Roger F. Harrington, 1989 IEEE AP-S Distinguished Achievement Awardee

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***Abstract*—Roger F. Harrington is widely recognized as one of the key figures in electromagnetics of the latter half of the twentieth century. He is most well-known for his development of the Method of Moments (MoM) and for his fundamental and pioneering contributions to computational electromagnetics (CEM). He is also viewed as an outstanding educator in CEM and fundamental electromagnetics owing to his two well-known textbooks and his widely-read papers in these areas. In this presentation, we summarize his many contributions leading to the 1989 IEEE AP-S Distinguished Achievement Award.**

Keywords—method of moments; electromagnetic modeling; computational electromagnetics; history of electromagnetics; electromagnetics education; AP-S distinguished achievement award

I. Introduction

Roger F. Harrington was born December 24, 1925, in Buffalo, NY, USA, and attended public schools there. He entered Syracuse University in 1943 as a student in electrical engineering, his studies being interrupted by World War II in 1944. During the war, he served in the U.S. Navy both as electronics technician and instructor at the U.S. Naval Radio Materiel School, Dearborn, MI. Returning to Syracuse after the war, he received the B.S. and M.S. degrees in electrical engineering in 1948 and 1950, respectively. He remained at Syracuse as an instructor and research assistant from 1948 to 1950, when he began studies at The Ohio State University, receiving the Ph.D. degree there in 1952 under the advisorship of Victor H. Rumsey. Returning to Syracuse University, he served as professor there until 1994. He has held visiting or guest professorships at the University of Illinois (1959–1960), University of California, Berkeley (1964), and the Technical University of Denmark (1969).

Following retirement, Roger served briefly as a visiting Professor at the University of Arizona. He currently resides in Wheaton, IL with his daughter, Judy. In the following, we summarize some of Roger's more important technical contributions and awards.

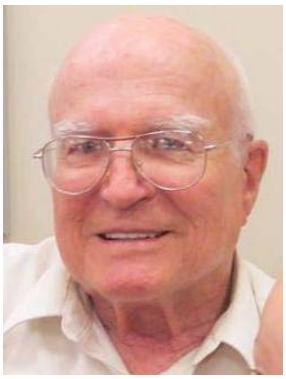

Fig. 1. The 1989 IEEE AP-S Distinguished Achievement Awardee, Roger F. Harrington.

II. Principal Contributions

In 1969, the first author was a graduate student finishing the Ph.D. degree with Raj Mittra at the University of Illinois. Desperate to find results for scattering from a conducting elliptical cylinder to validate their calculations, Raj suggested trying an alternative numerical approach, the so-called moment method, described in Roger's very recent paper and book [1], [2]. They found the method not only provided the required validation, but was more robust and easier to program than previous approaches, including their own. Indeed, Roger's short monograph on the Method of Moments (MoM) (to which the fourth author was a major contributor) permanently and all but completely changed the computational electromagnetics (CEM) landscape. MoM provided an approach for reducing any system of linear operator equations—including Maxwell's equations and equations derived from them—to a matrix system that can

then be solved using computers. While bits and pieces of the method had been tentatively explored in various disciplines, Roger's approach unified and significantly generalized most of the then-current approaches. The need at the time for solutions of antenna and scattering problems suggested the use of integral equation formulations, with their reduced number of degrees of freedom and automatic incorporation of radiation conditions. Even today, MoM remains most often associated with integral equation formulations, though the method applies to any linear operator equation, including PDEs. After the initial MoM publications, as the write-up for Roger's 2015 Benjamin Franklin Medal states, "he proceeded to extend and expand his techniques in a series of papers during the next decade and beyond. With the new mathematical techniques that Harrington pioneered, coupled with the ever increasing power of computers, engineers were able to model, simulate, and effectively design antennas of great complexity and types for everything from stealth aircraft to smart phones."

The method of moments is one of several areas of CEM in which Roger was able to visualize the importance of a nascent idea, to generalize it, put it on a sound mathematical footing, and finally to explain it sufficiently clearly and succinctly that engineers and researchers could use the results for practical calculations. Other examples of Roger's apparent "clairvoyance" include his work on bodies of revolution [3], his expositions on combined field equations [4], integral formulations for dielectric scattering, theory of characteristic modes [5], wire-to-surface junction modeling, and low-frequency integral equation treatments. His methods are still widely used, are incorporated in much of the commercial CEM software available today, and have an almost-infinite range of applications, including the following:

- Electrostatic problems
- Antennas and scatterers
- Scattering and radiation from 2-D and 3-D bodies of arbitrary shape
- Waveguide problems
- Aperture problems [6]
- Bioelectromagnetic problems
- Integrated circuits
- Nanomaterial and meta-materials

Roger has also been one of the profession's most influential educators. He published his first textbook in 1958, a book aimed at undergraduate and first year graduate students; it was unique in developing electromagnetic theory from students' knowledge of circuit theory. His two most popular books, *Time-Harmonic Electromagnetic Fields* (1961) [7] and *Field Computation by Moment Methods* (1968) [2], remain in print through IEEE press and together have amassed over a century of service as texts or references for thousands of graduate students and researchers, many of whom have had notable careers themselves. Roger was also extremely active in offering special and short courses around the world, including at the Universities of California, Mississippi, Southern California, Illinois, and Arizona in the USA, the Technical University of Denmark, the Universities of Naples and Trondheim in Europe, and the East China Normal University.

III. Awards

Roger has received numerous awards in addition to several local and national best paper awards. A summary of his principal awards and honors follows:

- IEEE Fellow Award, 1968
- Fulbright Lecturer, Technical University of Denmark, 1969
- Distinguished Alumni Award, The Ohio State University, 1970
- Syracuse Sigma Xi Research Award, 1971
- Visiting Scientist, Yugoslavian Academies of Science, 1972
- Distinguished Lecturer, IEEE Antennas and Propagation Group, 1973–1975
- IEEE Syracuse Section, Kurt Schlesinger Award, 1981
- IEEE Centennial Medal, 1984
- IEEE Antennas and Propagation Society Distinguished Achievement Award, 1989
- URSI Van der Pol Medal, 1996
- Nikola Tesla Foundation, Jubilee Tesla Medal, 1998
- IEEE Electromagnetics Field Award, 2000
- IEEE Third Millennium Medal, 2000
- Benjamin Franklin Medal in Electrical Engineering, 2015

The 1989 IEEE AP-S Distinguished Achievement Award was for his development of the method of moments, for his numerous advances in electromagnetic theory, and for his books and papers enabling so many students, researchers, and engineers to enhance their understanding of electromagnetic theory and its applications. Roger and Raj Mittra were also instrumental in establishing the IEEE AP-S Harrington-Mittra Award in Computational Electromagnetics, first awarded in 2014.

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