the field, resulting in beautiful developments that are at the centre of contemporary mathematics, with deep connections . . . to all major branches of mathematics of the last sixty years."

Robert Bryant
Duke University
Durham, North Carolina
Dan Freed
University of Texas at Austin

Frederick Hendrick Fisher

Frederick Hendrick Fisher, an ingenious experimentalist in ocean acoustics, died unexpectedly on 4 May 2005 in San Diego, California, following a stroke. From laboratory studies of sound absorption to at-sea observations of the details of sound propagation, Fred had made notable contributions to our understanding of underwater acoustics.

Fred was born in Aberdeen, Washington, on 30 December 1926. After graduating from high school, he joined the US Naval Reserve and was admitted to the US Naval Academy in 1945. In 1946 he transferred to the University of Washington, where he received his AB in physics in 1949. Continuing as a graduate student at UW, he became interested in physical acoustics, which had become an active field of research after World War II. During the war, the absorption of sound in seawater was found to be considerably greater than expected; in the late 1940s, physicists at UCLA and at the university's Marine Physical Laboratory (MPL, now part of the Scripps Institution of Oceanography) in San Diego had isolated the presence of magnesium sulfate as the cause. Eager to understand the details of this phenomenon, Fred joined Leonard Liebermann's research group at MPL in 1955. Fred devised methods for studying the properties of magnesium sulfate solutions at high pressure and completed his University of Washington PhD in physics in 1957 under Liebermann's supervision.

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Frederick Hendrick Fisher

Following a year as a research fellow with Frederick (Ted) Hunt's underwater acoustics group at Harvard University and chemist Benton Owen at Yale University, Fred joined the MPL research staff. In addition to continuing his laboratory research on magnesium sulfate, he began investigating sound propagation at sea—in particular, the accuracy with which sound could be used to determine the direction to a distant target. After conducting initial experiments using a US Navy submarine, he realized that a special platform would be required to support this work. Discussions of how best to make the necessary measurements led Fred and one of us (Spiess), stimulated by a comment by Woods Hole Oceanographic Institution's Allyn Vine about turning a submarine on end, to the concept of the floating instrument platform (FLIP)—a manned craft 110 meters long that could easily be towed to an open ocean research site where tanks could be flooded and the ship upended to provide a research platform with 90-meter draft. The platform is not only very stable relative to ocean surface waves, but its underwater structure allows hydrophones and other sensors to be mounted at positions accurately known in relation to the exposed, above-water laboratory structure.

Bringing the FLIP concept to reality involved a number of challenges; two in particular resulted in new approaches. First was the concept of shaping the hull to minimize heave response. Philip Rudnick did the theoretical design and Fred, in parallel, did tank experiments with models. The more challenging aspect was understanding the dynamics of flipping from horizontal to vertical and back again. Fred took this on and, with the MPL shop, built a variety of 10-meter-long models and flipped them in San Diego Bay. This fun learning period had the eventual payoff of translating the models, with the help of naval architect Lawrence Glosten, into the full-size version, which flipped for the first time in Puget Sound in 1962.

In addition to supporting Fred's research for more than three decades, FLIP was and is still used today by other acousticians, physical oceanographers, and atmospheric scientists. After carrying out the bearing-accuracy experiments that were the original goal (and that motivated the US Navy to fund the construction), Fred devised vertical hydrophone arrays that capitalized on FLIP's stability and could be deployed below to study the vertical directionality of ambient noise and to sample the entire water column for studying sound transmission.

For Fred and others, FLIP's stability at sea provided a personal advantage. Fred's seasickness was substantially mitigated once FLIP was vertical and it was time to deploy equipment and collect data.

Fred was not only an ingenious experimentalist in the laboratory and at sea, but he also enjoyed being with people and helping them work together. He was an outstanding tennis competitor, and shared the NCAA doubles championship in 1949 while at the University of Washington.

A central figure in the underwater acoustics community, Fred served in many roles, including president of the Acoustical Society of America (ASA) in 1983–84. Most recently, Fred was involved in a rather complex effort to declassify and ultimately publish scientific documents produced during the cold war that were related to the US Navy's fundamental efforts in undersea warfare.

We will all recall his many contributions to our understanding of ocean acoustics but, even more, his cheerful, friendly approach to life—embodied in his ever-present garish aloha shirts. Fittingly, ASA will honor his memory at its 2006 meeting in Hawaii where all his friends and colleagues can pay tribute and say, "Aloha, Fred."

William Kuperman
Fred Spiess
University of California, San Diego

Paul Aveling Redhead

Paul Aveling Redhead, one of the founders of vacuum technology and surface science, died on 9 July 2005 in Ottawa, Canada, after a long battle with heart disease.

Born on 25 May 1924 in Brighton, England, Paul received his BA from Cambridge University in 1944 and joined the British Department of Naval Ordnance, where he worked on tubes for microwaves and proximity fuses. After World War II, he undertook research on experimental vacuum tubes for the Services Electronics Research Laboratories. He was awarded an MA from Cambridge in 1948 for that work; in 1969 he re-

NRC

Paul Aveling Redhead

ceived his PhD from Cambridge.

In 1947 Paul joined the division of radio and electrical engineering of the National Research Council of Canada in Ottawa to develop key radar components. Until 1970 he led a distinguished team at NRC in establishing the methods and basis of both ultrahigh vacuum technology—which was to have such impact in many areas, including particle accelerators—and the field of surface science. After a three-year stint in research planning for NRC, he became director of the division of physics in 1973. He believed that the management of science was an important responsibility of scientists. In his last three years at NRC before retirement, he was a key member and secretary of the science and technology policy committee. He also served for many years on the NRC management committee, its tactical committee, the advisory board of TRIUMF, and the advisory committee for fusion-related research. He officially retired from NRC in 1986 but continued to work from an office there.

Paul will be remembered for his groundbreaking research in the generation, measurement, and utilization of ultrahigh vacuum, research that paved the way for many other developments in surface science. With NRC colleagues Peter Hobson and Ernie Kornelsen, he coauthored the classic book *The Physical Basis of Ultrahigh Vacuum* (Chapman and Hall, 1968), the defining book in that field. He developed the magnetron gauge for reliable measurement down to pressures of 10^{-14} torr, and one version of that gauge went to the Moon in the Apollo missions. He also developed thermal desorption spectroscopy and laid the foundation for electron stimulated desorption. In 1975, he received the American Vacuum Society's Medard W. Welch Award "in recognition of outstanding current research in the fields of vacuum science and technology, vacuum metallurgy, thin films, and surface science." He also received the Queen Elizabeth Jubilee Award in 1977 and the Medal for Lifetime Achievement in Physics in 1989, both from the Canadian Association of Physicists.

Paul served as president of AVS in 1967–68 and as editor of the *Journal of Vacuum Science and Technology* from 1970 to 1975. In 1970, he was awarded honorary membership in AVS. He continued to serve the society in many roles, including as both editor and author in recording historical events that he considered important: *Vacuum Science and Technology: Pioneers of the 20th Century* (AIP, 1994), *History of the American Vacuum Society 1953–1994* (AVS, 1995), and *50 Years of Science, Technology, and the AVS (1953–2003)*, a special issue of the *Journal of Vacuum Science and Technology A*, 2003.

The depth of the impact that Paul had over his career is so remarkable that he has left a tangible imprint on a wide range of scientific and technical endeavors involving the use and understanding of high vacuum. There are entire fields of science and generations of scientists that are dependent on Paul's contributions to the technology of making high vacuum in the laboratory.

During his prolific career as a scientist, technical manager, and historian, Paul had the opportunity to be a mentor for many of his colleagues. We count ourselves privileged members of that group because we had the opportunity to learn from him as our paths crossed in various conferences, committees, collaborations, coauthored papers, and unforgettable chats over a glass of beer. We were very fortunate to have Paul join us in a celebration of his contributions to our scientific community in a special "Symposium to Honor Paul Redhead" organized for the annual AVS symposium in October 2000. He agreed to that celebration if we promised to avoid anything that bordered on being pompous. We could never be pompous when talking about Paul—only grateful.

Fred Dylla
Thomas Jefferson National Accelerator Facility
Newport News, Virginia
Bill Westwood
Ottawa, Canada