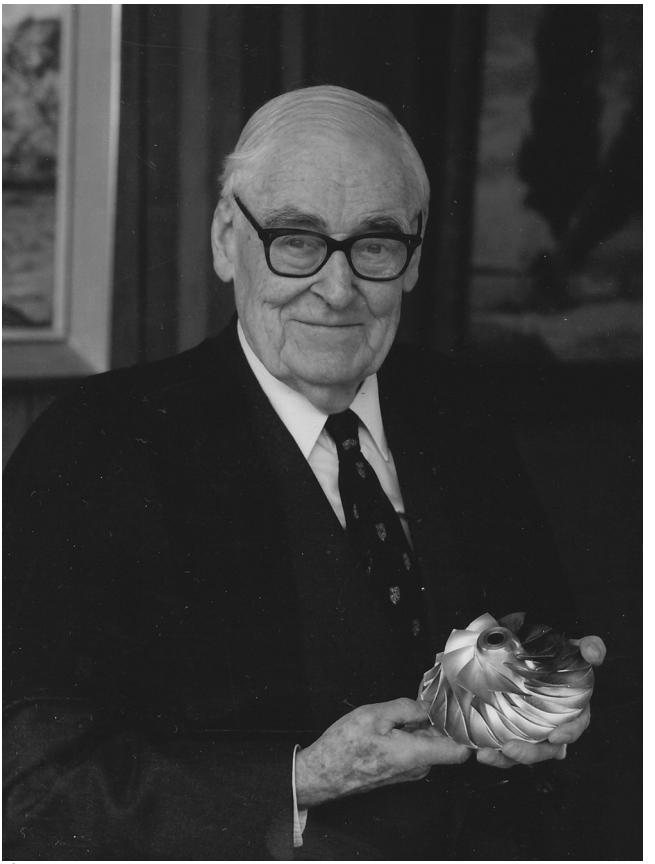

Photo courtesy of Julia Hedgecoe

William R. Hawthorne

SIR WILLIAM REDE HAWTHORNE

1913–2011

Elected in 1976

"For pioneering contributions in the understanding of fluid dynamics and thermodynamics and their applications in mechanical engineering, particularly jet engines."

BY EDWARD M. GREITZER AND JOHN H. HORLOCK

SIR WILLIAM HAWTHORNE, a pioneer in the aerodynamics and thermodynamics of gas turbine engines, and a sought-after technology advisor and consultant to industry and government, died in Cambridge, England, on September 16, 2011.

Will was born in Benton, England, near Newcastle-on-Tyne, May 22, 1913. His father was a consulting civil engineer, his mother one of the first women graduates in biology of the University of Glasgow. His family moved to London soon thereafter, and he was educated at Dragon School in Oxford and at Westminster School, where he rowed and also acted.

He won an exhibition to Trinity College, Cambridge, in 1931, where he read mathematics before moving to mechanical sciences, receiving double firsts at graduation. He took a particular interest in thermodynamics, winning the Ricardo Prize in that subject and sharing the Rex Moir Prize awarded to the best student in the Mechanical Sciences Tripos. He also rowed for Trinity and joined the Pentacle Club (conjurers), appearing in their London revue with his sleight-of-hand show; he maintained a lifelong love of conjuring. After leaving Cambridge, he worked as a graduate apprentice at Babcock & Wilcox in Renfrew.

In 1935 Hawthorne received a Commonwealth Fellowship to attend MIT, where he joined the chemical engineering department, working with Professor H.C. Hottel. His doctoral research was in combustion, in particular the influence of turbulence on flame length, showing that the rate at which oxygen mixes with fuel controls the length of the flame. It was this work for his ScD that would enable him to help Sir Frank Whittle later in the development of the first jet engines.

Hawthorne left MIT to take a position as a development engineer at Babcock & Wilcox, studying boiler and furnace design issues, but he returned to Cambridge, Massachusetts, in April 1939 to receive his degree and to marry Barbara Runkle, granddaughter of the second president of MIT. After the outbreak of war, Barbara came back to the US, where their son was born.

Hawthorne was posted as a scientific officer at the Royal Aircraft Establishment in 1940 when, as he said, he was "loaned" to Frank Whittle to help with the development of the jet engine. Hawthorne's insight was critical to solving the severe combustion problems that plagued the Whittle jet engine in 1940–41. The prototype engines, constructed in great secrecy with the personal support of Winston Churchill, could not be made to run smoothly because of instability in the combustion processes. Hawthorne realized that the answer lay in his thesis work on the mixture of fuel and air in flames and found a way to spray the fuel into fast-moving compressed air so that combustion took place reliably. By January 1941, the engine could run for long periods and the first successful flight took place on May 15, 1941. Hawthorne then became head of the newly formed Gas Turbine Division at the Royal Aircraft Establishment until 1944, when he was sent to the British Air Commission, Washington, with responsibility for technology transfer. He subsequently became deputy director of engine research in Britain's Ministry of Supply. For his wartime work he was awarded the US Medal of Freedom in 1947.

In 1946, Hawthorne became associate professor of mechanical engineering at MIT, where he was promoted soon after to George Westinghouse Professor of Mechanical

Engineering. At the MIT Gas Turbine Laboratory, in addition to his interest in, and exposition of, gas turbine thermodynamics, he began research on the fluid mechanics of turbomachinery, which was to remain a primary interest. This latter included his path-breaking research on secondary flow (a type of fluid motion often manifested as a flow swirling about the mainstream primary flow) in turbomachinery and many other fluid machinery applications. His work laid the conceptual foundation for current thinking about this important topic. His two daughters were born during the period he spent on the MIT faculty.

In 1951 Hawthorne returned to England when he was elected the first holder of the Hopkinson and ICI Chair of Applied Thermodynamics at Cambridge University, a post he held until 1980. He also became a fellow of Trinity College. But even while a full-time member of the Cambridge faculty, his relationship with MIT continued, as he became the first Jerome C. Hunsaker Visiting Professor of Aeronautical Engineering in 1955–56, a Visiting Institute Professor (MIT's highest professorial rank) in 1962, and a member of the MIT Corporation from 1969 to 1974. Further, these were not the only connections, because he was able to maintain ongoing and active collaborations with faculty and students at both universities. It is a pleasure to report that the technical and intellectual transatlantic linkages he created and fostered are still in place and the collaboration still vigorous.

Another of Hawthorne's interests developed as the Suez crisis unfolded in the 1950s. The oil tanker shortage that followed closure of the Suez Canal in 1956 encouraged Hawthorne to conceive and develop an alternative transport system. The "Dracone" project, as it was called, proposed flexible barges—long, sausage-shaped tubes that could be filled with fuel and towed, then collapsed after each delivery and returned for refill, even by air. The first Dracones snaked uncontrollably from side to side, but with intensive research and testing the problem was addressed and the motion made stable. The problem of finding sufficiently strong and flexible fabrics was also resolved. For Hawthorne, and many of his

students, the Dracone was a major development project. The Suez crisis ended before development was completed but Dracones were subsequently used for short-distance transport of fresh water and fuels to areas without port facilities, for military purposes, and in the cleanup of oil and effluent spills.

Hawthorne had great ability to see immediately where the root of an engineering problem lay and to visualize its solution, often in elegantly simple mathematical terms. He applied these skills with much success to understand the intricacies of the three-dimensional kinematics that are inherent in secondary flow. In this he was undoubtedly aided by his extraordinary ability to write original vector analysis of a particularly complex fluid flow as if he were writing a letter.

In 1968 Hawthorne was named Master of Churchill College, a new college at Cambridge University focusing on scientific and engineering studies, created, with substantial support from Commonwealth countries and from the United States, as a memorial to Sir Winston Churchill.

In addition to his many professional activities, Hawthorne was active and popular, known for his support for the rowing club and musical activities, and as a gracious host for the many visiting scholars. The Churchill Archives Centre, which he was instrumental in creating, now houses the papers of Winston Churchill, Margaret Thatcher, and many other distinguished political and military personalities. Hawthorne remained Master until 1983.

In parallel with his mastership, Hawthorne was head of the Engineering Department at Cambridge from 1968 to 1973. During this time he kept his research work going, and he and one of us (JHH) established the new Turbomachinery Laboratory, now known as the Whittle Laboratory.

During his career Hawthorne was sought after as an advisor to the British and American governments on a broad range of defense, energy, and security questions. Of these, we will mention only his chairmanship of the Home Office Scientific Advisory Council, in which he was active for almost a decade. He was made Commander of the Order of the British Empire in 1959 and knighted in 1970 for "services to

thermodynamics," a citation that greatly pleased him. In this regard, he has been described as "the first knight of the Second Law of Thermodynamics."

Hawthorne received a number of further honors and awards for his work. He was elected Fellow of the Royal Society in 1955, of which he was vice president in 1969–70 and 1979–81 and from which he received a Royal Medal in 1986. As vice president he led the first Royal Society visit to postwar China, during which he entertained the staff and passengers of the train he was travelling on with a magic show. He was elected foreign associate of both the National Academy of Sciences (1965) and the National Academy of Engineering (1976), honorary fellow of several professional societies including the American Institute of Aeronautics and Astronautics and the Royal Aeronautical Society, honorary member of ASME, and fellow of the Royal Academy of Engineering. He was the recipient of six honorary degrees.

In the context of US industry, Will had a long relationship with the Cummins Engine Company in Indiana. He was a director from 1974 to 1986 and carried out research on turbochargers, with Cummins and its British subsidiary, Holset, until the age of 85. He is credited with giving technology and research a more significant role in the company. He was also a long-time consultant to Pratt and Whitney, the jet engine manufacturer, helping to shape the direction of its early work on three-dimensional compressor flows.

Hawthorne was a genius of originality in a variety of fields in mechanical engineering, producing many major papers, each beautifully written. In a way one of us (JHH) became his scribe, writing a textbook on actuator disc theory in 1978 and, in 2003, another book on gas turbine cycles, based partly on the brilliant course first given by Hawthorne at MIT and dedicated to him.

Hawthorne's hobbies included cookery, theater, and conjuring. In connection with the last of these he was a member of the Cambridge University conjuring club as an undergraduate and its president for 20 years, and he celebrated his 70th and 80th birthdays with conjuring shows

on both sides of the Atlantic. A high point of the latter was his demonstration of sawing a young woman in half and then joining her together again, a feat reported as the most ambitious and spectacularly successful postprandial talk ever held in Churchill College's Senior Combination Room. Another hobby lay in his appreciation of science fiction, starting as a young admirer of the works of H.G. Wells. For many years he was a subscriber to *Astounding Science Fiction* magazine, and he would reflect with colleagues on the feasibility of some of the ideas advanced therein.

Sir William's colleagues particularly remember him as a generous and enthusiastic teacher who encouraged others to excel, and as an engineer committed to his profession, imbued with a strong sense of duty and the belief that engineering could contribute to solving important problems facing humankind. They also recall his continuing interest, even in old age, in the institutions he served, and in new developments, ideas, and issues.

His wife, Barbara, was a graduate of Radcliffe College. She died in 1992. They are survived by their children Alexander, Joanna Amick, and Elizabeth O'Beirne-Ranelagh, and grandchildren Alexandra Amick Vrazo and Charles Amick.