Tellegen was the guest of honor at the International Symposium on Electrical Network Theory, London in September 1971, where he presented a paper on circuits with negative resistance elements. This symposium evolved to what is now the major known as the IEEE International Symposium on Circuits and Systems Society.

In the period 1946–1966 Tellegen was professor extraordinary of circuit theory at TU Delft. Adams, Bordewijk and Duinker were among those who received their doctoral degree working with him. From 1942 to 1952 he was president of the Dutch Electronics and Radio Society, which made him a honorary member at the end of this period. From 1948 to 1960 he was chairman of the Dutch Committee of the International Union of Radio Science (U.R.S.I.) He was vice-president of U.R.S.I. from 1952 to 1957. From 1957 to 1960 he was vice-chairman of its commission VI, especially charged with circuit theory. From 1946 to 1966, he was professor extraordinary of circuit theory at TU Delft.

The Institute of Radio Engineers of Australia made Tellegen a honorary life member in 1953. He received the Research Prize of the Royal Netherlands Society of Engineers in 1954, the Fellow Award of the IEEE in 1955, and the IEEE Edison Medal in 1973 "For a creative career of significant achievement in electrical circuit theory, including the gyrator." Tellegen was elected a member of the Royal Netherlands Academy of Arts and Sciences in 1960. In 1970 the TU Delft conferred on him the degree of doctor honoris causa in technical sciences.[1]

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[1]A slightly edited version of that available at the website: https://ethw.org/Bernard_Tellegen. Copyright is held by IEEE.

Hendrik Wade Bode

Hendrik Wade Bode (December 1905–June 1982) was an American engineer, researcher, inventor, author and scientist, of Dutch ancestry (his name is therefore pronounced `B-oh-d-ah, with a long `o' and a voiceless `e', and tonic accent on the first syllable). As a pioneer of modern control theory and electronic telecommunications he revolutionized both the content and methodology of his chosen fields of research. His synergy with Claude Shannon, the father of information theory, laid the foundations for the technological convergence of the information age, by which is meant the convergence of mathematics, information theory, telecommunication, control theory and electronic design, as exemplified by modern Artificial Intelligent systems.

Bode was born in Madison, Wisconsin. His father was a professor of education, and a faculty member at the University of Illinois at Urbana-Champaign by the time young Hendrik was ready for elementary school. He entered Leal Elementary School and rapidly advanced through the Urbana school system to graduate from high school at the age of 14. Immediately after graduation from high school he applied for admission to the University of Illinois but was denied because of his age. Decades later, in 1977, the same university would grant him an Honorary Sc.D. Degree. He eventually applied and was accepted at Ohio State University, where his father also taught, and he received his B.A. degree in 1924, at age 19, and his M.A. degree in 1926, both in Mathematics. After receiving his M.A, he remained at his alma mater, working as a teaching assistant, for an additional year.

Fresh from graduate school he was promptly hired by Bell Labs in New York City, where he began his career as designer of electronic filters and equalizers. Subsequently, in 1929, he was assigned to the Mathematical Research Group, where he excelled in research related to electronic networks theory and its application to telecommunications. Sponsored by Bell Laboratories, he reentered graduate school, this time at Columbia University, and he successfully completed his PhD in physics in 1935.

In 1938, he made important contributions to control systems theory and mathematical tools for the analysis of stability of linear systems. He developed the asymptotic magnitude and phase plot that bears his name, the Bode plot, which displayed the frequency response of systems clearly. His work on Automatic (Feedback) Control Systems introduced innovative methods to investigate the system stability using the frequency domain

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concepts of gain and phase margin derived from his now famous plots. The method is based on the observation that a log-representation of the magnitude (in dB) is additive in the contributions of elementary factors of poles and zeros in the transfer function, and the observation that the instability of a fed-back system is generated by positive feedback (i.e., a phase difference of 180 degrees or more at some critical frequencies), an estimate, which is obtained by comparing the magnitude plot with the corresponding phase plot. Although the method has good engineering properties and is very useful for the initial design of a (linear time-invariant) system (like an amplifier), it suffers from a lack of generality (the Bode plots can only be derived fairly accurately for simple systems), it does allow for quick and easy assessment and provides a sometimes surprisingly accurate estimate of stability. Bode had a good working relationship with Harry Nyquist, who succeeded in deriving an exact criterion for the stability of a system based on its (complex) frequency response, drawn out in the complex plane, and using complex function calculus.

But he made perhaps his most important contributions at the onset of Second World War, with the development of a fully automatic anti-rocket defense system. It was a sophisticated example of Artificial Intelligence *avant la lettre.* To develop it, Bode had to solve intricate mathematical, communication, and control problems. The input part of the system consists of the analysis of radar images (also the radar was a new invention at the time), locking the radar on the incoming rocket, calculating as well as possible the rocket's trajectory from the collected radar images, determining the required battery settings, representing, and communicating this information to the ground stations, which could then operate automatically and in split seconds. For all these tasks some nasty mathematical problems had to be solved, like the inaccuracy of taking derivatives (estimating the speed of the rocket), or the automatic implementation of mathematical functions (there were no usable digital computers yet). The system successfully defended London from the V-1 flying bombs during Second World War. After the war, Bode along with his wartime rival Werner von Braun developer V-1 flying bomb, and, later, the father of the US space program, served as members of the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA. During the Cold War, he contributed to the design and control of missiles and anti-ballistic missiles.

He made important contributions to the design, guidance and control of anti-aircraft systems during Second World War. He helped develop automatic anti-aircraft control systems, whereby radar information was used to provide data about the location of the enemy aircraft, which was then fed back to the anti-aircraft artillery servomechanisms enabling automatic, radar-augmented enemy aircraft ballistic tracking. The radar signal was locked on target and its data was wirelessly transmitted to a ground receiver that was connected to the artillery servomechanism feedback control system, causing the servo to accurately modify its angular position and maintain it for an optimum amount of time, long enough to fire at the calculated (predicted) coordinates of the target and thus successfully track the target. The system successfully defended London from the V-1 flying bombs during Second World War. After the war, Bode along with his wartime rival Werner von Braun developer of the V-1 flying bomb, and, later, the father of the US space program, served as members of the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA. During the Cold War, he contributed to the design and control of missiles and anti-ballistic missiles.

In 1944, Bode was placed in charge of the Mathematical Research Group at Bell Labs, His work on electronic communications, especially on filter and equalizer design, continued during this time. In 1945 it culminated in the publication of his book Network Analysis and Feedback Amplifier Design (Van Nostrand Reinhold 1945), which is considered a classic in the field of electronic telecommunications and was extensively used as a textbook for many graduate programs at various universities as well as for internal training courses at Bell Labs. In 1952, he was promoted to the level of Director of Mathematical Research at Bell Labs. In 1955, he became Director of Research in the Physical Sciences, and remained there until 1958, when he was promoted again to become one of the two Vice Presidents in charge of Military Development and Systems Engineering, a position he held up to his retirement. He also became a director of Bellcomm Inc., a company associated with the Apollo program. Bode was in many ways a precursor of the modern methods in estimation and control, which necessarily had to go back to the time domain (as most of the systems used were now time variant), but his work on these two fields (estimation and control) provided for much problem setting and direction. These now essential topics were then further developed by Bellman and Kalman for use in the Apollo program, and have become mainstays.

By the time of his retirement in October 1967, he held a total of 25 patents in various areas of electrical and communications engineering, including signal amplifiers and artillery control systems. Soon after retirement, Bode was elected to the academically prestigious Gordon McKay Professor of Systems Engineering position at Harvard University. During his tenure there, he pursued research on military decision making algorithms and optimization techniques based on stochastic processes, that today play an essential role in modern estimation and control theory. He also studied the effects of technology on modern society and taught courses on the same subject at Harvard's Science and Public Policy Seminar, while supervising and teaching undergraduate and graduate students at the same time in the division of Engineering and Applied Physics. In 1974, he retired for the second time and Harvard awarded him the honorary position of Professor Emeritus. He, nevertheless, kept his office at Harvard and continued working from there, mainly as an advisor to government on policy matters.

In 1948, President Harry S. Truman awarded Bode the President's Certificate of Merit, in recognition of his remarkable scientific contributions to the war effort and to the United States of America. Bode has received many other awards, honors and professional distinctions including the Ernest Orlando Lawrence Award (1960), Edison Medal of the IEEE (1969), Rufus Oldenburger Medal of the American Society of Mechanical Engineers (1975), Richard E. Bellman Control Heritage Award from the American Automatic Control Council (1979), member of the National Academy of Sciences (1957) and a founding member of the National Academy of Engineering. He was also a member or fellow in a number of scientific and engineering societies such as the IEEE, American Physical Society, Society for Industrial and Applied Mathematics and the American Academy of Arts and Sciences.[1]

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[1]The above article is an edited version from that given at the website: https://en.wikipedia.org/wiki/Hendrik_Wade_Bode with additional input from Professor Patrick DeWilde.