

# IEEE Information Theory Society Newsletter



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## Obituary for William Lucas Root, 1919-2007

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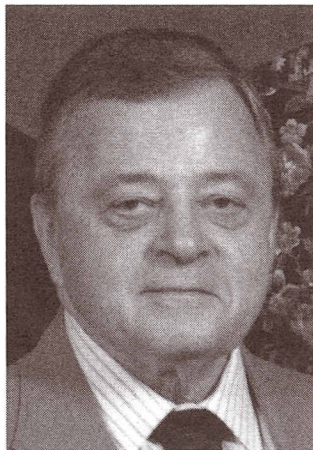
With great sadness we report the death of our friend and colleague, Bill Root, at the age of 87. As an early pioneer in Statistical Communication and Information Theory, Bill transformed the very landscape of the then nascent discipline.

To fully appreciate the impact of Bill Root's early work on statistical communication theory, we need to understand the state of the discipline in the early 1950s. There was no organized curriculum in the area, and the then limited research was carried out by electrical engineers, physicists and mathematicians who were self-taught. Consequently, the theoretical literature consisted of assertions or "theorems" that were vaguely stated, based on unspecified hypotheses, and "proved" by plausibility arguments. Most researchers were oblivious to such tools we now consider standard: probability measures and structures, ergodicity properties, integration theory (e.g. convergence modes and Fubini's theorem), functional analysis (e.g., Hilbert and Banach spaces), properly applied central limit theorems, spectral representations, etc.

Bill Root was instrumental in placing statistical communication theory on a sound mathematical basis. Two publications were especially influential. The first, affectionately known as "Davenport and Root,"<sup>1</sup> is a text introducing seniors and beginning graduate students to the analytical basis of the analysis of signals and systems in the presence of noise. Published in 1958, it was enthusiastically adopted everywhere, and was accepted as the standard text for approximately the next twenty years. Because it introduced most students to this area, the text had tremendous influence in determining the cultural setting of the discipline.

The book provides the student with a sound background in probability theory as a basis of the statistical analysis of signals and systems. Although the mathematical sophistication is consistent with its intended audience, the rigor and accuracy of its approach far exceeded previously existing teaching materials.

The second publication setting the standard for an understanding of the mathematical basis of parameter estimation and detection of signals in noise is another classic, namely the epochal paper generally referred to as "Kelly, Reed and Root,"



which appeared in 1960. An interesting fact illustrating the state of the discipline at that time is that it was rejected by the *IEEE Transactions on Information Theory* as being "too mathematical."<sup>2</sup> Although the methodology and standard of rigor of this work have been well established since, they were innovative and standard setting in their time.

The first part<sup>3</sup> applies likelihood testing to various models of a radar signal in gaussian noise with an absolute continuous spectrum. The interest here lies in the use of the Karhunen-Loeve expansion to represent the noise as a convergent in mean sum of mutually independent random variables. The idea, which was novel at the time, was presented

in a rigorous fashion that was far beyond the customary fashion.

The continuation<sup>4</sup> employs similar methodology to discuss the maximum likelihood estimates of signal parameters, again using statistical decision theory in conjunction with Karhunen-Loeve like expansions. Some special cases are considered, and the structure of the solutions elucidated. As in the first part, the emphasis is on analytical results attained through rigorous mathematical techniques.

His interest in signal detection and information extraction continued with research on applying game theory to develop maximin receivers (1961), studying singular Gaussian measures (1963) and stability issues in detection problems (1964). He continued his collaboration with E. Kelly investigating the sensitivity of radiometric measurements (1963). Later (1968), he developed channel capacity formulas and coding for Gaussian and nonprobabilistic channels. In 1976, he began research on characterizing complex systems in input-output terms, involving abstract spaces and developing function-analytic tools for this purpose. All these investigations involved important problems that were resolved with the precision and rigor that characterized his research and teaching throughout his career.

William Lucas Root was born in Iowa in 1919. In 1940, he graduated from Iowa State University with distinction as a top student in Electrical Engineering. He then went on to

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# Obituary for William Lucas Root *continued from page 1*

MIT, where he earned the master's degree in Electrical Engineering in 1943. His further education was interrupted by World War II; he served as a Marine officer until the end of the war. Returning to MIT, he earned the doctorate in mathematics in 1952.

Upon receiving his doctorate, Bill joined the Analysis Group at Lincoln Laboratories, becoming its head in the period 1959-1961. It was during his stay at Lincoln Laboratory that Bill first became involved in the statistical analysis of radar signals.

In 1962, and until his retirement in 1987, Bill was Professor of Aerospace Engineering at the University of Michigan. However, his reputation as a leading researcher brought him many invitations to teach and do research elsewhere; he served in Visiting Professor capacity at the University of California at Berkeley and Michigan State University, and as a Visiting Scholar at Cambridge University and the Mathematics Research Center at the University of Wisconsin.

In recognition of his research, Bill was made a Fellow of the IEEE in 1965. He was further recognized as a National Science Foundation Senior Postdoctoral Fellow (1970). In 1986, as Shannon Lecturer, he received the highest honor bestowed by the *IEEE Professional Group on Information Theory*; at the time, he was cited for "...consistent and profound contributions to the field of information theory."<sup>5</sup>

Bill Root was widely admired by his colleagues, not only for research prowess, but for his sterling personal qualities. He combined a dry wit with an unusually modest and humble demeanor. His integrity was legendary; he refused to present results that were not rigorously stated and proved. On at least one occasion, he withdrew a paper that had already been accepted, on the grounds

that he felt that the results therein were not sufficiently important.

As a research advisor for doctoral students, he motivated his doctoral students to meet his high standards and continually extend their horizons. As a classroom teacher, he was simply superb—direct and clear, demanding yet at an appropriate student level. Many of his classroom students volunteered that he was the "best teacher they ever had."

Professor Root was the organizer and first chairman of the graduate program in computer, information, and control engineering at the University of Michigan, which for many years was renowned for the distinction of its faculty and students. He treated colleagues and students alike, demanding from them integrity, high standards, precision in research, and a little bit of humility. He did this with his easy manner and good humor.

Bill will be missed by all those who had the good fortune to interact with him.

<sup>1</sup> W. Davenport and W.L. Root, *An Introduction to the Theory of Random Signals and Noise*, McGraw-Hill, New York (1958)

<sup>2</sup> Personal communication by William L. Root

<sup>3</sup> K.J. Kelly, L.S. Reed, W.L. Root, The detection of radar echoes in noise I. *J. Soc. Indus. Appl. Math.*, 8, 309-341 (1960)

<sup>4</sup> K.J. Kelly, L.S. Reed, W.L. Root, The detection of radar echoes in noise II. *J. Soc. Indus. Appl. Math.*, 8, 481-507 (1960)

<sup>5</sup> Personal communication by William L. Root

## From the Editor *continued from page 2*

very first meeting, I was touched by his warm personality, sense of humor, and enthusiasm for research. Our passion for information theory made us become friends. Over the years, Sergio became a family friend because of his love for flying that he shared with my finance Chris. Chris and I were shocked and deeply saddened by the news of the plane crash that killed him. We had only just talked during ISIT in Nice with Sergio and we were looking forward to welcome him and his family in Chicago, so close to Notre Dame. I miss Sergio's enthusiasm, good spirits and boundless energy. My deepest condolences to his wife Viviana, his sons Alejandro and Luciano, and all his friends.

Please help to make the Newsletter as interesting and informative as possible by offering suggestions and contributing news. The deadlines for the next few issues of the Newsletter are as follows (please notice that the deadlines have been moved forward by about a week with respect to the past):

Issue	Deadline
December 2007	October 10, 2007
March 2008	January 10, 2008
June 2008	April 10, 2008
September 2008	July 10, 2008

**Electronic submission in Ascii, LaTeX and Word formats is encouraged. Potential authors should not worry about layout and fonts of their contributions. Our IEEE professionals take care of formatting the source files according to the IEEE Newsletter style. Electronic photos and graphs should be in high resolution and sent in as separate file.**

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I wish everyone a great beginning of the fall semester.

*Daniela Tuninetti*