

## IN MEMORY OF LARRY GREENSTEIN, PROMINENT WIRELESS RESEARCHER AND COMSOC VOLUNTEER

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Professor Larry Greenstein, for decades an important ComSoc volunteer, distinguished researcher, and close friend and colleague of many of us, passed away August 17, after a long illness, at the age of 81. A Life Fellow of the IEEE, Larry was a pioneering researcher and leader in the field of wireless communication at Bell Labs, AT&T Labs (where he was made an AT&T Fellow), and finally at Rutgers University. He was well known for his high scholarly and ethical standards, and his calm and wise way of working through divisive issues. He mentored and fostered the careers of many now-prominent contributors to wireless research and deployment. The respect, admiration and love he earned from them and his many friends and co-workers was a testament to his exceptional character, empathy and warmth. When you were with him, you felt like you had his focused attention.

Larry received the B.S., M.S. and Ph.D. degrees in electrical engineering from the Illinois Institute of Technology (IIT) in 1958, 1961 and 1967, respectively. From 1958 to 1970, he was at IIT Research Institute, where he worked on radio frequency interference and anti-clutter airborne radar. He joined AT&T Bell Laboratories in Holmdel, NJ in 1970. Over a 32-year AT&T career, he conducted research in digital satellites, point-to-point digital radio, optical transmission techniques and wireless communications. For 21 years during that period (1979-2000), he led a research department renowned for its contributions in these fields. In 2002 Larry became a research professor at Rutgers University WINLAB (Wireless Information Network



Larry Greenstein

Laboratory), a role he held until his retirement in 2014. At WINLAB Larry worked on PHY-based security techniques, MIMO-based cellular systems, broadband power line systems, cognitive radio and channel modeling. He also served as an invaluable mentor to graduate and undergraduate students, including co-advising several doctoral students.

Larry's technical contributions over his storied career were broad, deep, and highly impactful in both theory and practice. He is known as the "Father of Propagation"; radio propagation models and their wide ranging impact were close to

his heart. He made pioneering contributions to communication over multipath fading channels. He characterized propagation and analyzed the performance of urban microcells, a key element of cellular planning in cities. Results were reported in widely referenced papers, beginning with the prize-winning "Measurement-Based Estimates of Bit-Error-Rate Performance in Urban Microcells at 900 MHz," co-authored with N. Amitay and G. J. Owens and published in 1992 in the *IEEE Transactions on Vehicular Technology* [VT].

"Uplink Capacity in a CDMA Macrocell with a Hotspot Microcell: Exact and Approximate analyses," co-authored with S. Kishore, H. V. Poor and S. C. Schwartz and published in the *IEEE Transactions on Wireless Communication* in 2003, was another prominent publication, describing the interworking of microcells and macrocells. "A New Path-Gain/Delay-Spread Propagation Model for Digital Cellular Channels," co-authored with V. Erceg, Y. S. Yeh and M. V. Clark and published in VT in 1997, illustrated his keen interest in propagation models and the importance of his contributions to the cellular industry. His work was always both scholarly and applied, addressing practical problems whose solution underlies today's broadband wireless infrastructure. His paper "Frequency Selective Fading Effects in Digital Mobile Radio," co-authored with Bernard Glance and published in the *IEEE Transactions on Communications* in 1983, won the prestigious Leonard G. Abraham prize paper award in the field of communication systems. This all-time classic paper set the foundations for digital mobile radio. The models that were developed in cellular wireless standards (3GPP, ITU-R and IMT), WiFi standards (802.11) and early fixed wireless standards (802.16) were based substantially on Larry's work.

Within ComSoc, Larry was for many years a key part of its leadership. As a member of the Board of Governors and in other positions, he was often given difficult assignments such as devising a new election system that would give a fair chance for election to members from every part of the world. He also contributed significantly to publications policies, balancing the needs of authors, editors and readers. His patience and appreciation for all perspectives allowed him to overcome stubborn differences that had impeded the evolution of ComSoc into an open global society.

Larry was an IEEE Life Fellow, an AT&T Fellow, and a recipient of ComSoc's highest technical achievement award, the Edwin Howard Armstrong Award. He also received several awards for his research and tutorial papers, including the prestigious IEEE Donald G. Fink award in 2011 for the most outstanding survey, review, or tutorial paper published (in *IEEE Proceedings*) across all IEEE publications in a given year. Larry served on numer-



Larry and Pearl at the AT&T Fellow ceremony.

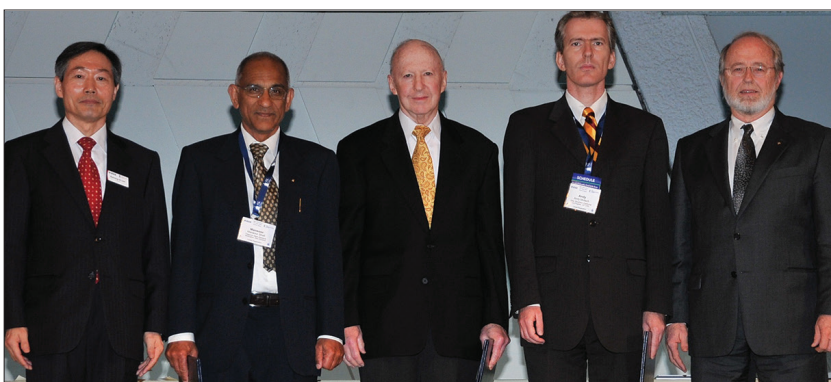
ous editorial boards and technical program committees for ComSoc and as its Director of Journals for two terms. For his outstanding leadership in this role Larry was honored in 2010 with ComSoc's Joseph LoCicero award for exemplary service to publications.

Larry was a generous mentor to everyone who crossed his path, especially young people and women engineers. He consistently shared his profound breadth and depth of knowledge about wireless communications with others, often during conversations in his office with a life-sized paper cutout of Einstein prominently displayed. He was a passionate, effective, and wise teacher. His encouragement and enthusiasm for the work of his colleagues, summer interns, and students inspired them all. Larry also served as an exceptional role model and teacher in how to write good papers and effectively present research results. In fact, Larry was a master at giving crisp, clear and really funny presentations incorporating his truly unique sense of humor and exceptional storytelling prowess. His influence on others in the field was pervasive, deep, and long-lasting. Larry's exceptional mentoring was recognized in 2001 with the AT&T Labs Charles Thompson Outstanding Mentor Award and in 2014 as the inaugural recipient of ComSoc's Women in Communications Engineering Mentoring Award.

Larry and his beloved wife Pearl, whose tragic death a few years ago cast a deep shadow over his life, were treasured and devoted friends to many in the community. They were fun-loving and curious, happy to share milestone events and decadent dinners with friends as well as to travel with them to interesting parts of the world. These included travel in Anatolia after ICC 2006 in Istanbul, with a tour guide who told Larry and his companions, one day, "tomorrow we will go to the Agency." It took some time to grasp that she meant "Aegean Sea" and this memory entertained Larry and his friends for years after. Larry took pleasure in new sights and contacts with people from many countries, adding to the experiences that defined his tolerant and sympathetic character.



Larry with Steve, Andrea, David, Reinaldo and Len at a conference.



Byeong Gi Lee and Gordon Day presenting the IEEE Donald G. Fink award to Mansoor, Larry and Andy.

The void in our lives left by Larry's death will never be filled, but we are comforted by the memories of his creative and generous life and its profound impact on the world of technology and on us personally. Readers are invited to submit their memories of Larry to a web page that has been set up for that purpose: <https://www.comsoc.org/memorial/larry-greenstein>. In addition, a 2019 memorial event will be arranged in the New Jersey area.