SIDNEY DARLINGTON
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1906–1997

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SIDNEY DARLINGTON, one of world's most creative and influential circuit theorists, died at his home in Exeter, New Hampshire, on October 31, 1997, at the age of ninety-one. He was a man of uncommon depth and breadth whose first love was circuit theory. He made important and widely known contributions in several areas, including network synthesis, radar systems, rocket guidance, and transistor networks.

Sid was born in Pittsburgh, Pennsylvania. He received a B.S. degree in physics (magna cum laude) from Harvard College in 1928, a B.S. in electrical communication from the Massachusetts Institute of Technology in 1929, and a Ph.D. in physics from Columbia University in 1940. In 1929 he became a member of technical staff at Bell Laboratories, where he remained until he retired in 1971, as head of the Circuits and Control Department, at the then-mandatory retirement age of sixty-five. He was a member of both the National Academy of Engineering and the National Academy of Sciences. In 1945 he was awarded the Presidential Medal of Freedom, the United States' highest civilian honor for his contributions during World War II. The award was established in that year by President Truman to reward notable service during the war. He received the Institute of Electrical and Electronics Engineers (IEEE) Edison Medal in 1975 and the IEEE Medal of Honor in 1981.
In Darlington’s early days at Bell Laboratories, there was much interest in electrical filter theory, mainly in connection with the exacting needs of systems using frequency-division multiplexing. At that time, filter theory differed from what it is today in that it was marked by adhoc techniques in which complex filters were designed by cascading less complex filter sections whose attenuation characteristics were specified in graphical form. This was often unsatisfactory for several reasons. For example, the theory available did not adequately take into account the loading of the various sections on their predecessors. Sid’s brilliant contribution was to recast the filter design problem as two problems—approximation and network synthesis—and to solve each problem. The first problem is to approximate the desired, typically idealized filter characteristic using a real rational function of a complex variable, and here Darlington made significant pioneering contributions involving the use of Tchebyscheff polynomials. His main contribution, which concerned the exact synthesis of a two-port network that realized (i.e., implemented) the rational function, was the introduction of his well-known insertion-loss synthesis method. This work by Darlington led to his beautiful structural result that no more than one resistor is needed to synthesize any RLC impedance.

It is interesting that his results were not widely used until many years after they were obtained. This occurred partially because more exacting computations were required than for the earlier “image-parameter” filter designs. Also, because of its novelty, it was not easy for filter designers at the time to fully appreciate Darlington’s contributions. This is easier to understand in the context of the history of the development of lumped-constant filter theory, which originally was an extension of the theory of transmission lines, and in which originally the concepts of a propagation constant, characteristic impedance and reflection factor played a prominent role. Sid’s work also profoundly influenced electrical engineering education. After World War II, the Darlington synthesis of reactance two-ports was taught to a generation of graduate students who learned that linear circuit design could be formulated precisely in terms of specifications and tolerances, and that the problems formulated could be
solved systematically. With concurrent advances in communication and control theory, electrical engineers began to appreciate that higher mathematics was a powerful tool for advanced study and research. This helped pave the way for the introduction of system theory and system analysis, and thus further broadened the scope of electrical engineering education.

During World War II Sid was heavily involved in several studies of military systems. These studies concerned mainly the development of computers for antiaircraft gun control and bomb-sights. For a seven-month period beginning in 1944, he took a leave of absence to join the United States Office of Field Service. He was assigned to the 14th Antiaircraft Command in the southwest Pacific, where he served as a consultant and technical observer. It was this work that led to his being awarded the Medal of Freedom.

In addition to never losing interest in circuit theory, Sid retained an interest in military systems—and related systems—throughout his tenure at Bell Laboratories. One of his most important contributions is the invention of what is called chirp radar. The chirp idea is a way to form a pulsed radar's transmitted signal so that relatively high peak power is not needed to achieve long range and high resolution. This involves transmitting long frequency-modulated pulses. The corresponding reflected and received (“chirped”) pulses are “collapsed” into relatively short pulses using a network that introduces a time delay that is frequency dependent. The idea has been widely used, and there has been much interest in the design of the needed delay networks—not only at Bell Laboratories, but at many other companies and at universities. Darlington's IEEE Medal of Honor citation reads: “for fundamental contributions to filtering and signal processing leading to chirp radar.”

Sid also did influential work concerning rocket guidance. In 1954 he ingeniously combined radar-tracking techniques with principles of inertial guidance to develop the highly effective Bell Laboratories Command Guidance System, which has launched many of the U.S. space vehicles, including NASA's Thor Delta booster and the Air Force Titan I missile. The system has proved to be remarkably reliable and has played a central role
in placing into orbit many satellites, including the Echo I communications satellite, Syncom, and Intelsat.

Darlington is best known for an idea that he probably developed very quickly—the Darlington transistor—a simple circuit made up of two or more transistors, which behave like a much-improved single transistor. As is well known to the circuits and systems community, this idea is widely used and has had a great impact on the design of integrated circuits.

Sid was a visiting professor for periods of time of from one to six weeks at the University of California, Berkeley, between 1960 and 1972. In 1978 he was a visiting professor at the University of California, Los Angeles, for a month. He gave many lectures and very much enjoyed these visits. Colleagues and students often remarked among themselves about how impressed they were with his keen physical insights, sophisticated mathematical talent, and pursuit of definitive results. After Sid retired from Bell Laboratories, he became an adjunct professor at the University of New Hampshire, where he received an honorary doctorate in 1982. He was a consultant to Bell Laboratories from 1971 to 1974. Darlington held more than forty patents and was active in professional society activities. During 1959 and 1960 he chaired the IEEE Professional Group on Circuit Theory, and in 1986 he received the Circuits and Systems Society's first Society Award.

Sid was a man of great personal and professional integrity. He was an intense but gentle man who was surprisingly modest. He was also a gregarious person who knew a lot about many things and had much to say. A colleague once commented that, “Asking Sid Darlington a question was like trying to take a drink from a fire hose.” Sid is survived by his wife, Joan, of Exeter, New Hampshire; two daughters, Ellen and Rebecca; and his sister Celia.