as co-authors. Undergraduates have had summer research experiences at Argonne National Laboratory, Exxon Research Laboratory, Fermi National Accelerator Laboratory, Kitt Peak National Observatory, and Los Alamos National Scientific Laboratory. In addition, several students in the aerospace design option have been members of national award-winning teams in aerospace engineering.

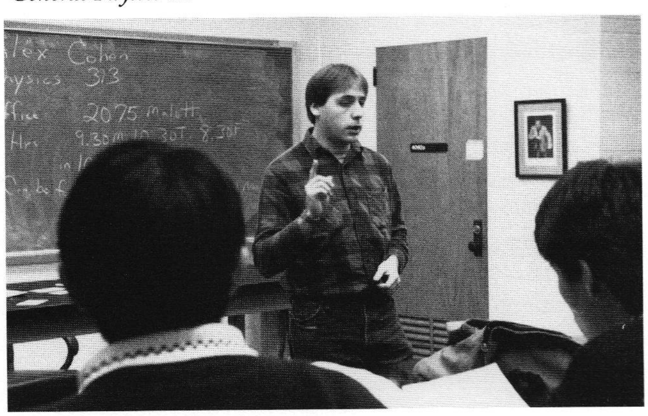
The department also has faculty in astronomy and atmospheric science. While they are not directly involved in the engineering physics program, they are available to engineering students. The astronomers are interacting with current and future NASA projects, such as the Hubble space telescope. Data from this mission and others planned by NASA will be available here for analysis. The atmospheric science program includes research in analyzing and reducing air pollution, severe weather prediction, and weather modification. The faculty in both of these fields make extensive use of undergraduates in their research, and engineering physics students who wish to stray beyond the usual boundaries can find additional opportunities here.

The Future

New discoveries in physics and chemistry are moving ever more quickly to applications in new technologies. In the forty years since its development in the laboratory, the transistor and the solid state electronic devices which followed have revolutionized the world and have led us into the information age. The laser, which emerged about ten years later, has become an important tool in fields as diverse as medicine, manufacturing, and fiber optics communication. Techniques developed in physics laboratories have become important diagnostic tools in medicine in the form of computer assisted tomography, positron emission tomography, and magnetic resonance imaging. X-ray diffraction was used to unravel the double helix structure of DNA, the knowledge of which has led to the emerging field of bioengineering.

If controlled nuclear fusion becomes a reality, it offers the promise of an almost inexhaustible source of energy, without the concommitant problemof the generation of long-lived radioactive wastes characteristic of nuclear fission. The possible development of high-temperature superconductivity offers almost limitless oppotunities. While present superconductors are used to produce strong magnetic fields for use in nuclear accelerators and magnetic resonance imaging, the liquid helium required for cooling is too expensive for widespread use of them. High-temperature superconductors have been found which can operate at liquid nitrogen temperatures, a much less expensive alternative. However these materials are ceramics which can not be wound into coils. Research is therefore necessary on both learning to fabricate these materials into useful forms and finding superconducting materials that will work at even higher temperatures.

A graduate teaching assistant gives instruction to students in a laboratory section of General Physics III.



All of these changes have passed, or will need to pass, through a period from their discovery to their incorporation within standard engineering fields. It is the province of the engineering physicist to implement the flow of this new science from the laboratory to practical applications. This continued flow is essential if the United States is to retain its present preeminence in world trade. New products and new technologies must continue to be developed.

We believe the engineering physics program offers an interesting and exciting opportunity for students who wish to learn more of the scientific applications that underlies much of modern engineering technology.

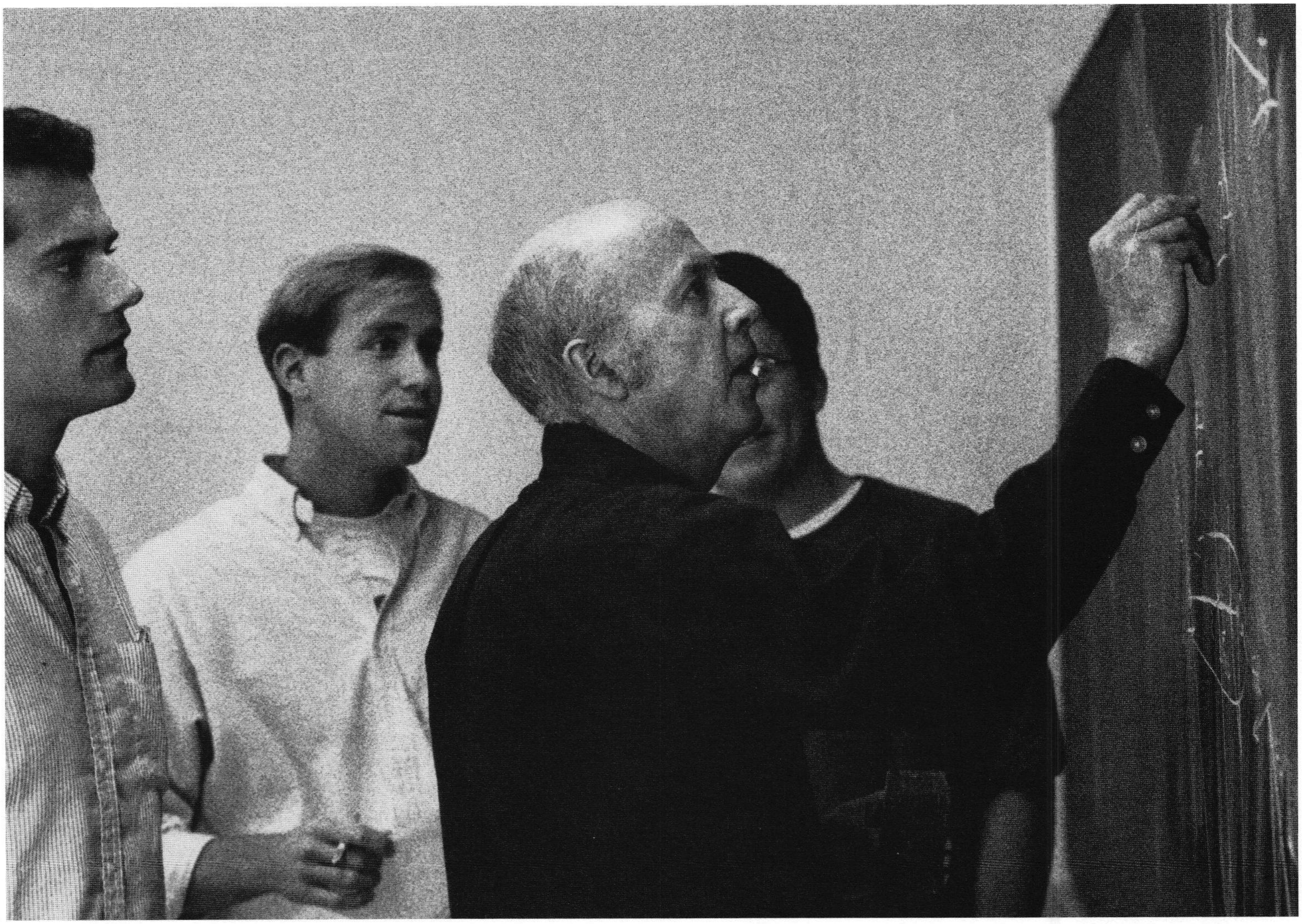
Mechanical Engineering

Mechanical engineering is characterized by a broad involvement in the science and technology basic to industrial activity. This includes the manufacture of goods, provision of services, and control of environment. Specific to these activities are the design, analysis, construction, and control of mechanical devices and systems, the analysis and control of natural phenomena, the management of industrial activities, and research and development in new areas of endeavor. Mechanical engineers apply their knowledge and techniques across a broad spectrum of industries and are sought by many professional firms.

Inclusion of a mechanical engineering department in the School of Engineering was actively sought soon after the school was approved in 1890. Funds became available to support the mechanical engineering program. The Kansas Board of Regents approved mechanical engineering as a degree program in the School of Engineering in 1899. Petroleum and aeronautical engineering courses began under mechanical engineering, but later evolved into separate departments. In 1965, the mechanical engineering department was enlarged to include engineering drawing, which had once been a separate department. In 1968, the department absorbed the Department of Metallurgy and Materials Engineering, which had absorbed the shop practice department earlier.

The department has evolved over these years into a well-balanced program that currently offers the Bachelor of Science, Master of Science, Doctor of Philosophy, and Doctor of Engineering degrees. Graduate areas of study in mechanical engineering include computer-integrated manufacturing and behavior of materials, computational mechanics and finite element analysis, heat transfer and thermal-fluid system design, mechanical system design and analysis, and robotics and control systems.

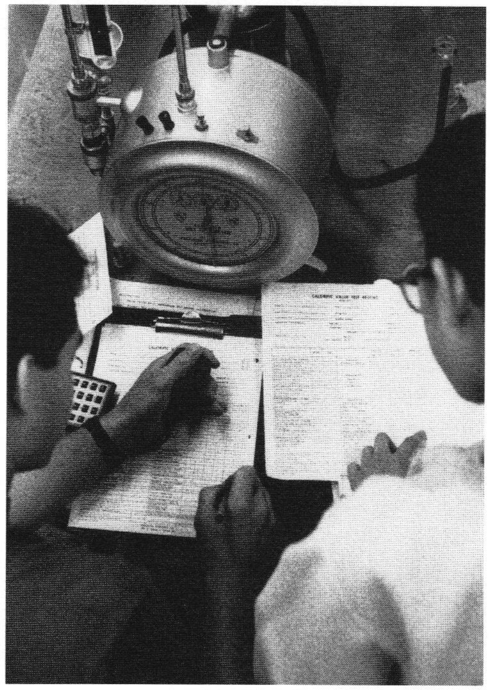
The first B.S. degree in mechanical engineering was awarded in 1900. The first M.S. degree was awarded in 1913, and the first Ph.D. was awarded in 1983. The total number of degrees awarded by the department through 1990 are: B.S.: *2,859,* M.S.: *309,* Ph.D.: *11.* The percent of



Professor Robert Humholtz, center, leads a class in Mechanics and Dynamics of Machinery.

mechanical engineering B.S. degrees to total engineering B.S. degrees granted rose from 12 percent in the late 1920s to 23 percent in the late thirties.

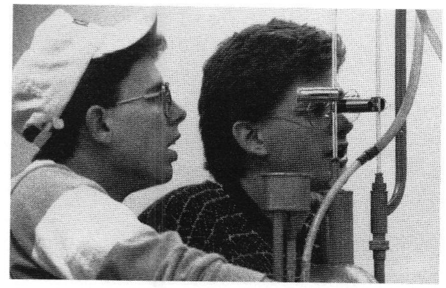
Professor W. K. Palmer taught the first mechanical engineering courses in fall 1899. By fall 1906, the teaching staff had increased to five and included professors Walker, Hood, Corp, Wheeler and Ward. Since the department was established, eighty-two full-time faculty members have taught mechanical engineering courses. Faculty members who served the department for twenty years or more are: Walker, Sluss, Tait, Hay, Kipp, Nemecek, McBride, Forman, Lindquist, Umholtz, Barr, Bockhorst, Burmeister and Reese.



Awide variety of equipment is utilized by studets in the Mechanical Engineering program at KU

The members of the Mechanical Engineering Faculty are:

Dae-Sung Bae, assistant professor (Ph.D., Iowa); dynamic analysis of mechanical systems.
B.G. Barr, professor (M.S., Kansas); computer-integrated manufacture, augmented telerobotics, automation.
Louis C. Burmeister, professor (Ph.D., Purdue); solar energy, heat transfer, thermal-fluid sciences
Hector McI. Clark, associate professor (Ph.D., London); wear and erosion, materials selection.
Terry N. Faddis, associate professor and chairman(D.E., Kansas); mechanical design, composite materials, computer-integrated manufacturing, augmented telerobotics.
Donald A. Gyorog, professor (Ph.D., Wisconsin); thermodynamics, control theory, internal combustion engines.
K. Matsuoka, assistant professor (Ph.D., Purdue); intelligent control systems, robotics.
Charles D. Reese, professor (Ph.D., Oklahoma); mechanical design, computer-aided design.
Karan S. Surana, Ackers Distinguished Professor (Ph.D., Wisconsin); computational mechanics, finite element methods and software engineering.Peter W. TenPas, assistant professor



Students conducting and experiment in the Thermal-Fluids Lab in Learned Hall.

(Ph.D., Iowa State); computational fluid dynamics and heat transfer, thermal system design.
Robert C. Umholtz, associate professor (M.S., Kansas); kinematics, dynamics of machinery, computer-aided design.
Bedru Yimer, professor (Ph.D., Dayton); heat transfer, thermal system design, fluid mechanics, thermodynamics.
Robert P. Zerwekh, professor (Ph.D., Iowa State); metallurgy, materials science.

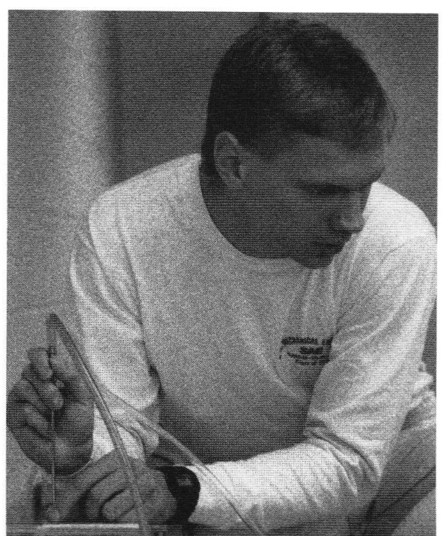
Professors, McBride and Yimer, have won Hope awards for excellence in teaching. Rose is the only engineering professor to receive the Chancellor's Career Teaching Award. Forman, Reese and Bauleke have received the Gould Award for excellence in engineering teaching.Faddis has received the Miller Award for research.

The Mechanical Engineering Department recently received a full six-year accreditation by ABET. This is particularly significant because only 40 percent of the mechanical engineering programs in the nation receive the six year accreditation. The ABET report stated:

The mechanical engineering department faculty is well-qualified, balanced in age, industrial experience, and research activities... " and mechanical engineering students are good and, when asked, express satisfaction with their educational experience."

The department was originally housed in old Fraser Hall. Old Fowler Hall was utilized for shop practice beginning in 1900. In 1909, the newly completed Marvin Hall housed all engineering departments. Later, mechanical engineering used the mechanical engineering laboratory building south of Marvin Hall. The department remained housed in the laboratory building until 1963 when it moved to the old Electrical Engineering Laboratory Building behind Marvin. The department moved from there into new Fowler Hall in 1968 when it absorbed the Metallurgy and Materials Engineering Department. It remained there until 1975 when the Learned Hall addition was completed. Mechanical engineering now occupies much of the third floor, parts of the second floor in the east wing (tower), the first floor of the east wing and some of the basement of Learned Hall. The department also has research space in Nichols Hall.

Hands on experience with equipment that the student will use as a professional is key to the educational process at KU.



The space assigned to mechanical engineering includes 24 offices, ten laboratories, one classroom, a conference room, and the engineering shop. The most recent ABET report states:; 'The department has made great strides in upgrading laboratory equipment and computers.'

In the period just after World War II, the department offered both the M.S. and B.S. degrees. The three areas then emphasized by the department were thermal sciences, mechanical design and industrial engineering. Those undergraduates who majored in industrial engineering had Industrial Engineering Option specified on their B.S. in Mechanical Engineering diploma. In the 1960s, the engineering programs, including mechanical, began to focus their efforts more toward graduate study and research. The department began to participate in the school's Doctor of Engineering program, establishing a base of doctoral-level engineering education and increased its efforts to secure funded research.

The first Ph.D. student in mechanical engineering began his degree work in 1977. In the past few years, the department has reduced its undergraduate teaching load by offering required courses only once a year. During this same period, the number of graduate courses offered each semester has nearly tripled.

The average mechanical engineering undergraduate enrollment in the past fifteen years has been:

- *Freshman* 71
- *Sophomore* 58
- *Junior* 60
- *BS degrees awarded* 61

During the same time period, the faculty size has been reduced from 17 to 13, while the graduate program has been greatly expanded. The department's first Ph.D. was awarded in 1983 and an average of two Ph.D. and nine M.S. degrees were awarded per year over the past five years. Dean Locke has proposed increasing the size of the graduate programs of the school by 50 percent. The proposed degree production for the departmentwould be 14 M.S. and 3 Ph.D. degrees awarded a year. With a graduate student body of 45 M.S. candidates (15 full-time and 15 part-time in Lawrence and 15 part-time at the Regents Center) and 12 full-time Ph.D. candidates, these numbers could be reached. The Dean's records show a fall 1989 enrollment of 11 full-time and 28 part-time M.S. candidates and 9 full-time and 9 part-time doctoral students. As can be seen by the numbers, the department already has the pool of students needed to reach the dean's goals.

The Board of Regents has recommended that undergraduate engineering enrollment be limited. In view of the increased emphasis on graduate studies, the reduced size of the faculty, and the physical limitations of the facilities and equipment, the department proposes to admit a quota of 60 freshmen a year beginning in fall 1991 with the goal of awarding 45 to 60 B.S.M.E. degrees a year.

The department has greatly expanded its research efforts in recent years. Notable funded research projects include:

1980-90 Energy Analysis & Diagnostic Center *$893,000*
1981-83 Technical Assistance Energy Program *$362,000*
1985 to date Rule and Knowledge Base for a Workstation that Produces Prismatic Parts *$662,000*
1988 to date Program of Augmented Telerobotics *$700,000*

A Mechanical Engineering student at work in the Computer Graphics lab in Learned Hall

Research emphasis is continuing to be placed upon the areas of computer integrated manufacturing, computational mechanics, and the thermal-fluid sciences. The ABET report stated:

"The mechanical engineering program has undergone significant change in the past few years: faculty retirements, new faculty members, curricular changes, renewed emphasis on research, and upgrading in laboratory equipment and computers. It appears that through these changes the program has developed very positive momentum with which to move into the future."

Resumés of the histories of the various departments of The School of Engineering

Before presenting brief histories of the various departments or programs in the School a few preliminary paragraphs of general interest may be useful.

The students who graduate from the School have very high scores on the ACT tests that they have taken in their junior or senior year in high school. These tests cover English, mathematics, natural science and social science. The tests have associated with them national norms. The University has tabulated by school and by year the average scores of students who have graduated from the university. There are five scores tabulated – the four noted above and a composite score. For the last four years, of the nine schools in the University, the engineering students on average have had the highest ACT scores in four of the five tests and are either first or second in the other one, English. The average composite score of the engineering graduates places them in the upper 15% of the students nationally who took the ACT test. The existence of scholarships funds, provided by alumni, allow the School to attract an outstanding body of freshmen. Starting in the seventies, extensive and continuing efforts have been made to attract minorities into engineering. In the eighties, a significant number of women have entered the engineering program.

One way that the citizens of the state may be assured that the engineering programs are in a satisfactory condition is to know that the individual programs have met the requirements of the national engineering accrediting board known as ABET. This board provides, upon request, a body of visitors who will conduct a thorough two-day inspection of a program and make recommendations for certification or not. The maximum period for certification is six years.

During the period 1873 through May 1990, the degrees awarded are classified as bachelor's, professional, master's and doctor's. The number in each category are:

Type of Degree	Period Awarded	Number Awarded
bachelor's	1873-1990	14,448
professional	1906-1960	162
master's	1911-1990	2,566
doctor's	1951-1990	378

A comparison of the average salary offers made to students graduating in the various engineering programs at KU with the salary offers made nationally in similar programs shows that the KU graduates receive essentially the same salary offers as are made nationally. In the 1989-90 year, 112 companies visited the School to interview graduating engineers. These companies include some of the largest companies in the nation as well as governmental organizations.

Up until the end of WWII, the basic activity of the School was to provide undergraduate instruction to engineering students. After the war, a major effort was made to add professors to the staff who had doctoral degrees. The result of this effort is that essentially all the faculty today hold this degree and they come from many different universities in the nation. Also after the war, a number of federal organizations created programs to support university research in mathematics, science and engineering. Some of these organizations were certainly interested in supporting research that might help them in their cold war operations. Others of them took a wider view and were willing to support basic, pure, or long-range research programs. Among the government organizations supporting university research, one can include the Office of Naval Research, the Atomic Energy Commission, the Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration. The combination of a faculty experienced in research and government agencies willing to support their work has resulted in forty years of active research in the School.

In addition to research funds from the federal government the State of Kansas has also provided support for research. Funds have been provided for general research, for the development of methods for increasing the recovery of oil from Kansas reservoirs, for improvement in the control and utilization of water, for a cooperative research program with the Kansas Department of Transportation, Kansas State University and KU to strengthen and expand studies on transportation, and for the Center of Excellence in Computer Aided Systems Engineering (CECASE).

The fascination with flight and the desire to participate in the development of aeronautical and astronautical technology has a long history at the University of Kansas. Long before a Department of Aeronautical Engineering was established in 1941, KU faculty and students were engaged in aviation activities. The first documented aeronautical activity was the construction of a Bleriot-type flying machine by a group of undergraduates in 1911 and the building and flying of a second aircraft in 1914. This early work, although primitive, established a tradition of flying our designs rather than just working with theory.

The first formal courses in aviation were taught in the fall and spring of 1917. This course was a basic ground school course similar in purpose to our AE 242. As was true throughout the world, the interest in aviation sparked by World War I had waned after the war. The next major event in aviation that changed the publics perception of aviation from a sport to an important element in the transportation system was Charles Lindbergh's solo flight from New York to Paris. All of aviation, particularly aircraft design, underwent a major change in philosophy at about this time. Rather than using trial and error techniques, aircraft designers were relying more and more on the science of flight being discovered at the National Advisory Committee for Aeronautics and at universities. KU's interest was rekindled with the arrival in 1928 of Earl D. Hay as Chairman of Mechanical Engineering. Professor Hay, in addition to his other interests, was fascinated with aeronautical engineering. His influence is seen at KU with the offering in the 1928-1929 academic year of two courses: one in aerodynamics and the other in aircraft design. Also, between 1929 and 1931 a grant of $2,000 was allocated for the design and construction of a wind tunnel housed under the football stadium. This tunnel was used to conduct research over the period of 1931 to 1965.

The aeronautical program was formalized in the 1931 catalog by being listed as one of the four professional options in the Mechanical Engineering Department. Coinciding with this was an increase in the number of courses to five, plus the opportunity to do thesis work in aeronautics.

In 1940, as the possibility of war became more and more evident, the university administration became increasingly preoccupied with the development of programs that would serve the war effort and at the same time, would keep the university operating. One program undertaken was a pilot training program funded by the Civil Aeronautics Authority. KU was selected as one of 13 universities for the program. KU provided ground school training for which the students were given academic credit. Flight training was conducted by the operators of the Lawrence Airport. This program, coordinated by Professor Harry Stillwell, was extremely successful. KU, in fact, trained more students than any other university except the University of California.

The prewar activities combined with the rapid buildup of the aviation industry in Wichita and Kansas City made this an appropriate time to consider the establishment of a separate program in Aeronautical Engineering. On January 28, 1941, the Board of Regents authorized the change of the Aeronautical option in Mechanical Engineering to a major leading to the degree of Bachelor of Science in aeronautical Engineering. An examination of the curriculum shows a required 140 hour program with emphasis similar to today's program: math, science, engineering sciences and specialized aeronautical courses. Beginning in 1949, the department was visited by the accreditation teams and has been continuously accredited.

Enrollments in the program have followed the cycles inherent in the aviation world. Events like wars, recessions and international tensions have a major impact on the industry and is reflected in the enrollment figures. Examples of times of high enrollments include the GI's use of the GI Bill to finance their education in the late 40's, the launch of Sputnik by the Russians in 1958 and the recent emphasis on military buildup by the Reagan Administration. Major valleys in enrollment occurred due to the Korean War and the following recession in the early 50's and the recession in the early 60's. Following a national trend of falling enrollments in 1962, the department was combined with Mechanical Engineering to form a Department of Mechanics and Aerospace Engineering. As enrollments grew with the reemphasis on aerospace at the national level and as the aerospace academic and research activity increased on campus, the department was again made a separate department in 1967 as the Department of Aerospace Engineering. In 1947 the department granted its first master's degree, and in 1957 granted its first doctorates. Throughout the up and down cycles of national activity, the department has always attracted highly qualified students and faculty who share a passion for things that fly and who are dedicated to extending and applying the aerospace technology needed to maintain the preeminence of the United States. Through 1990 the department has awarded 1099 bachelor's degrees, 153 master's degrees and 37 doctoral degrees.

Throughout its history, the department has provided assistance to the aerospace industry in Kansas, the region and the nation. A major aid in the delivery of these services was the establishment in 1972 of the Flight Research Laboratory (FRL) in the Center for Research, Inc. This provided a focus for all the faculty to conduct research. The FRL has had grants from NASA, the FAA and industry in the broad range of research areas where faculty have expertise. The FRL is one of a small number of university research organizations still active in flight research. The establishment of the FRL marked a shift in the department from one that serves the local needs to one that provides service at the national and international level. Responding to requests from industry and NASA, the department participated in the development of the Master of Engineering and Doctor of Engineering programs. These degrees provide training in both advanced technology and project management. These programs were approved by the Board of Regents in 1969 as School of Engineering degrees. In 1989, these degrees were changed to department administered and designated degrees. Another service activity is the extensive set of short courses offered by the department through the KU Division of Continuing Education. These courses offered to practicing engineers and scientists have grown from a single course in 1970 offered in Lawrence to over 25 courses offered both in Lawrence and throughout the United States and selected courses in Europe and Australia. Finally, the commitment of the department to Kansas was demonstrated by the signing of a cooperative agreement with Wichita State University in 1989. This agreement encourages joint research that draws on the unique facilities and faculty that exist at both universities to form research teams that are nationally competitive.

Architectural Engineering

The architectural engineering program at the University of Kansas admitted its first students in 1912. Goldwin Goldsmith was named head of the department in 1913. Professor Goldsmith's statement of objectives for the training of architectural engineers is essentially unaltered today. He felt that these engineers would successfully cope with the technical aspects of building design and construction while at the same time recognizing that architecture is essentially a fine art. Consequently, architectural engineers not only receive instruction in technical areas, but also in architectural design, history, and theory.

Shortly after the department was formed, it began awarding degrees in architecture as well as architectural engineering. This practice continued until 1968 with the creation of the School of Architecture and Urban Design.

Although the architectural engineering degree has always been awarded by the School of Engineering, its administration was essentially from the School of Architecture and Urban Design. In 1978 an agreement was reached whereby the department's responsibility was shared equally by the School of Architecture and Urban Design and the School of Engineering. At about the same time the curriculum was increased from four to five years in order to encompass the greater breadth and depth of professional needs.

The program has been continuously accredited since 1937. Over the years the curriculum has undergone significant revisions in order to meet the changing needs of the profession. The complexity of building projects now requires that students receive instruction in illumination, building power systems, acoustics, heating, ventilation, and air conditioning, and construction management, as well as their more conventional studies in building structures. Instruction in these areas had formerly been housed in other engineering departments. It must be concluded that additional curricular changes will be made in the future.

Chemical and Petroleum Engineering

The chemical engineering and the petroleum engineering programs at the University of Kansas had different paths of creation and development until the programs were merged in 1961. Consequently, it is appropriate to separate the historical development of each program prior to the merger.

Chemical Engineering

Chemical engineering emerged from the field of chemistry as products based on chemical and physical processes were brought from the test tube to commercial production. As the nation entered the twentieth century, the demand for industrial chemicals stimulated development of improved processes and lower costs. The internal combustion engine created a market for large volumes of motor gasoline and other refined products. The conversion from heating by coal and wood to fuel oil was driven by plentiful supplies of crude oil which could be refined into low cost fuels. Continued advances in chemistry led to the creation of synthetic fabrics, rubber and plastics. Production of these materials in large quantities resulted in the growth of the profession. In many cases chemical engineers were involved in creating marketable products from these new raw materials. Emerging technologies such as electronic materials processing, biomedical engineering and biotechnology are now providing new opportunities for chemical engineers to contribute to the needs of society.

The evolution of the chemical engineering program at KU is a reflection of the changing technology during the last hundred years. Beginning in 1912, chemical plants were analyzed and designed on the basis of fundamental considerations called unit operations. Each process was subjected to intense study in research programs to understand fundamental concepts, to develop methods of predicting process performance and to design the process for large scale operation. As our understanding of these concepts increased coupled with the availability of high speed computers, it became possible to simulate plant performance for many processes prior to construction. The curriculum changed with changing technology. Courses in unit operations were augmented by thermodynamics and kinetics as fundamental concepts and methods to compute process performance were developed. The process design sequence at KU has gained national recognition as several KU seniors received awards in the student design contest problem sponsored by the American Institute of Chemical Engineers.

The graduate program at KU evolved principally after Word War II. During this period, KU researchers made major contributions to technologies in the thermodynamics of vapor liquid equilibria and boiling heat transfer. The Low Temperature Laboratory, now known as the Kurata Thermodynamics Laboratory, contributed to the development of technologies for the extraction of helium from natural gas and the development of cryogenic plants for the recovery of ethane-plus from natural gas prior to pipeline transport. Our current graduate program offers a wide range of research topics from traditional areas to some of the emerging technologies such as plasma processing and controlled drug delivery. Several textbooks and one reference book have been published by the faculty in chemical engineering. The texts cover chemical engineering kinetics, phase equilibria and process equipment, and the modelling of chemical processes. Two faculty members served as the editor and assistant editor of the sixth edition of Perry's Chemical Engineers' Handbook which is used worldwide as a standard reference.

Petroleum Engineering

The petroleum engineering program was established in 1937 to meet the needs of the oil and gas industry in Kansas for trained engineers. The program of instruction was focused on operations of oil and gas fields. During this time there was ample shut-in production of oil and gas in the United States as production capability exceeded demand. By the late 1950s, the situation had changed and oil imports became a noticeable part of the nation's oil supply. Researchers in universities and industry began to study methods of predicting recovery of oil and gas from petroleum reservoirs. This thrust was strongly aided by the development of digital computers which opened new horizons for management of petroleum reservoirs. With the availability of computers, it became possible to develop mathematical models to predict the performance of petroleum reservoirs. The field of reservoir engineering evolved in the 1960s and a strong program in reservoir engineering was developed at KU through a combination of curriculum revisions, research and selection of faculty. This strength continued with the merger of the chemical and petroleum engineering program in 1961.

In 1974 the Tertiary Oil Recovery Program, known as TORP, was formed by faculty in the Department of Chemical and Petroleum Engineering. Among the goals of TORP was to investigate methods of improving recovery of oil from existing reservoirs. A strong research program was developed which is directed at processes that are potentially applicable to Kansas reservoirs. In 1983, a field liaison program was developed to test new technology in Kansas oil reservoirs. The field liaison program has been cited as a model program by the Department of Energy. TORP also interacts with the Kansas oil industry through the Tertiary Oil Recovery Conference which is held on alternate years.

Our faculty has participated in joint research projects involving the Departments of Chemistry, Geology, Microbiology and the Kansas Geological Survey. A process for use of a new biopolymer for permeability modification was developed and patented through one of these cooperative projects.

The petroleum engineering curriculum is influenced by research interests of the faculty and accreditation requirements. Courses on waterflooding and enhanced oil recovery evolved from research programs within the department. Courses on drilling and well completion, production and well logging were added to broaden the background of our graduates and to meet accreditation requirements. A textbook on waterflooding was written by one of the faculty and a text on enhanced oil recovery processes is in preparation. Chapters on sucker rod pumping of oil wells and thermochemical alteration of crude oil were written by faculty members for other books.

Petroleum engineering continues to contribute to the societal needs by helping maintain the supplies of crude oil and natural gas that make up about 40 percent of the nation's energy needs.

Civil Engineering

Civil engineering at the University of Kansas, as practiced by its faculty and graduates, has had a significant impact on the development of Kansas, the United States and the World. Since 1873 when the first B.S. degree in civil engineering was awarded, to the present, the faculty has been continuously engaged in creating a vision for undergraduate and graduate students of the tasks to be done in providing the necessities for a more civilized world. For over one hundred years of civil engineering education at KU, the faculty and students have addressed a changing technology reflective of the demands of an evermore sophisticated society.

During the first twenty-five years, civil engineering instruction emphasized surveying and route layout, which were vital in development of towns and cities and to the railroad and roadway systems which connected them. Design coursework focused on stone masonry, timber, and iron construction.

At the turn of the century, civil engineering education at KU incorporated coursework in sanitary and hydraulic engineering in a partial response to the State of Kansas being assigned regulatory authority by legislative statute. Water-borne diseases were a major problem. As cities developed, taller and more complex structures were constructed and the automobile began to influence transportation patterns. Structural design of large buildings and the design and construction of surfaced highways were addressed in courses added to the curriculum.

World War I spurred a spate of technological development with military application. However, during the decade following the war, much of the new technology found its way into commercial products, especially machinery. Infrastructure development remained the focus of the profession as the economy provided the tax revenues for improved water, sanitary, and highway systems.

During the 1930's, the economic depression slowed new technological development in the United States. Many of the New Deal programs often emphasized public works and conservation projects that were focused on improving the quality of rural life. The development of hydroelectric power generation became an important factor in river basin planning and development. Adequate water supplies for public and industrial consumption, and for agricultural purposes remained an important regional issue for civil engineering education at KU.

The effects of World War II on civil engineering education at KU were substantial. Once again, military applications spurred a burst of technology advancement. Veterans returned to the campus after the war with vivid memories of wide-spread destruction. These men were serious about finishing their degrees and going to work to spur the continued industrial development of the United States and to rebuild much of Europe and the Far East. The curriculum began to include a more rigorous approach to engineering mechanics and to structural design as structural steel and reinforced concrete became the materials of choice. Soil mechanics and foundation engineering became more of an introductory subject on the undergraduate level rather than an advanced program of graduate study.

The emphasis on engineering science and applied mathematics received a national burst of support following the launching of Sputnik by the Soviet Union. An increasing emphasis on engineering research was also noted on the national level as the Federal government became a major sponsor of graduate-level civil engineering research. The KU civil engineering program was not left untouched by these national trends. The disastrous flood of 1951 in the Kansas River basin produced a congressional mandate for water basin planning and the development of coordinated flood control water storage reservoirs. Graduate education in water resources became a major priority for the KU civil engineering department. Environmental health engineering and environmental health science were also added on the graduate level. The engineering mechanics program was merged into the civil engineering department. Learned Hall was designed to incorporate civil engineering instructional and research laboratories in environmental, structural, geotechnical, and hydraulic engineering. An off-campus M.S. program was started in Kansas City to meet the continuing education needs of the rapidly developing civil engineering community of nationally active consulting firms.

The last twenty years have produced a new emphasis on protecting the environment and the KU academic programs relating to these societal concerns continued to provide the applied science and engineering design needed by the profession. Air pollution became a major national and international problem. The development of the digital computer has provided the impetus for major improvements in the analysis and design of structures using all types of materials. The microcomputer has put vast computational power on the desk of a civil engineer either in research or in professional practice. The KU Transportation Center was developed to provide a wide range of educational services to local and state government and to the consulting engineering profession. Sophisticated instrumentation, such as the scanning electron microscope and image analysis, has been added to civil engineering research capability. As has been the case for over one hundred years, the KU civil engineering academic programs have incorporated both the new tools and the new technical challenges into the teaching and research programs to prepare our future graduates for productive professional careers

Electrical and Computer Engineering

Electrical engineering became a fully recognized course of study at the University of Kansas in 1887 when an enactment of the Kansas Legislature authorized its establishment. This was four years before the School of Engineering was organized and provided an administrative home for electrical engineering. To illustrate the alertness and foresight of the Kansas Legislature, an item from '*A Brief History of Engineering Education in the United States*,' published in December 1977 in *Engineering Education*, states, "it was only after 1893 that engineering education became accepted as a distinct and worthy field in higher education."

Thus, almost five years before engineering education had achieved its recognized status, and likewise before the Columbian Exposition in Chicago in 1893 had presented a display of the latest developments in the use of electricity, KU had established a college program in electrical engineering.

The 1886-1887 catalog showed how quickly qualified members of the faculty organized to provide courses in electrical engineering:

> *This course is designed to give students as complete a preparation for the profession of electrical engineering as is possible within the limits of a college course. To this end the curriculum comprises, in addition to the study of applied electricity, full courses in general physics and chemistry; such training in mathematics as is necessary to the proper understanding of the theories of electricity and magnetism; in French and German, as will enable the student to read scientific works in those languages; and in mechanical drawing, as is required in the preparation of working drawings of machinery. Such studies in civil engineering as are deemed essential to the electrical engineer are also included in the course.*

Members of the engineering faculty who taught these first classes included Professors Blake and Marvin.

The wheels of the world were rapidly becoming electrified, and they began to spin faster at the turn of the century. Energized by the electrically operated displays featured at the World's Columbian Exposition, surcharged by the first automobile exhibit at Madison Square Garden in 1900, and the first flight in space achieved by the Wright Brothers in 1903, an exploding industrial expansion was getting under way. This was switching our nation from imitation into innovation made possible by electricity.

Students enrolling in electrical engineering at KU were mostly from Kansas and adjacent states. Their somewhat rural background, where improvisation was a way of life, perhaps gave them a wider range of practical knowledge than their eastern counterparts had. With this inherent resourcefulness and with the help of enterprising instructors, they were able to overcome some of the shortages of equipment in conducting their early experiments.

In the years following the Columbian Exposition in 1893, applications of electricity were unfolding at a phenomenal rate. Textbooks became out-of-date as they were being written. As a result, the laboratory method of teaching became the primary means of instruction. In reality, this seeming 'handicap' became more of a benefit than anticipated.

The electrical laboratory was not actually, nor could it have been sufficiently, equipped to enable the students to conduct all experiments being formulated by an enterprising instructor trying to keep pace with 'electricity.' Shortages were perhaps unintended developers of resourcefulness and ingenuity. The faculty and instructors worked hand-in-hand with the students to make the most of the resources available in the lab or even elsewhere on the campus. The 1900 *Jayhawker* reports that Professor Blake and his department (students) made all the electrical connections in the electric organ being installed in University Hall (Fraser). This extensive project provided a unique source for on-the-job training.

In the school year 1941-1942, the telephone and radio courses were retitled 'communications'. During the war years, the primary department effort was devoted to Navy V-12 courses. In the postwar era of 1946-47, the department procured a Phillips Network Analyzer, an analog computer used to solve electric utility network problems. It was different from other such computers in that it operated at 60 Hz instead of a much higher frequency. The high frequency was believed to be necessary to simulatethe very large impedance angle of alternating current generators. The Phillips Analyzer used clever phase shifting networks to obtain the same result. It was used by area utilities for a number of years, but became obsolete with the advent of high-speed digital computers.

During the fifties sponsored research began to grow. One of the first major contacts was for a study of radar positional errors resulting from anomalies in the permittivity of the earth's atmosphere. This contract with the U.S. Army Signal Corps involved theoretical modeling, together with extensive calculations for ray tracing done by an electronic analog computer.

The Remote Sensing Laboratory was founded in 1964. This laboratory focuses on the application of radar systems to remote sensing of the environment and has a worldwide reputation for leadership in this area of research. Students who have done their graduate work in this laboratory have gone on to distinguished careers, and the laboratory has produced a long list of 'firsts' in remote sensing.

The Telecommunications and Information Sciences Laboratory, TISL, was founded in 1983 to coordinate research in support of the new graduate program in telecommunications. This group developed the Block-Oriented Simulation System, BOSS, which is used to model telecommunication systems. This software package has been purchased by major industrial firms in the communications business. The TISL group is focusing on the development of computer-aided design tools for telecommunication systems.

The computer engineering program grew out of the electrical engineering program in a manner analogous to the growth of electrical engineering out of the physics program. The computer engineering program was an outgrowth of a set of required and elective courses in the design and programming of digital systems. By 1980 about half of the graduates with the B.S.E.E. degree were choosing the 'digital option' for their program electives. In 1984, the name of the department was changed to electrical and computer engineering. The proposal, endorsed by the Kansas Board of Regents in fall 1984, was selected by the university as its top priority for new programs for the 1985 legislative session. The legislature fully funded the first phase of the proposal in the fiscal 1986 budget and fully funded the second phase in the 1986 legislative session.

The Department of Electrical and Computer Engineering continues to assist the state and nation, indeed the world, by its research contributions and production of outstanding engineers.

Engineering Physics

Engineering Physics had its beginnings at KU in the 1930s. In 1938, the Department of Physics and Astronomy had established a curriculum leading to the B. S. degree in industrial physics in the College of Liberal Arts and Sciences. This degree, however, was short in basic engineering courses because the students had to fulfill the general requirements of the College.

J. D. Stranathan, chairman of the department, believed that the industrial physicist was actually an engineer, and that there would be a greater need for this type of individual in industry after World War II. This led the department to begin discussions of a degree in engineering physics in the fall of 1944. In January, 1945, a request for such a degree program was approved by the faculty of the School of Engineering and forwarded to Chancellor Deane W. Malott. He approved it shortly thereafter and sent the request to the Board of Regents. They approved it in May, and the first graduate in the program, a Navy V-12 student, received his degree that spring. (Things seemed to have been accomplished much more rapidly in those simple times. However this action may have been expedited by the fact that no new faculty or resources were requested.)

The program grew rapidly in its early years. Eighteen B.S. degrees were granted in 1948, and a peak was reached in 1960 and 1961, when twenty and twenty-two degrees were awarded. However, it has always remainded a small program. In the interval since its inception in 1945 to 1990, a total of 355 students have graduated with this degree.

In spite of the small numbers, the graduates have done well and have made significant contributions to the academic and industrial communities. At least four have been or are professors or administrators at major universities, and many have had or are having successful careers in industry and the military. Others have moved as far afield as medicine.

Until the late 1970s, the curriculum still contained relatively few hours of engineering. Increasing pressure from ECPD (now ABET) for a significant engineering design component in engineering curricula for accreditation forced a major change in the engineering physics curriculum. With the urging and support of Dean Kraft, the curriculum was changed in 1979 to include a choice of five design tracks, with over 25 percent of the hours in engineering. These tracks gave the students the option of an emphasis in aerospace, chemical, electrical, or mechanical engineering, with several tracks combining two areas. With this change, the students now graduate with a solid engineering background to complement the continuing strong background in physics and mathematics.

Mechanical Engineering

The primary goal of the mechanical engineering department at the Unvierstiy of Kansas, throughout its history, has been to educate young people in the contemporary theory, principles and practices of mechanical engineering.

Professor W.K. Palmer introduced the first mechanical engineering courses in 1899 with the 1899 catalog introduction:

Mechanical Engineering — *The function is twofold: to offer to the students of other engineering fields such lines of work as their particular needs require, and to afford to the students of the university an opportunity to specialize in the direction of the purely mechanical side of engineering. The purpose is to present an opportunity, not merely for mechanical training of a manual character, but for preparation of a higher order in the scientific subjects in which the engineer must be thoroughly trained who is to devote himself to the great questions involved in the designing, manufacturing and operation of machinery of every description. Especial stress will be laid upon the making of practical machine drawings, the designing of machines, and the preparation of the necessary working drawings, the cultiviation of the inventive ability, and a familiarity with the operations involved in construction of engines,* *boilers, machinery, and mechanical appliances of all kinds. Students thus prepared will find large opportunities open to them, in the designing of machinery and power equipment, and in the management of power plants and manufacturing establishments, in the production and development of valuable inventions, and in the work of the consulting engineer.*

Students did find the opportunities in the field of mechanical engineering and not only in Kansas. The Kansas Engineer magazine reported that graduates found employment in such far away places as Honolulu, the Philippines, Panama, Columbia and Butte, Montana.

In subsequent years, several areas of national growth influenced the mechanical engineering department: (1) the rapid development of the automobile, (2) the expansion of railroads, (3) the growth of power plants and (4) the demand for water and sanitary systems. With the stress onlocomotives, mining equipment, manufacturing machines, automobiles, and electric power systems, the university was being pushed to supply students familiar with such equipment and knowledgeable enough to respond creatively to the need for more advanced machinery. Machine elements such as gears, bearings, and instruments; efficiency in boilers, engines, compressors and gearing; and piping system stresses were areas of immediate concern.

For example, in 1900, 8,000 motor vehicles were registered in the United States. By 1913, the year Henry Ford set up a moving assembly line to produce the Model T, there were 1,258,000 and by 1918 there were 6,160,000. This created considerable pressure on the Department of Mechanical Engineering to develop a curriculum to support this rapid industrial growth. Railroad growth in Kansas alone had grown from 700 miles of road bed at the end of the Civil War to over 7,000 miles by the end of the nineteenth century. The electrical industry was feeling the same growth pressure and was hiring mechanical engineers to design and build more power plants. Electrical generation rose from six billion kilowatt-hours in 1902 to over 43 billion kilowatt-hours in 1917.

As the country recovered from World War I, the requirement for engineers also changed. There was more demand to develop engineers knowledgeable about automobiles, airplanes, and advanced machinery. Industrial safety was also becoming a concern. Safety problems resulted from boilers exploding, machinery breaking apart, and general metal fatigue. Factories were operating long hours, and pressure to produce more in a given time placed new stress on the workers. This resulted in additional pressure on the universities to achieve new and higher skills in the engineering schools.

Hiring of engineers was slow during 1921 and 1922, but improved by 1923. By January 1924 the dean was concerned that many high schools were discouraging students from becoming engineers. A national survey in that year indicated that engineering schools were graduating 9,000 engineers per year, and the demand was for nearly 40,000 per year. The driving force for this demand for mechanical engineers was the array of problems faced by the railroads, materials and heavy earth-moving equipment industries. The demand for producing basic materials such as steel and building materials required many mechanical engineers.

It is surprising that engineering and total university enrollments did not drop even more during the Great Depression than they actually did. Although comparatively few Kansans were financially hurt by the stock market crash itself (October 1929), agriculture (the major source of Kansas income) suffered, beginning as early as 1925 when the prices of farm products began to fall. By 1931, almost all Kansans were experiencing loss of income. Although engineering enrollments decreased about 20 percent from the 1929 enrollment to the 1932 low, engineering baccalaureate degree production was fairly stable and began to increase in the late

1930s. In fact, the ratio of mechanical engineering degrees to total engineering degrees granted rose from 12 percent in the late 1920s to 23 percent in the late thirties.

Compounding the hardships and recovery from the Depression was the arrival of the 1937-1938 recession during which industrial production in the United States precipitously dropped from 1937 to 1938 and only partially recovered in 1939. For some industries and individuals, financial recovery did not occur until the eve of World War II. Perhaps the Great Depression prepared everybody for the hardships of World War II. The winds of war did not leave much time between these two events. Although Congress declared war on Germany and Japan in December 1941, most students remained in school until the summer of 1942. Many remained the following year, awaiting draft calls or hoping to complete all or part of their college work before donning uniforms. Enrollment in the fall of 1943 increased, but this was partly due to wartime programs instituted by the army and navy.

The postwar period brought more hectic times for almost all university departments, but was more pronounced in engineering because of the disproportionately large number of veterans enrolled in engineering. The design of ships, airplanes, jeeps, guns, radar and many other items of military equipment undoubtedly impressed many young servicemen who selected engineering careers, but a heavy demand for engineering graduates also influenced enrollment. The pent up demand for manufactured consumer products after the war also created a great demand for mechanical engineers and the employment opportunities were many and varied. The rapid expansion of transportation systems, both highway and air; the mechanization of farming; and the rapid growth in the petroleum, petrochemical and plastics industries also provided many jobs for mechanical engineering graduates during this period.

The atomic bomb and the space program spurred an increased emphasis on engineering research and the federal goverment became a major employer of mechanical engineers. In the 1970s, an energy crisis brought on increased acitvity in research on alternate fuels and methods of increasing the efficiency of energy systems. These events plus a continuing growth in the consumer economy ensured employment opportunities for mechanical engineers.

Today, the Department of Mechanical Engineering continues its vigorous participation in education, research and public service. Efforts are concentrated in the two ABET mandated stems: 1) energy and 2) structures and motions in mechanical systems. The disciplinary topics covered by the energy group are the thermal-fluid sciences (thermodynamics, fluid mechanics, heat and mass transfer) and their applications (momentum machines, heat power, air conditioning, solar energy, energy management, aspects of manufacturing, aspects of environment changes). Undergraduate engineering education for a slightly smaller number of students is expected in the near future due to both enrollment control and to reduced numbers of applicants.

The energy group expects to continue enhancement of its research and graduate programs to the benefit of Kansas, the region, and the nation. This expectation is consistent with the statement of the Board of Regents that the first prioriity of the Unviersity of Kansas is its research graduate programs. External funding for pursuit of research and development projects on which graduate students can work is essential for this activity, so an outward looking point of view will increasingly be found that brings the faculty and graduate students into contact with engineers and technologists in industry and in national research centers to commonly work to discover and devise ways to solve or ameliorate the worst features of technological problems faced by our society. The regional technical community will continue to be served by graduate courses taught in the evening on the Lawrence campus, by intermittent workshops, by continuing education courses on timely technical topics, and by taking action based on input from the advisory board of the department.

The disciplinary topics covered by the structures and motions in mechanical systems group are computer-integrated manufacturing and behavior of materials; computational mechanics and finite elementanalysis; and robotics and control systems. Future undergraduate and graduate education prospects are similar to those of the energy group. Research and external funding has been significant. In 1980 NASA's Office of Technology Utilization funded establishment of the Industrial Innovation Laboratory to promote the application of microprocessors to intelligent mechanical systems. In 1983 the Computer Integrated Manufacturing Laboratory was established to conduct research on topics related to automation and robotics technologies for the 'factory of the future' with the Automated Manufacturing Research Facility of the National Institute of Standards and Technology, with funding by the U.S. Navy. In 1988 a long term augmented telerobotics research and technology transfer program was begun in cooperation with the Automation Technology Branch and Technology Utilization Office of NASA Langley Research Center, the Kansas Technology Enterprise Corporation and local industry. Researchers are exploring the application of NASA technology in shared control of telerobotic devices and hierarchical control and microprocessor based mechanical systems to improve space station assembly and operations. These three laboratories were combined into the Intelligent Systems and Automation Laboratory (ISAL) in 1989. Current areas of research include automated process planning, adaptive control, expert systems, articficial intelligence, versatile fixturing, CAD and CAM, computer integrated manufacturing, shared control, voice control, tactile augmentation of telerobotic systems, automated joining of fiber optic cables, and the utilization of sensors to determine depth of burn wounds in humans.

The Computational Mechanics Laboratory conducts computational mechanics research and development in solid mechanics, structural mechanics, fluid mechanics, system dynamics and control, and the thermal sciences. The nature of the laboratory and its breadth of technical expertise make it useful for industry and government for the variety of interdisciplinary problems that can be undertaken and the magnitude of projects that can be supported. The finite element system FINESSE is a major research tool available for computational work and software development.

As the Department of Mechancial Engineering at the University of Kansas looks to the future, the goal originally stated by Professor Palmer of "preparation in a higher order" still reigns and the department continues to prepare its graduates for productive professional careers.

Looking back through 125 years of the history of The University of Kansas and that portion of it concerned with the education of engineering students, one sees the response made by the University and School to the technical needs of society. For the first eighty years (1866-1946), engineering education to the bachelor's degree was adequate. After WWII, this was no longer sufficient. At the end of WWII, only four faculty had doctoral degrees. Today, essentially every faculty member has this degree. Also, up to the end of WWII the writing of technical articles and books by the faculty was uncommon. Today, such work is considered important and required for advancement and salary increases. The School awarded its first doctoral degree in 1951. Today, with a faculty of about the same number as the combined faculties of chemistry, mathematics and physics, the School of Engineering is now awarding more doctoral degrees than these departments combined. The School is discharging its responsibility to make the University active in advanced university education and research.

For several decades the School has had major unmet needs for funds for facilities, equipment, and maintenance. Some of these needs have been partially met through the generosity of alumni and engineering-related firms. One notable example has been the Spahr Engineering Library which will now provide space well into the twenty-first century. Several large recent endowments for scholarships will, among other things, permit the Departments of Chemical and Petroleum Engineering and Mechanical Engineering to attract outstanding beginning students. A recent action by the Board of Regents will allow the University to charge engineering students a special fee which will be used to partially provide the funds needed for equipment and maintenance.

If present day predictions are to come true, in a decade or two the School will have a majority of students who are women and minorities. If such a situation develops, the School can be proud of the opportunity to have had a part in advancing two important new groups into the professions. The creation of advisory committees for the School and for the departments, with a majority of the members from industry, has been and will continue to be of major help in the years to come.The extent to which the economy of the nation will influence the support that industry and government will give to engineering education and research is not clear. Certainly, this School, like other engineering schools, has participated in good times and bad times. But, looking back through the decades, one can always find in each of them positive and meaningful advances.

Ad Astra Per Aspera

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