
DON PAUL

... of *The University of Texas at Austin*

WILLIAM J. KOROS

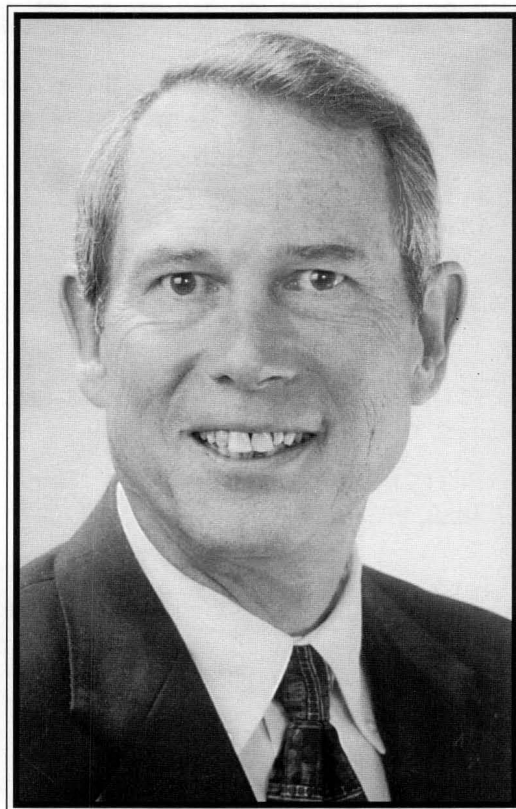
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I recently conducted an experiment by asking several colleagues at the University of Texas at Austin what words came to mind when they thought of Don Paul. For those who know him well, it is not surprising that the common descriptors included “smart,” “organized,” “honest,” “practical,” and “tough.”

While those five words undoubtedly capture his core personality, the word “productive” also pops to mind when I think of Don. By any standard, Don’s prodigious contributions to the chemical-engineering and materials-science literature place him almost in a class by himself. In addition to coauthoring over 450 archival journal articles and editing eight books, Don has also mentored 52 PhD students, 47 MS students, and 46 postdoctoral fellows during his career at Texas. Serving as the Editor-in-Chief of *Industrial and Engineering Chemistry Research* for fifteen years and being on the editorial boards of eight other journals has made his impact on the field of chemical engineering truly enormous.

Don’s research interests include the broad areas of polymer science and engineering and chemical engineering. His eight edited books cover a broad range of topics, but they have a common thread as a result of his interest in polymers.

Don’s current research involves polymer blends, mem-



branes for separations, drug delivery, packaging, and polymer processing. The blend research deals with the thermodynamics of polymer-polymer miscibility, phase diagrams and interfaces, reactive compatibilization of multiphase mixtures, rubber toughening, the control of phase morphology during processing by both chemical and physical means, and polymeric nanocomposites. His research on diffusion in polymers involves investigation of structure-property relationships to design better membranes for separation processes, improved barrier materials, physical aging of thin films, and “thermal switch” membranes.

Don has also contributed significantly to theories and models for describing sorption and permeation of small molecule penetrants in polymers. A broad range of materials, including rubbery, glassy, semicrystalline and liquid crystalline states of these materials, has been considered. Synthesis and characterization of novel materials is a key aspect of his work in all of the above sub-areas.

A BROAD ARRAY OF CONTRIBUTIONS

One of our departmental colleagues once joked that he held a still-unproven hypothesis that there are really identi-

cal twins with the initials DRP who operate from Don's office. While highly valuing productivity, Don's high standards for quality are also apparent, and his recognition as a creative and insightful investigator documents this aspect of his nature.

Beginning with the 1973 ACS Arthur Doolittle Award, a steady stream of honors bestowed on Don by colleagues underlines the respect in which his work is held by the chemistry and chemical engineering communities. In addition to the Doolittle Award, the ACS has recognized his contributions through the Phillips Award in Applied Polymer Science and the E.V. Murphree Award for Contributions to Industrial and Engineering Chemistry. The AIChE has recognized him with the Stine Materials Engineering and Science Award and the William H. Walker Award for Contributions to the Chemical Engineering Literature as well as by election as a Fellow.

He was elected to the National Academy of Engineering in 1988 for "outstanding research contributions on polymeric materials and for leadership in chemical engineering education." Don's Council of Chemical Research Malcom Pruitt Award and the Plastic Institute's Educational Service Award also emphasize not only his impact in scholarly publication and research arenas, but also his leadership at the interface between industry, government, and academia.

Don has presented numerous invited lectures, including the Warren McCabe lecture at North Carolina State University, the R.L. Pigford Memorial Lecture at the University of Delaware, the Ashton Hall Cary Lectures at Georgia Institute of Technology, and the Donald L. Katz Lecture at the University of Michigan. He has also served the chemical engineering community through his contributions to committees and organizations throughout his career. He was on the Education Projects Committee of the AIChE from 1968-77 and served as the editor for the *Chemical Engineering Faculties Directory* from 1967-77. He also was an ABET accreditation visitor from 1974-83. Don's ability to speak to both the chemistry and the chemical engineering communities is reflected by his active work with both the ACS and the AIChE.

Don served on the Executive Committee of the ACS Division of Polymeric Materials Sciences and Engineering from 1980-85 and in many capacities related to ACS publications well beyond his work as Editor in Chief of *I&EC Research*. His work on *I&EC Research* has seen close to 50,000 pages of archival journal pages published under his watch, with the collaborative assistance of many editorial colleagues, since 1986. His editorial contributions have also included service on editorial boards for *The Journal of Membrane Science*,

Polymer Engineering and Science, *Journal of Applied Polymer Science*, *Chemical Engineering Education*, *Polymer*, *Journal of Polymer Science*, *Polymer Physics*, *Polymer Contents*, and the Imperial College Press Series on Chemical Engineering.

Beyond the AIChE and ACS, Don has also been involved in activities of the Council of Chemical Research, serving on its Governing Board (1981-84) and its Executive Committee

[Don] published a classic paper regarding the mechanism of hydraulic permeability through membranes [that] helped call attention to the new program in polymers at UT and launched the membrane activities that have been a strong and continuous component of UT's graduate-studies area for over three decades.

(1983-84). He was a member of the Founding Committee of the North American Membrane Society. His work with the National Academy of Engineering has included service on the NAE Peer Committee in 1989-92 and 1994 as well as the Membership Committee from 1994-97. The National Research Council benefited from his input on its National Materials Advisory Board from 1988-94, its Committee on Polymer Science and Engineering from 1992-94, its U.S. National Committee on the International Union of Pure and Applied Chemistry from 1993-96, and its Solid State Science Committee from 1994-97. He also served on panels for Materials Science and Engineering at NIST and on the panel for International Benchmarking of U.S. Materials Science and Engineering Research.

Don's story begins in North Carolina where he grew up on a small farm near Washington, NC. He freely acknowledges the strong effect that this background has had on his lifestyle and motivation. An anecdote regarding this point is useful here. Don once told me that he recalls going out to hoe weeds out of a large field one hot North Carolina day. Looking at the very large and intimidating field, he decided not to think in terms of its size. Instead, he looked down the first row and thought, "I can get to the end of this one." Hoeing his way to the end of the row, he straightened up and looked down the next row, deciding "I can get to the end of this one, too." You can guess the rest—128 rows later he looked back on the entire field with a sense of accomplishment and an insight that has remained with him throughout the years. Whether it is writing papers or books, or educating nearly 150 graduate students and post docs, it is best to take it "one row at a time" and to just keep on working.

Don's contributions to teaching have also been widely recognized. He received the General Dynamics Teaching Award in 1977, which is the highest teaching recognition in the College of Engineering, and it focuses on contributions to undergraduate education. In 1994, our department nomi-

TABLE 1
Don Paul's Former Graduate Students

PhD Students

D.R. Kemp (1972)
C.E. Locke (1972)
O.M. Ebra-Lima (1973)
W.J. Koros (1977)
A.H. Chan (1978)
C.A. Cruz Ramos (1978)
J.E. Harris (1981)
R.S. Barnum (1981)
E. Woo (1984)
J.-S. Chiou (1985)
Y. Maeda (1985)
A.C. Fernandes (1986)
M.J. El-Hibri (1986)
T.A. Barbari (1986)
M.E. Fowler (1987)
N. Muruganandam (1987)
M.C. Schwarz (1987)
C.-H. Lai (1988)
P.S. Tucker (1988)
A.C. Puleo (1988)
J.H. Kim (1989)
P.C. Raymond (1989)
J.M. Mohr (1990)
J.S. McHattie (1990)
H. Kim (1990)
G.R. Brannock (1990)
T.-W. Cheng (1991)
I. Park (1991)
D.H. Weinkauff (1991)
Y. Takeda (1992)
C.L. Aitken (1992)
C.K. Kim (1992)
T.A. Callaghan (1992)
M. Aguilar-Vega (1993)
J.D. Le Roux (1993)
M. Nishimoto (1994)
P.P. Gan (1994)
B. Majumdar (1994)
A.G. Gonzalez (1995)
M.R. Pixton (1995)
M. Lu (1995)
A.J. Oshinski (1995)
S. Ziaee (1995)
K.A. Schult (1996)
C.T. Wright (1997)
F.A. Ruiz-Trevino (1997)
G.S. Wildes (1998)
W.R. Hale (1998)
M.S. McCaig (1998)
G.D. Merfeld (1998)
R.A. Kudva (1999)
J. H.-C. Chu (1999)
Z. Mogri (2001)

MS Students

D.R. Kemp (1969)
J.H. Troell (1969)
O.M. Ebra-Lima (1970)
J. St. Lawrence (1970)
V. Mavichak (1970)
C.E. Vinson (1971)
D.H. Carranza (1972)
A.E. Mann (1972)
R.E. Robertson (1972)
M. Garcin (1973)
J.O. Altamirano (1974)
J.R. Stell (1974)
J.D. Paciotti (1974)
A.A. Rocha (1974)
W.E. Garmon (1975)
R.L. Imken (1975)
S. McSpadden (1975)
A.J. Meyer (1975)
D. Wahrmund (1975)
T.R. Nassar (1976)
R.N. Mohn (1977)
R.E. Bernstein (1977)
J.C. Tiffany (1978)
G. Wonders (1978)
E. Nolley (1978)
A.J. Erb (1979)
D.W. Bartlett (1979)
C.R. Lindsey (1979)
P.-T. Chang (1980)
M.D. Lorenz (1980)
J.J. Ziska (1980)
P. Masi (1980)
E.A. Joseph (1981)
W.A. Smith (1981)
E.Y. Adham (1982)
T.D. Traugott (1982)
W.E. Preston (1982)
S.R. Murff (1983)
J.D. Keitz (1983)
C. McCutcheon (1983)
J.-L. G. Pfennig (1984)
V.J. Triacca (1989)
G.P. Shaver (1989)
J. Oshinski (1990)
A.B. Lombardo (1994)
S. Gupta (1995)
A. Kelkar (2000)

nated Don for the University-wide Graduate Teaching Award. We contacted his former graduate students for possible letters of support. The response was overwhelming. Letters poured in from all over, since by that time Don's former students had achieved distinguished positions in many parts of the world. The recurring theme of these letters was an expression of the writer's feelings of deep appreciation for Don's help in their educational development by his tough, but ultimately compassionate, mentorship. As one of these former students, I was more than pleased that Don received this highly competitive award in recognition of his educational efforts.

Don's BS in chemical engineering was earned at North Carolina State University (1961) and his graduate work was carried out at the University of Wisconsin, Madison (1965). He has been recognized by both of his alma maters with distinguished graduate awards.

In addition to summer work at DuPont in the nonwoven fabric area in 1960-61, Don was a Research Chemical Engineer at Chemstrand Research Center in North Carolina's Research Triangle Park from 1965 to 1967.

LIFE AND LEADERSHIP IN THE DEPARTMENT

Don joined the University of Texas faculty in 1967 and has been here now for 34 years. Progressing through the ranks to Associate Professor in 1970 and to Full Professor in 1973, he took an early role as a departmental leader. He served as the department's Associate Chairman from 1973-77 and as its Chairman from 1977-85. During his Chairmanship, Don recognized the need for a forward-looking approach. He assembled a committee comprised of distinguished leaders in the chemical and petrochemical industries as well as from the academic community to evaluate the curriculum. The committee also analyzed the future needs of the department and the larger chemical engineering community. Many of the elements of this visionary plan are still used as the guiding principles for our department.

One of Don's favorite statements is that "chemical engineering is defined by what chemical engineers do." That attitude helped position the department as an early player in the polymer, materials science, microelectronic, and biotechnology opportunities that have helped maintain the vitality of our discipline.

Don was also quick to see the need for better bricks, mortar, and laboratory facilities to allow the department's movement toward the new technological areas, while still maintaining connections to its petrochemical roots. He was a key person in acquiring the needed resources to construct our current modern facility, which was occupied in 1986 at the end of his term as Chairman. Strong connections with our alumni and industrial friends also led to the establishment of a large number of endowed positions in the department and college during this period. Don himself was selected as the T. Brockett Hudson Professor in 1978 and as the Melvin H. Gertz Regents Chair in Chemical Engineering in 1985.

Following his term as Chairman, Don returned to his active research and teaching duties in the department and served as a mentor for several faculty who were at the time making the transition to academia from industry. During the time he served as Chairman, he managed to maintain an energetic research program, but when he stepped down from that

position, a literal explosion of activity became apparent through his PhD supervision and his publications.

MAJOR TECHNICAL CONTRIBUTIONS

Don's interests and contributions in polymer engineering and science have included work in both polymer blends and membranes. Not surprisingly, he has managed to also combine his insights in these two separate areas to provide important contributions in advanced blend membrane systems for gas separation membranes.

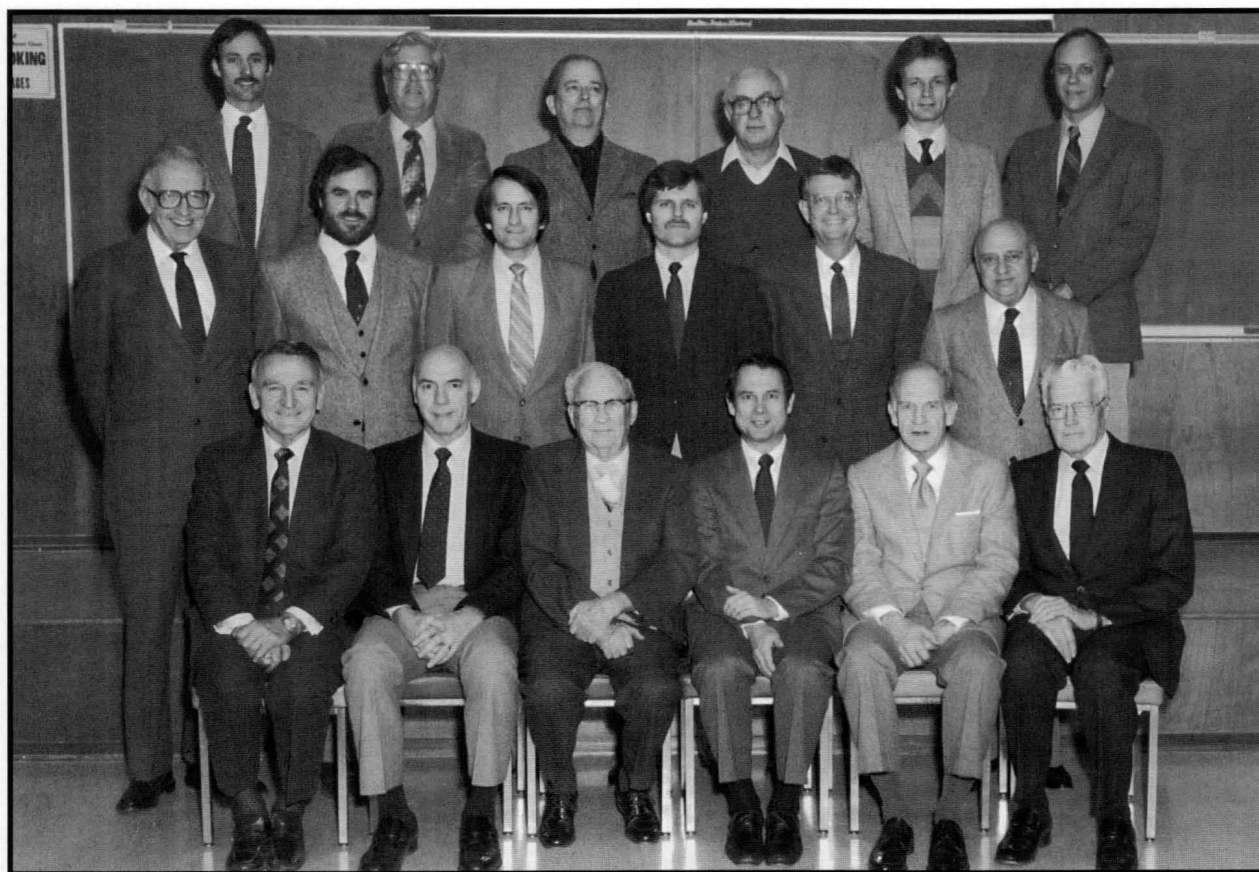
Don's work in polymer blends has led to an important route to new commercial polymer products. His work has integrated thermodynamics, interfacial phenomena, rheology, process, morphology, and properties of these novel materials to provide a solid scientific foundation for this field. Since the late 1940s, numerous papers have suggested that polymer-polymer mixtures were unlikely to be miscible. This belief discouraged and delayed the development of any widespread interest in blends. Indeed, the favorable entropy of mixing for two polymers was known to be very small, if not

entirely negligible. Moreover, the premise at the time was that enthalpic effects were positive and unfavorable for mixing.

Don was a pioneer in focusing attention on polymer-polymer interactions as the key to developing miscible blends. He and his colleague, Joel Barlow, published an important paper showing that intramolecular repulsive interactions in random copolymers can provide the basis for exothermic mixing, thereby promoting miscibility with other polymers. This effect meant that such random copolymers could form miscible blends, even when the corresponding homopolymers could not. This non-intuitive concept was simultaneously recognized by two other groups and is now a cornerstone of polymer-blend technology.

In 1992, Don and his students initiated a series of papers that combined this copolymer model with a modern equation-of-state theory of mixing. Their work allowed a matrix of interaction energies to be constructed to predict the miscibility of multiple polymers and to design copolymers for controlled phase behavior in blends.

This work is also useful for understanding and designing



UT's chemical engineering faculty at the time of Don's Chairmanship in 1984. **Top row:** Keith P. Johnston, E.T. Beynon, James R. Brock, Hugo Steinfink, Douglas R. Lloyd, Joel W. Barlow. **Middle row:** James R. Fair, Thomas F. Edgar, Gary T. Rochelle, John G. Ekerdt, James E. Stice, Herbert Grove. **Seated:** John J. McKetta, Eugene H. Wissler, William A. Cunningham, Donald R. Paul, Howard F. Rase, Joel Hougen. (Missing: David M. Himmelblau, W.J. Koros, R.P. Popovich, and R.S. Schechter)

phase-separated (immiscible) blends in which polymer-polymer interactions are manifested in the nature of the interface between the phases. Don's work in this area has been commercialized through long-standing collaborations with various companies.

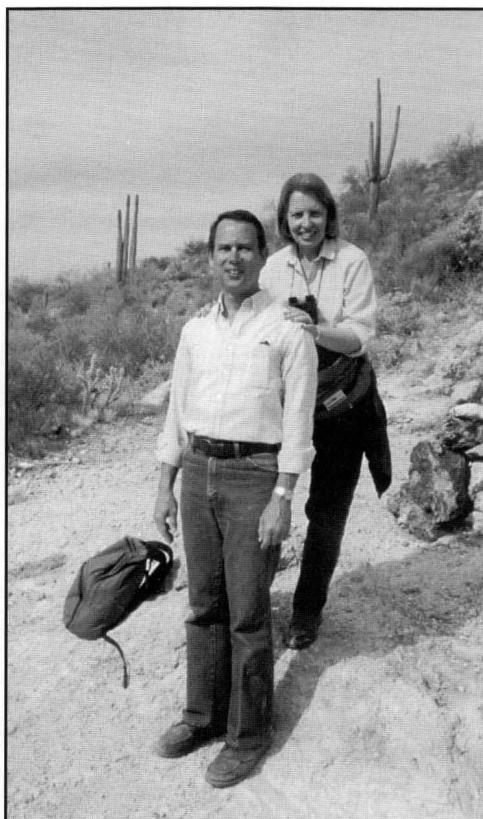
In addition to the enormous amount of work in polymer blends, Don has pioneered the development of membranes. Within his first year as an Assistant Professor at Texas, he published a classic paper regarding the mechanism of hydraulic permeability through membranes. This paper helped call attention to the new program in polymers at UT and launched the membrane activities that have been a strong and continuous component of UT's graduate-studies area for over three decades. Soon after completing this paper on liquid permeation, he published a second classic analysis of membranes—this one related to gas transport in glassy polymers. Don cooperated with the group at Monsanto that developed the first truly commercially successful gas separation membrane system, called "Prism."

Over the intervening years, Don and his co-workers have systematically studied the relationship between polymer structure and the gas permeation properties of novel materials synthesized in their labs. Important principles of molecular design have emerged from his work. These insights have been codified into a group contribution scheme for predicting membrane performance. Several new materials of significant commercial interest have been identified. Moreover, novel processing schemes involving flourination, crosslinking (and of course, blending) of polymers and low-molecular-weight compounds have been studied.

FAMILY

The only commitment that exceeds in length Don's association with the UT department is the one with his extraordinary wife, Sally. Don and Sally met while in graduate school at Wisconsin in 1963. Her disposition and nature caused her to take an interest in children with special needs. Completing her Masters in Speech Therapy meshed well with the timing of Don's completion of his PhD, and they celebrated by getting married in 1964. After locating in Austin, they raised a family that includes Mark, a master pastry chef trained at the James Beard School in New York City, and Ann, who is currently an auditor with the State of Texas.

Over the years, Don and Sally shared another favorite



Don and Sally on a hiking trip.

activity—hiking. In addition to hiking, boating, and other outdoor pursuits, Don has a great love of cooking and a passion for music, especially jazz and blues. His music collection is of such a size that only someone with his organization skill could maintain it in functional form.

In 1995, the saddest event in Don's life removed Sally from him and his children. Her death led to a period of deep mourning that eventually yielded to the tough nature that, as noted in the introduction, is one of Don's signature qualities.

THE RECENT PAST AND THE FUTURE

I recall having lunch with Don eighteen months after Sally's death. He had his old spark back and told me that he wanted to do something significant for the institution that had helped him so much. He said he had been thinking about the lack of a formal Materials Science Department at UT and how this was often cited as a

problem that needed to be dealt with. He said, "I now see this as a possible advantage, rather than a disadvantage, if it is handled properly." He unveiled an idea for a materials institute that would cut across college as well as departmental boundaries.

Don visualized a network of individuals linked together by their common interest in materials and with a core of instruments and facilities in a central institute. His vision quickly spread beyond lunchtime conversation to the offices of deans and the vice president of research. With the valuable support of the administration, Don's concept moved toward reality.

At this point, Don's "take-one-row-at-a-time" approach resurfaced. He made the rounds from the physics department to the chemistry department to the aerospace, chemical, electrical, and mechanical engineering departments, recruiting support at the grass-roots level to match the upper-administration support. In 1998, the Texas Materials Institute became a reality, and Don was inducted as its first director. Under his leadership, materials work is now prospering at UT. New facilities, new positions in various departments, and colleagueships that would probably not have occurred have begun—one row at a time. Our colleagues in the department, in the college, and across the university appreciate and value Don's catalytic contribution in fostering this unusual and valuable addition to our university. We are all indebted to Don for his uniquely broad and deep contributions. □