

● Introduction to the Festschrift for Robert C. Waag

INTRODUCTION TO THE FESTSCHRIFT FOR ROBERT C. WAAG

I am pleased and honored to write this introduction for my colleague and friend, Robert C. Waag. Our careers have paralleled, overlapped, and intersected in various ways over the years. Our relationship goes back to before we even knew each other, having both been born in Pennsylvania (Bob 2 years my elder) and having both attended Cornell University in the Electrical Engineering Department, with Bob receiving his MS degree at the same commencement ceremony where I received a BEE degree. Bob went on to complete a doctoral program there, majoring in communications engineering, while I carried out a 4-year commitment as an officer in the U.S. Navy, fulfilling my commitment in return for the naval scholarship that funded my time at Cornell. After Bob's graduation with a PhD, he served as an officer in the US Air Force. After my tour in the navy, I matriculated in the graduate program in electrical engineering at the University of Rochester. After his tour in the Air Force, Bob arrived there as an assistant professor, the same year that I received my MS degree. During my first two years at Rochester, I found an entrance into medically related research working under Professors Ed Carstensen and Ray Gramiak in the field of sonography. After my graduation with a PhD, my academic career continued for decades at Yale University and Wake Forest University, while Bob's academic career continued at Rochester with a joint appointment in the Department of Radiology in 1973 and promotions to associate professor in 1975, professor in 1985, and the Arthur Gould Yates Professor of Engineering in 1994. During his early years at Rochester, Bob, like me, was introduced to the field of diagnostic ultrasound, which was to be the major field of his academic work for decades to come.

Between Bob's graduation from Cornell and his service in the Air Force, he spent a short period at Sandia Corporation modeling electro-mechanical systems that were experimental generators for ultrahigh (megagauss) magnetic fields. In the Air Force, he received a certificate of merit for an analysis of a new detector for magnetic flux density measurements and a commendation medal for contributions in experimental evaluation of data transmission techniques. Subsequently, Bob received honors from the Radiological Society of North America, National Institutes of Health, National Heart and Lung Institute, World Federation for Ultrasound in Medicine & Biology, Alexander von Humboldt Foundation, Ruhr-Universität Bochum in Germany, University of Paris, Tokyo Institute of Technology, the American Institute of Ultrasound in Medicine, Japan Society of Ultrasonics in Medicine, Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris, Eta Kappa Nu, Tau Beta Pi, Phi Kappa Phi, and Sigma Xi. He has held leadership positions in the American Institute of Ultrasound in Medicine and the Institute of Electrical and Electronics Engineers, has served on the editorial boards of the *Journal of Clinical Ultrasound*, *Journal of Ultrasound in Medicine*, *Journal of Ultrasound in Medicine and Biology*, and *IEEE Transactions on Biomedical Engineering*, and holds two US patents. He co-edited in 1975, with Ray Gramiak, one of the earliest textbooks in the ultrasound field, *Cardiac Ultrasound*. As you would expect, he has produced countless publications, presented many lectures at various meetings, collaborated with several professionals in the field, and guided numerous students.



Robert C. Waag

Professor Waag has been a pioneer in medical ultrasound since his early work in cardiology with Dr. Gramiak. For over 40 years, he has worked at the leading edge of research in medical ultrasound, illuminating areas and opening paths that are original, independent, and mathematically advanced. He has made seminal contributions to the field and our understanding of what is possible in a number of areas, including scattering of ultrasound in biological tissues, Doppler signal processing, ultrasonic tissue characterization, wave propagation in heterogeneous tissue, and aberration correction for imaging systems.

It is hard to overstate Professor Waag's contributions to these topics. At the end of the 1970s there was still great uncertainty over the scale and scope of scattering, absorption, and attenuation in biological tissues. His 1980s papers on scattering convincingly defined the correlation lengths, K-space signatures, and relative effects of density and compressibility and of scattering in tissues. Similarly, in the areas of wave propagation and aberration correction, ultrasound imaging suffers from the degrading effects of heterogeneous tissue. His clever approach was to take MRI images of human tissue and segment them. The different tissue types were assigned realistic acoustic parameters, and these were fed into forward-propagating

models. His movies of wave propagation in these tissues are the most realistic and most illuminating depictions that have ever been produced. When you couple these results with his rigorous mathematical framework for aberration correction and inverse solutions to the imaging problem, the overall accomplishment is without peer. Together, these are truly a “magnum opus” of research, all leading to greatly improved imaging and vastly improved understanding. These singular contributions are worthy of the recognition given to Professor Waag in this Festschrift dedicated to him.

FREDERICK W. KREMKAU
Professor of Radiologic Sciences
Co-Director, Program for Medical Ultrasound
Center for Applied Learning
School of Medicine
Wake Forest University
Winston-Salem, North Carolina
Past President, American Institute of Ultrasound in Medicine
E-mail: fkremkau@wakehealth.edu

<http://dx.doi.org/10.1016/j.ultrasmedbio.2014.02.001>