ACOUSTICAL SOCIETY OF AMERICA

GOLD MEDAL

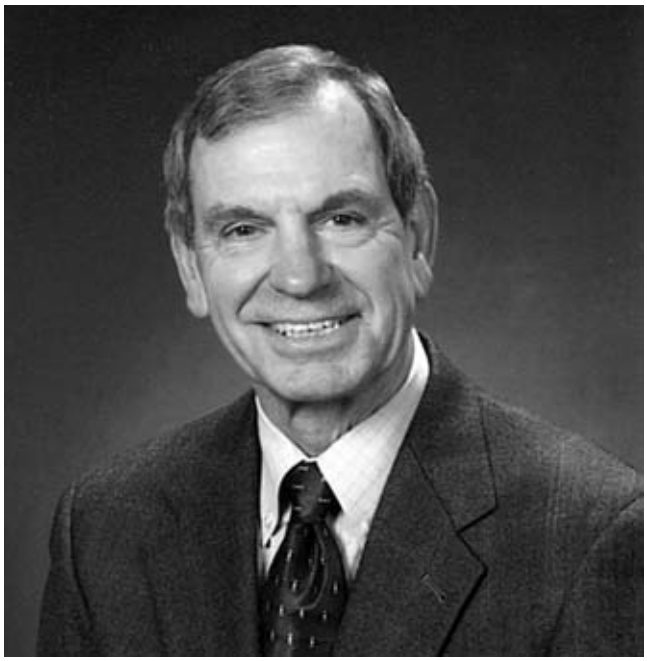
Lawrence A. Crum

2013

The Gold Medal is presented in the spring to a member of the Society, without age limitation, for contributions to acoustics. The first Gold Medal was presented in 1954 on the occasion of the Society's Twenty-Fifth Anniversary Celebration and biennially until 1981. It is now an annual award.

PREVIOUS RECIPIENTS

Wallace Waterfall	1954
Floyd A. Firestone	1955
Harvey Fletcher	1957
Edward C. Wente	1959
Georg von Békésy	1961
R. Bruce Lindsay	1963
Hallowell Davis	1965
Vern O. Knudsen	1967
Frederick V. Hunt	1969
Warren P. Mason	1971
Philip M. Morse	1973
Leo L. Beranek	1975
Raymond W. B. Stephens	1977
Richard H. Bolt	1979
Harry F. Olson	1981
Isadore Rudnick	1982
Martin Greenspan	1983
Robert T. Beyer	1984
Laurence Batchelder	1985
James L. Flanagan	1986
Cyril M. Harris	1987
Arthur H. Benade	1988
Richard K. Cook	1988
Lothar W. Cremer	1989
Eugen J. Skudrzyk	1990
Manfred R. Schroeder	1991
Ira J. Hirsh	1992
David T. Blackstock	1993
David M. Green	1994
Kenneth N. Stevens	1995
Ira Dyer	1996
K. Uno Ingard	1997
Floyd Dunn	1998
Henning E. von Gierke	1999
Murray Strasberg	2000
Herman Medwin	2001
Robert E. Apfel	2002
Tony F. W. Embleton	2002
Richard H. Lyon	2003
Chester M. McKinney	2004
Allan D. Pierce	2005
James E. West	2006
Katherine S. Harris	2007
Patricia K. Kuhl	2008
Thomas D. Rossing	2009
Jiri Tichy	2010
Eric E. Ungar	2011
William A. Kuperman	2012



CITATION FOR LAWRENCE A. CRUM

. . . for discovery and invention in physical and biomedical acoustics and for leadership in acoustics worldwide.

5 JUNE 2013 • MONTRÉAL, CANADA

Lawrence A. Crum was born on a small subsistence farm in Ohio, the third of five brothers. As is the case with his brothers, Larry is an overachiever and highly competitive. He worked hard to gain acceptance into the US Naval Academy, where he excelled at focus and discipline, two traits that have served him well throughout his career. He also excelled at fencing and was named the National Collegiate Athletic Association (NCAA) national fencing champion (in Èpèe) in 1963, an achievement for which he is very proud.

Larry received his Ph.D. in Physics at Ohio University in 1967 working under Burt Stumpf. As one of only two acoustics graduate students in the Physics Department, he was tasked with writing papers on the top 10 US acousticians of the day, and through this learned of the likes of Robert Beyer, David Blackstock, Floyd Dunn, Frederick Hunt, and Isadore Rudnick. Upon graduating, he wrote each a letter inquiring of postdoc opportunities, to which most replied positively. Larry selected Harvard and spent a thrilling year there working side by side with Tony Eller and Bob Apfel. Larry and Bob became fast personal as well as professional friends, rooming together at ASA meetings for 25 years.

Larry returned to Annapolis to teach, and while there, he continued his pursuit of athletic excellence as a champion fencer with aspirations to join the US Olympic team. Concurrent obligations as a family man kept him from Olympic glory, but his excellent research skills did set the stage for his next adventure – the University of Mississippi (UM). Larry was recruited by Hank Bass, who sought to establish the UM Physics Department as a nationally recognized nexus in the world of physical acoustics. His UM career was punctuated by two signature sabbatical leaves, one in 1978 with Terry Coakley at the University of Wales and the other in 1985 with Mary Dyson *et al.* at Guys Hospital, University of London. The former resulted in the famous "Crum Jet" movie (and ubiquitous photo) of a re-entrant jet traversing a pulsating bubble, while the latter spawned his seminal work on the role of cavitation in shock wave lithotripsy. Soon after he returned from London, Larry teamed with Hank to establish the National Center for Physical Acoustics (NCPA), serving as its second Director (1990-1992).

In 1992, Bob Spindel convinced Larry to forgo the heat and humidity of the south and accept a senior research position at the University of Washington Applied Physics Laboratory (APL), where he went on to develop a multi-faceted and highly successful program incorporating elements of bubble-related physical acoustics, acoustical oceanography, and biomedical ultrasonics. His work on bubble related ocean ambient noise was particularly impactful and led one Office of Naval Research (ONR) program manager to write that Larry's work had inspired a "paradigm shift" in the way the Navy views bubbles. He proved quite skilled at attracting funds to address important problems and fuel translational research, that is, research that facilitates the translation of findings from basic science to practical applications. He secured substantial Defense Advanced Research Projects Agency (DARPA) support for several projects, including the use of high intensity focused ultrasound (HIFU) to control bleeding in a battlefield scenario. With this $10M grant and supplemental support from the University, Larry founded the Center for Industrial and Medical Ultrasound (CIMU), a center devoted to basic and translational research in biomedical ultrasound.

The progression of Larry's scientific career has traversed a variety of fields and disciplines. His early work in bubble dynamics, mass transfer, and radiation stress led to his focus on the physical effects of high-energy cavitation in both the physical and biomedical context. This was followed by the discovery of single-bubble sonoluminescence, his seminal work in bubble-related acoustical oceanography, and his eventual immersion in the exciting new field of HIFU therapy and related applications. His work received substantial exposure. He has authored over 200 peer-reviewed journal publications and 100 conference papers, much of it involving cavitation of one form or another. He has published in *Nature*, *Science*, *Physical Review Letters*, the *Proceedings of the Royal Society of London*, and numerous

other prestigious journals, including 65 papers in the *Journal of the Acoustical Society of America*. The potential implications of sonoluminescence—that a bubble can collapse so violently that atoms can fuse – was even debated on the floor of Congress.

Larry's work in medical ultrasound underscores a key aspect of his personal and professional philosophy—his belief that meaningful research is more than just a quest for knowledge. To make a difference, one must address important problems, and in HIFU he saw a technology that could save lives. His commitment to both performing and promoting translational research has borne fruit, resulting in a heightened awareness of HIFU technology among the academic community, industry, and funding agencies. Groups around the world are now employing HIFU-based techniques to address problems ranging from cancer therapy to bloodless surgery to drug delivery.

Larry's leadership skills, tireless energy, infectious enthusiasm, and affable personality have served him well throughout his career. In addition to helping to establish NCPA and CIMU, he served on the American Institute of Physics Governing Board (1999-02; 2003-08), and countless advisory and organizing committees for national and international meetings. He helped found the International Society for Therapeutic Ultrasound and served as its President from 2009-2012. He was elected President of the World Congress on Ultrasonics (2001), President of the Board of the International Commission for Acoustics (1998), and, most notably, the Vice President and President of the ASA (1995 and 1997, respectively). In his role as an officer of the ASA, Larry's affection for, and synergy with, his good friend Bob Apfel (President, 1994) was most apparent, for they embodied an effective tandem whose impact was greater than the sum of the parts. Notable outcomes include the Society's initial inroads into the world of electronic publishing and a suite of efforts targeted at increasing the Society's international impact and scope.

In spite of a frenetic pace sustained over almost five decades, Larry has devoted time for a rewarding personal and private life with his wife Jane and four children. He is also an insightful and engaged mentor who takes a long-term and personal interest in his students. Larry believes in training students and postdocs in both the art of scholarship and the craft of research programmatics. The result is a family tree populated by a veritable who's who of contemporary physical acoustics and biomedical ultrasound—people known for exemplary scholarship and leadership within the ASA and across the globe. Larry is also a businessman; having started two companies and boasting 14 patents awarded, with over a dozen more pending. He still makes his home in Seattle and continues to work at the Applied Physics Laboratory.

Larry Crum lives and breathes the ASA, a man who sees the Society as an irreplaceable feature in his professional and personal landscape. He idolizes giants from the Society's past while his former students help lead the Society's present. ASA meetings are his home away from home, and he has rarely missed one in the past 40 years. Larry's contributions have been widely recognized by his colleagues in the US and abroad. He was a Fullbright Fellow in 1985, received a *Doctorem Honoris Causa* from the University of Brussels in 1997, was named Honorary Visiting Professor of Chongqing University, Honorary Foreign Professor of Physics at Moscow State University in 2002, and Honorary Visiting Professor at Nanjing University in 2010, and was awarded the Distinguished Service Medal of the Civilian Research and Development Foundation in 2005. In 2009, he was elected to membership in the Danish Academy of Natural Science. Among his most cherished awards are the Helmholtz-Rayleigh Interdisciplinary Silver Medal (2000) and the ASA Student Council Outstanding Mentor Award (2006).

In awarding the Acoustical Society Gold Medal to Larry Crum, we recognize his exceptional contributions to the science and technology of acoustics, his leadership within the ASA and the international scientific community, his vision and commitment to important translational research, and the profound impact he has had on the lives of countless students and colleagues. Not too shabby for a young boy who grew up on a Midwest farm, and liked to play with swords.

THOMAS J. MATULA
RONALD A. ROY
DAVID T. BLACKSTOCK