THOMAS F. EDGAR
of the
University of Texas at Austin

When Tom Edgar first joined the faculty at UT-Austin in 1971, he was given an excerpt from a 1966 speech by John McKetta, then Dean of Engineering, which summarized the expectations of a faculty member:

> **He/she should expect to write proposals for research, equipment, and special projects; to publish articles, reports, papers, and books; to keep up-to-date in his/her profession field; to serve on councils, boards, and committees; to maintain the best possible relations with alumni, legislators, and the business and industry of the region—in short, to be a responsible member of the community and to participate in many of its activities. But we all know that these many activities must never overshadow our greatest concern—the student. If our responsibilities to, and concern for, the student ever become secondary, we will be violating the trust we accepted when we joined the faculty.**

In his twenty years as a faculty member, Tom Edgar has pursued this creed, excelling in teaching, research, administration, and professional service.

The influences that shaped Tom's career began when he was a young boy growing up in Bartlesville, Oklahoma (which at that time probably had the highest number of chemical engineers per capita in the U.S.). His academic instincts were honed in the eighth grade when he won the Oklahoma Spelling Bee and received an all-expense paid trip to the National Spelling Bee in Washington, D.C. (this was his first national meeting!).

Becky, Jeff, Donna, and Tom on their favorite type of family vacation.

Then, when Sputnik was launched in 1959, thrusting America into the space race, the resulting heightened consciousness of science led Tom to begin dabbling in various technical fields. Encouraged by his father (a metallurgical engineer), his mother (a teacher and a housewife), and an older brother (an electrical engineer), he undertook several science-fair projects (including one on fuel cells) which whetted his appetite for science and engineering. As a high-school senior he won the Bartlesville Science Fair and a trip to the National Science Fair.

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During his senior year, Tom's parents became concerned about his choice of a career, so he took a battery of special aptitude tests. He scored high on memorization and vocabulary (the spelling-bee influence!), but low on spatial reasoning—which indicated he should *not* become an engineer. Perhaps organic chemistry would be a good field....

But Tom ignored the aptitude-test results, and in 1963 he enrolled in chemical engineering at the University of Kansas. He was influenced to consider a research career in his second semester when his audition for a part-time job to become a radio announcer for a classical music station was unsuccessful. Tom mentioned the audition to J.O. Maloney, who promptly arranged for a lab-assistant job with Russ Mesler making high-speed movies of nucleate boiling.

At KU, Tom's only "B" was in transport phenomena (darn that Bob Bird!); it is ironic that transport was the first course he was assigned to teach at Texas. He became heavily involved in campus activities while at KU, which presaged the future level of his professional service. Also of benefit were a number of summer jobs in industry and an NSF undergraduate research project in process control.

Tom has fond memories of his first experience with computer programming. The students in his material and energy balance course were told to write a computer program for flash vaporization (iterative calculation) within a two-week period of time, and it was suggested that they could learn how to write the computer program on their own. This effectively *forced* Tom to learn how to use the computer! The result was that computer decks took up more than their share of his desk space during the next ten years.

With this background, it was only natural for Tom to study for the PhD under Leon Lapidus at Princeton, who was probably the leading authority on numerical analysis and optimal control at that time. Since Tom had a NSF fellowship, Leon left him alone to "do his thing," so in his free time Tom became involved in several athletic clubs and eventually started as prop for the Princeton rugby team for two years.

Tom's PhD dissertation dealt with the "minimum time" control problem, which is consistent with his mother's comment that he always wanted to be first to finish any activity (unusual for a second child). He managed to finish his PhD in the "minimum time" (less than three years) even though he was balancing child-care responsibilities (his wife Donna was pursuing a Master's degree at Rutgers), athletic pursuits, and research activities.

STARTING A CAREER

One of the worst times to graduate was in 1971—there were probably only three or four academic jobs available that year, and industry was not hiring. As a college freshman, Tom had decided he wanted to be a professor, so he was delighted when the University of Texas offered him a faculty position with a princely start-up package of $10,000. At that time there was limited government research funding (especially in control), few PhD students, and a teaching load of four courses per year. Tom set about to identify fundable projects where new modeling and control techniques were needed to solve the problems.

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During the early 1970*s*, Tom decided to broaden his background by exploring energy technology. He was influenced by having an office next to John McKetta, who was at the time gaining great attention for his views on the energy crisis. When Tom came across an obscure reference to underground coal gasification (UCG), he became interested in pursuing research on the problem. As he recalls, the brief article stated that UCG was an economically attractive synfuel alternative, especially for deeper coal seams—but that a major difficulty existed in that the process could not be *controlled* and was not well understood. "A perfect application for modeling and control," he thought. Since the State of Texas was blessed with large reserves of deep lignite and was accustomed to drilling for energy, Tom put together an interdisciplinary research project involving chemical, petroleum, and environmental engineering, in addition to geology, which was funded by NSF, DOE, and a ten-company consortium.

Tom's research in coal gasification and combustion focused on developing fundamentally based mathematical models in a field noted for empirical approaches. The general thrust of the UCG research was to determine those physical and chemical conditions conducive to application of UCG. Between 1974 and 1984, the interdisciplinary group that he directed developed computer-based methods for scale-up and experimental methods to characterize a given

coal deposit for UCG. Mathematical models were verified in small-scale reactors, combustion tubes, and at the field scale. These techniques were used by several oil companies and by government laboratories and included computer models and experimental correlations for channel growth/sweep efficiency, product gas composition, gas-solid reaction characteristics, drying and mechanical properties, sulfur reactions, combustion tube tests, block gasification, flow characteristics, environmental impact, and technical and economic evaluation.

Many of these results, presented in some forty papers, have also been applied to conventional gasification and combustion processes. Of his papers on UCG, a 1978 *AIChE Journal* review article and a book chapter in *Chemistry of Coal Utilization* (1981), stand as key chemical engineering references in the field. Tom's research efforts were recognized by the AIChE Colburn Award in 1980; it was probably the only time this award has been given for "coal-burning."

While the UCG work focused heavily on modeling, Tom did not leave the control field during this period. His interests in multivariable control broadened to include adaptive control in the 1970*s*. In 1977, he received one of two best-paper awards at the Joint Automatic Control Conference. His 1981 work with a PhD student, Ernie Vogel, on an adaptive dead-time compensator solved a long-standing problem inherent in many chemical processes, and has been cited or used by a large number of subsequent investigators.

PROFESSIONAL INVOLVEMENT

Tom's leadership in professional activities began when he and another engineering faculty member founded the minority engineering program at UT-Austin in 1974. At that time there were few minorities in engineering and no engineering scholarships for economically disadvantaged students at Texas. Tom helped get the recruitment program started, established a tutoring program, raised $60,000 for scholarships from industry (a large sum in 1975!), and served as director for two years. After a successful start, the Equal Opportunity in Engineering Program now has the fifth largest number of minority students in engineering in the U.S.

Having learned how to balance a variety of outside activities with a heavy research and teaching load, Tom became active in a number of groups, including the CAChE Corporation, the AIChE CAST Division, and the American Automatic Control Council. He was selected by CAChE to edit the AIChEMI Modular Instruction Series in Process Control and an issue of *Computers and Chemical Engineering* on the "Application of Computer Graphics in Chemical Engineering." These modules are still being distributed by AIChE and have been important supplements to the standard textbooks for process control. Tom also worked with Duncan Mellichamp to develop the eight-volume CAChE Monograph Series in Real-Time Computing. His success in leading a variety of CAChE projects led the other CAChE trustees to elect him as Vice-President of CAChE in 1980 and as President from 1981-84, solidifying CAChE's financial base so the non-profit educational group could grow in influence during the 1980*s*.

A bearded Tom with Dale Seborg at an authors' meeting in Kuwait in 1983.

Since 1981, Tom has served in a variety of positions in the AIChE CAST Division, and he thus provided important leadership as the division grew to the second largest division in AIChE. These offices included Director, Vice-Chairman, and Chairman (in 1986). For the past three years he has been the AIChE Council Liaison to the CAST Division, having been elected a Director of AIChE in 1988.

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nary American Control Conference every year and has seen it become the premier automatic control conference in the world during that time. His service activities in that organization include Arrangements Chairman (1974), Finance Chairman (1982), Program Chairman (1979), and General Chairman (1987). He was selected as Director (AIChE representative) of the American Automatic Control Council (AACC) in 1982 and in 1988 was elected by representatives of the six other sponsoring societies as Vice-President. He is just now finishing up a two-year term as President and is leaving AACC in excellent shape for the future.

Tom has also been a driving force behind the CPC (Chemical Process Control) series of conferences and co-chaired (with Dale Seborg) the second conference in 1981. He served on the organizing committee and as session chair in 1986 and 1991 and was also the 1991 conference manager for CAChE (held at South Padre Island). Perhaps Tom is best remembered for his role as awards co-chairman in 1986 and 1991; CPC awards are like Harvard Lampoon awards and rely on a highly developed sense of humor.

During the 1980*s*, Tom also took on a variety of editorial board activities. He and other colleagues founded a new journal on subsurface processing in 1978 (*In Situ*, published by Marcel Dekker), and he served as General Editor until 1988. In addition, he has served on a variety of journal editorial boards including *AIChE Journal, Computers and Chemical Engineering, Chemical Engineering Reviews, Journal of Process Control,* and most recently as process-control editor of *Chemical Engineering Education.* He serves on the advisory board to the chemical engineering editor of John Wiley and Sons, and is also highly sought after as a program evaluator (Utah and Arizona State) and on departmental advisory committees (Kansas, MIT, and Maryland).

BOOK-WRITING

The decade of the 1980*s* also resulted in a flurry of books by Tom and his colleagues. In 1982 he had three book projects in progress. His first book, a professionally-oriented book on *Coal Processing and Pollution Control,* (Gulf Publishing, 1984), brought together a wide array of information on all aspects of coal utilization, covering extraction, conversion, and pollution control.

Tom taught an undergraduate elective course on optimization since 1972, and as a result joined with David Himmelblau to write *Optimization of Chemical Processes* (McGraw-Hill, 1988). This book continued the important role that UT-Austin has played in this area of chemical engineering, beginning with Beveridge and Schechter's successful book (*Optimization: Theory and Practice*) in 1966. The recent textbook shows how the optimization field has matured in the past twenty years; its focus is on problem formulation (modeling) and it emphasizes only those optimization methods proven to be the best ones, while extensive coverage on various applications of optimization is also provided. *Optimization of Chemical Processes* is highly student-oriented in its presentation and sold nearly two thousand copies in its first year of publication.

Perhaps Tom's best known book is *Process Dynamics and Control*, written with Dale Seborg and Duncan Mellichamp. This book had its origins in a five-day short course that Tom, Dale, and Duncan first gave at the University of California, Santa Barbara, in 1978. It had a very long gestation period due to extensive class-testing at ten universities (at various times) changes in process control technology, geographical separation, extensive revisions by each of the three authors, UCSB faculty governance assignments, building a house, etc (the excuses and accusations are endless). In the California "spirit," Dale's philosophy was to "sell no wine before its time." Tom wrote most of the first drafts for the twenty-eight chapters, and Dale and Duncan then tore them to shreds (Tom's version). In any event, the book (published by Wiley in 1989) has received excellent reviews and is now the number-one textbook on process control. It won the ASEE Meriam-Wiley Distinguished Author Award as the top new engineering textbook in 1990.

RECENT RESEARCH ACTIVITIES

In spite of his many outside activities and responsibilities as Chairman at Texas since 1985, Tom has managed to continue his strong research efforts

and is currently investigating modeling and control applied to such diverse areas as chemical reactors, distillation columns, pressure swing adsorption, and most recently, microelectronics manufacturing. While he was a "lone wolf" in his previous research efforts, alliances with his UT colleagues Jim Rawlings, Ike Trachtenberg, and David Himmelblau have permitted him to continue supervising a large number of graduate students. Tom still does much of the proposal and publication writing, and his students have learned to expect many corrections on their writing efforts. During his twenty-year career at Texas he has supervised forty-one MS and thirty-seven PhD students, which is due in part to his many good ideas and effective salesmanship techniques.

Tom's laboratories contain a wide array of highly instrumented equipment, always connected to some computer (PC*s*, workstations, commercial distributed control systems). Asked about recent technical achievements, Tom lists several examples:

- **demonstrating high sensitivity of some nonlinear control schemes (with Chuck Alsop)**
- **developing theoretically-based criteria for measurement selection in distillation columns (with Wayne Bequette)**
- **developing a new computationally efficient scheme for using nonlinear programming to compute model-predictive controllers and demonstrating it on a packed distillation column and packed-bed chemical reactor (with Jim Rawlings, Ashu Patwardhan, John Eaton, and Glenn Wright)**
- **validating a fundamental reaction-transport model for a commercial multiwafer low pressure chemical vapor deposition reactor, the first highly documented modeling study on polysilicon in the industry (with Tom Badgwell and Ike Trachtenberg)**

Over half of his current research group is focusing on the modeling and control of microelectronics processes, with support from NSF, the State of Texas, Sematech, Semiconductor Research Corporation, and Texas Instruments. Tom says the state of control technology in the microelectronics industry today is the same as it was for the chemical industry in 1970 and thus presents many opportunities to have an impact. His goal is to see model-based feedback control developed and implemented for a wide variety of unit operations, mainly in etching and deposition reactors.

Tom believes strongly in teaching excellence; all of the books he has written have arisen out of supplemental materials developed for his courses (he still can't believe how he had the time to teach four *different* courses for seven years). Students appreciate his sense of humor, his gregarious manner, and his genuine interest in them as individuals. Because of his excellent memory, he is able to learn all of his student's names in one week, aided by his semi-Socratic classroom pedagogy. Students like the fact that the door to his office is always open, even though he is busy as department chairman and as an advisor to many graduate students.

Tom has been extremely effective in influencing a rise in national visibility for the Department of Chemical Engineering at UT-Austin. He served as Department Graduate Advisor from 1979-1985, a time when PhD enrollment tripled. UT-Austin now ranks third in the U.S. in PhD*s* produced and is also third in research funding. The process control group is the largest of its type among chemical engineering departments. While the UT research focus has recently become more fundamental and science-oriented, it is still held in high esteem by industrial practitioners, as is evidenced by the latest poll by *U.S. News and World Report.*

Consistent with his personal juggling act, Tom recognizes that the Department must have an atmosphere where good teaching and good research are valued, and where the students will receive a quality education. Evidence of this at Texas are the engineering teaching awards won by Presidential Young Investigators and the Outstanding AIChE Student Chapter Award in 1990 (the last time they won was when Tom was student chapter counselor in 1974). Tom also places a high priority on alumni relations and interactions with industrial supporters.

As Chairman, Tom spends a good part of his time in setting new directions for the department and in young faculty development. Adam Heller (who came to Austin in 1988 from Bell Labs) states, "Tom Edgar's leadership has allowed the Department to expand beyond its previous national strengths in polymers, separations, and process control into two new areas—microelectronics and biotechnology." Jeff Hubbell comments, "Tom Edgar spends considerable time so that young faculty have the opportunity to become successful."

His friend Bob Seader (at Utah) sums up Tom's impact on chemical engineering as follows: "Tom is one of the best known and most well-respected young engineering educators in the United States. During a period of twenty years, he seems to have had one major goal: to do everything he can do to advance his profession and to help others to best utilize these advancements. He is a tireless worker of almost unlimited energy, an inspiration to his many colleagues, and a servant to his profession." ❐