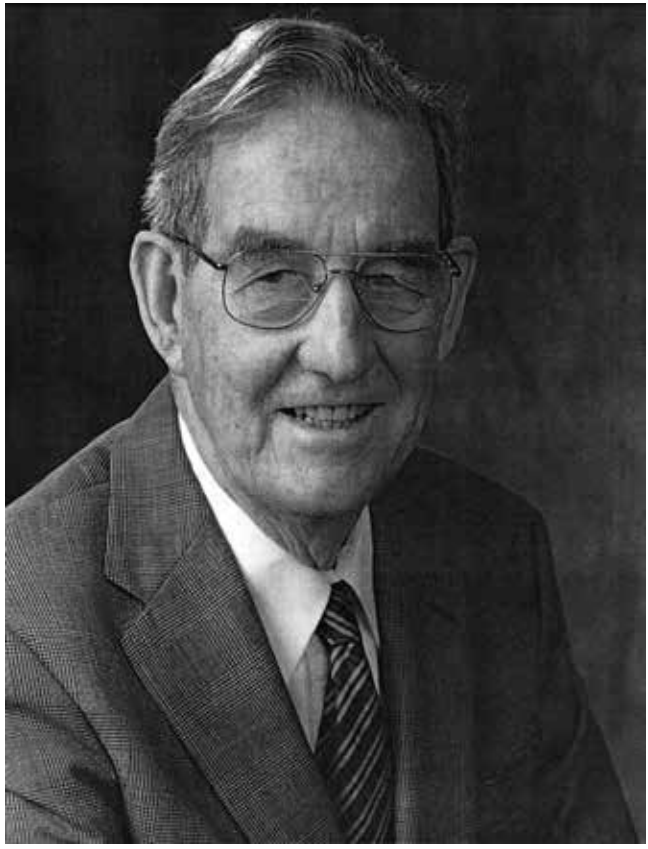

Thomas J. Hannratty

THOMAS J. HANRATTY

1926–2016

Elected in 1974

"Contributions in the analysis and design of turbulent, gas-liquid, and solid-liquid flow systems."

BY RICHARD C. ALKIRE AND WILLIAM R. SCHOWALTER

THOMAS JOSEPH HANRATTY was born in Philadelphia on November 9, 1926, and passed away in Urbana, Illinois, on August 24, 2016, at age 89.

As a student at Southeast Catholic High School in Philadelphia, he was deeply inspired by the Norbertine Fathers, who provided him with a sound foundation for a professional career. He was appointed editor of the school newspaper and yearbook, and had many opportunities for public speaking—he was a member of the debate team and gave the valedictory address at graduation. These activities not only provided skills that he would use throughout his life, but also challenged him to discern essential ideas from a large amount of data.

He graduated from Villanova University in 1947 with a bachelor's degree in chemical engineering and began his engineering career that year at Fischer & Porter Company (Hatboro, PA), where he worked on the metering of complicated fluids. The following year he began taking night courses at the Ohio State University while working at Battelle Memorial Institute, where he became involved in the development of a gas-phase catalytic process for the manufacture of hydrazine rocket fuel. Thus was born a taste for research that he never lost.

After obtaining his master's in chemical engineering at Ohio State, he was admitted to the PhD program at Princeton. By that time, it had been recognized in the field of chemical engineering that the design and operation of a large variety of chemical processes used a relatively small number of "unit operations." When Hanratty arrived at Princeton, the emphasis was shifting to include an engineering science approach that expanded basic knowledge about the principles underlying unit operations. His PhD thesis (1953) on mixing in fluidized beds was part of a pioneering research program on reactor design directed by Richard Wilhelm.

Hanratty joined the faculty of the University of Illinois in 1953, when one of us (WRS) was a first-year graduate student. He made an immediate impact on the graduate student population, both because he was closer in age to the graduate students than to his faculty colleagues and because of his outgoing nature and sincere interest in the students' research. He also took responsibility for departmental courses in fluid mechanics and transport phenomena, and so began a labor of love in teaching chemical engineering students, which continued for more than 50 years.

By 1955 Hanratty had established himself as a contributor to the high reputation of the small but distinguished Department of Chemistry and Chemical Engineering at Illinois. Given his open and engaging style, it was natural for him to create informal study groups that would tackle new concepts across a broad range of fluid mechanics and that drew interested students from several different research groups. At that time, chemical engineering at Illinois had deep roots and emphasis on engineering science.

Hanratty remained at the University of Illinois for the rest of his career. He retired formally in 1997, but continued for nearly 20 more years as emeritus professor with an active research program and interaction with colleagues. In 2013 he authored the textbook *Physics of Gas-Liquid Flows*, published by Cambridge University Press.

A hallmark of his work is the breadth of his interests, which spanned wave generation, gas-liquid flows, suspension flows,

electrochemical diagnostics, structure of turbulence, drag reduction, modification of turbulence by imposed spatial and temporal oscillations, reactor design, turbulent mass/heat transfer gas transfer at an interface, and wavelike dissolution patterns.

Hanratty recognized that progress in describing industrially important two-phase flows was impeded by poor understanding of small-scale interactions. This led to pioneering studies of waves caused by air flow, of particle behavior in turbulence, and of concentration fields very close to an interface. Recognition of the importance of interfacial instabilities led to new understanding of wave generation and to how gas/liquid phases distribute in a pipeline. These efforts provided a scientific basis for describing the behavior of gas-liquid flows. His use of these basic studies to provide a phenomenological understanding of industrial problems established him as a leader in obtaining new predictive methods.

In addition, he invented electrochemical methods that enabled measurements of velocity and scalar fields closer to a solid boundary than was possible by other techniques. He used the electrochemical methods to study local and fluctuating mass transfer rates to a surface in contact with a turbulent field, and found that the fluctuations had length scales similar to the velocity gradient at the wall, but frequencies an order of magnitude smaller. The resolution of this apparent paradox produced major contributions to the field of turbulent mass transfer.

Also noteworthy was his use of these experimental techniques, along with computer simulations, to define the relation of turbulence production to vortex structures close to a wall, and to show how the vortices reproduce themselves. In addition, he showed how turbulence can be changed by imposed temporal oscillations, imposed spatial oscillations, and drag-reducing polymers.

In another happy coincidence, I (WRS) had the opportunity to again observe Hanratty at close range near the time of his formal retirement. I returned to Illinois in 1989 (after a process begun by Hanratty) as dean of the College of Engineering with

a faculty appointment in Chemical Engineering. My postdoctoral research group benefited enormously from association with Hanratty's research group, leading to an opportunity to publish papers coauthored with Hanratty and his students.

During his long career at Illinois, Hanratty advised a great number of graduate and undergraduate students, directing 77 PhD theses, 78 MS theses, 47 BS theses, and numerous senior research projects. His research with colleagues and students resulted in 256 scholarly publications. He also served as associate editor of the *International Journal of Multiphase Flows*.

In addition to the NAE, he was elected to the National Academy of Sciences and American Academy of Arts and Sciences. And his research was recognized by numerous awards: The American Institute of Chemical Engineers honored him with the Colburn Award (1957), Walker Award (1961), Professional Progress Award (1967), and Ernest Thiele Award (1986); and from the American Society for Engineering Education he received the Curtis McGraw Research Award (1963) and General Electric Senior Research Award (1979). He was selected for the inaugural Multiphase Flow International Prize (1998), and received honorary doctoral degrees from l'Institut National Polytechnique de Toulouse and Villanova University. He was named one of the most influential chemical engineers in the modern era (post–World War II) at the AIChE Centennial Celebration (2008).

Hanratty was survived by his wife, Joan (née Hertel); children John, Vincent, Maria, Michael, and Peter; grandchildren Monica, Kody, and Liam Hanratty; and his brother Joseph.