Leo L. Beranek
Autobiography
1914-2016

1. Early Years, K to 12

Leo Beranek was born in Solon, Iowa in 1914 and began his education at age 5 in a one-room (12 grades) schoolhouse in Tipton, Iowa. Leo's mother died when he was 11 years old and his father moved the family back to Solon. While at the Solon Public School Leo was introduced to the drums by the bandmaster and, encouraged by his father, was given instruction on the marching and trap drums. He joined a local dance band at the age of 14 and continued to play through his early years of college. Upon his father's remarriage at the start of Leo's sophomore year of high school (Fall 1928) the family moved to Mt. Vernon, Iowa where his father joined the Beranek Hardware Store in partnership with his cousin. Among other things, the Beranek Hardware Store sold radios that required installation and ongoing service and repair. Recognizing this as an expanding business, his father bought a correspondence school course on radio technology and repair for Leo to study. Leo took the weekly lessons seriously and, at his father's instigation, became an unpaid apprentice to Mt. Vernon's radio serviceman, a senior in the nearby Cornell College. Following that student's graduation, at the age of 16 Leo ascended to the role of Mt. Vernon's "Radio Man."

2. Cornell College, Mt. Vernon, Iowa

After graduating with highest honors from Mt. Vernon High School in 1931 Leo was accepted at Cornell College (IA). The Beranek Hardware Store was hit hard by the Great Depression and his father left Mt. Vernon that summer. Left to make his way on his own, he paid for his first year's tuition of $400 from the $500 he had saved from playing in a dance band and fixing radios. Fortuitously, he withdrew the funds the day before the bank closed permanently, another victim of the Great Depression. At Cornell he majored in Mathematics and Physics and played tympani in the college symphony orchestra.

Since his radio repair business did not generate sufficient funds to pay both tuition and living expenses, Leo was forced to put his studies on hold after his sophomore year. He took a job as an assistant in the engineering department of Collins Radio Company, a fledgling radio transmitter-manufacturing firm in Cedar Rapids, Iowa. After a year and a half, he had saved enough money to return to Cornell where he again set up a radio repair business and added to it a house electrical wiring service. His business became so popular that he had to hire two employees to keep up with the demand. Leo studied and attended classes until 3pm each day after which he went to his business office.

In August of the summer between his junior and senior years a chance encounter determined his future education. The principal highway between New York and San

Francisco then was the Lincoln Highway which ran through the center of Mt. Vernon and past the edge of Cornell. As he was walking along the street he came upon a car with Massachusetts plates that had a flat tire, which he offered to change. He and the driver struck up a conversation about Leo's studies and the financial constraints hindering his hopes to pursue graduate work. After some discussion, the driver suggested that he apply to Harvard University, offering to serve as a reference and providing the names of contacts to use at Harvard. To Leo's amazement, he came to learn that the driver of the car was Glenn Browning who owned a company that made radios, had taught engineering at Harvard University, and had written the article in *Radio News* that Leo had read in the library that same morning! Glenn Browning's introductions and recommendation were instrumental in Leo receiving a full scholarship to Harvard Graduate School for the coming year. He graduated from Cornell College in August of 1936 earning a Bachelor of Arts with Distinction.

3. Harvard University Graduate School

Leo arrived at Harvard in the Fall of 1936 and completed his first year of study with an "A" in every course. Professor F. V. Hunt, founder of the Underwater Sound Laboratory at Harvard, offered Leo a half-time paid position as his research assistant for the coming year where he could work toward a doctorate, with Hunt as his thesis supervisor. Leo submitted two papers to the Journal of the Acoustical Society in April 1940, both of which were published in the July 1940 issue to great and immediate acclaim, and was awarded a D.Sc. degree in June 1940.

4. Electro-Acoustic Laboratory, WWII

Not long after Leo's doctoral thesis on the properties of commercial acoustical materials was completed, President Franklin D. Roosevelt formed the National Defense Research Committee (the "NDRC") for the purpose of providing civilian research funds for the solution of military problems. In November 1940, the NDRC established the Electro-Acoustic Laboratory (the "EAL") at Harvard with Beranek as its Director. EAL's initial assignment was to develop a new light-weight acoustical material for reducing noise levels in the cockpits of military airplanes. Beranek, working with the Owens Corning Fiberglass Company, developed the materials that remain state-of-the-art to this day. EAL's next assignment was to make speech communication possible among the flight crew in military aircraft when flying above 30,000 ft. The lack of cabin pressurization required that oxygen masks be worn. Because of the urgency of the need, the EAL was expanded to 100 personnel who tested existing communication equipment and monitored and analyzed the change in voice level and hearing at various high altitudes in order to develop new equipment to make voice communication possible. This research was highly successful and by late 1942 new earphones, microphones, oxygen masks and noise reducing helmets were shipped to the Army, Navy and British Air Forces.

The U.S. Army was planning a "fake" army to deceive enemy forces. It developed tanks, trucks, and gunnery made from foamed plastic that were to be located near the shore in eastern England and to be used on European soil if invasion was successful. To be successful, the movement of this "equipment" had to be noisy, which required large loudspeakers. The EAL was asked to invent and rapidly build a large testing room that would confine the noise indoors while not internally reflecting sounds from the walls which would make the tests invalid. Beranek, with the aid of a paid Harvard senior student, did the research that led to the construction of a very large room with thick concrete walls lined on all six surfaces with four-foot long glass-fiber wedges, each with a base that was 8 inches' square. The heavy loud-speaker equipment was moved in and out of the chamber for testing on a four-foot wide track. The chamber proved so successful that it remains the state-of-the-art model for chambers of all sizes built and used throughout the world. Further, Beranek's research lead him to coin the term "anechoic" which literally means, "characterized by no echo." The word was added to the dictionary in 1948.

5. Systems Research Laboratory, WW-II

As a result of EAL's success in solving military problems, Beranek was asked by the U. S. Navy Department's Bureau of Ships to set up a laboratory to improve a ship's ability to ward off attacks by Japanese Kamikaze aircraft. The purpose of this laboratory, actually called the Systems Research Laboratory, was to speed up the time between the radar detection of an airplane and the time when the guns could be fired on the target. As it was, the Kamikazes flew in at low altitude and the radar on the ship could not detect them until they appeared over the horizon. The resulting radar information had to be sent to the gunnery stations, which then had to turn their guns in the right direction before shooting. This sequence took so much time that the Kamikaze bombs would strike the ship. Beranek built a "ship on land," dubbed the "USS Beavertail" by the Navy, in a building located on the southern tip of an island in Narragansett Bay (Jamestown, R. I.). This "ship" had the latest radar equipment and could be "test raided" by aircraft from the nearby Quonset Air Force base. Testing was completed in early 1945 and the first results of the research were being installed on naval ships just as the war ended.

The following year, while on the faculty at Harvard with a Guggenheim Fellowship, he wrote the book *Acoustic Measurements.* During this same time period, he perfected the original design of the Hush-a-Phone, a telephone accessory that gave the user privacy when using the telephone handset. It was the success of this product that inspired the landmark telecommunications case *Hush-a-Phone vs. United States (1956)* wherein the court ruled that this device could be the first foreign attachment to an AT&T product. The fallout from this ruling ultimately led to the breakup of the Bell Telephone System into a group of "Baby Bells."

6. Associate Professor of Communication Engineering at M.I.T.

In the Fall of 1947 Beranek became an Associate Professor for Communication Engineering and the co-director of the Acoustics Laboratory at the Massachusetts Institute of Technology. There he taught a course in acoustics for seniors and graduate students and wrote the book *Acoustics*, which became a standard textbook throughout the world.

7. Bolt Beranek and Newman, and the United Nations Buildings

The construction of new buildings blossomed in the United States after WWII and architects frequently sought acoustical consulting services from the professors and researchers at MIT. In November 1948, in response to this demand, the President of MIT asked Professors Richard Bolt, a professor in the Physics Department, and Beranek to establish an acoustical consulting firm. A year later Robert Newman, a professor in the Architectural Department, was added and the firm became known as Bolt Beranek and Newman. The partnership's first sizeable job was as acoustical consultants on the permanent headquarters building of the United Nations in New York City. BBN capitalized on the success of the U.N. building in New York to become the largest acoustical consulting firm in the world.

8. Curing NASA's Big Noise Problem and Shoehorning in the Jet Age (PNYA)

The next two big BBN jobs headed by Beranek were for NASA in Cleveland, and the Port of New York Authority in New York. NASA had a jet engine test facility in Cleveland that, when first used in 1950 to test a new supersonic jet engine, created such a loud noise for miles around that the City of Cleveland shut the facility down. Beranek, building on his earlier experience with the military, designed and built the world's largest muffler and within a year the jet engine noise problem was completely resolved. Similarly, the NYPA job was noise-reduction based and required that Beranek and his staff first determine the maximum noise that a new passenger jet airplane should be permitted to make when flying over neighborhoods adjacent to the JFK airport and then take measurements to determine how much noise the new Boeing 707 jet plane made. Based on the fusion and analysis of the resulting data sets the Boeing 707 jet airplane was required to attach large mufflers to its engines and follow a prescribed takeoff procedure to adequately reduce the neighborhood noise.

9. Building the ARPANET and giving birth to the INTERNET

In 1955, while President of BBN, Beranek lead the firm to an expansion of its activities beyond acoustical consulting by hiring Professor J.C.R. Licklider, a renowned experimental psychologist and computer scientist, away from MIT. By 1965 he and others had assembled one of the best computer software groups in the East. In 1968 the group responded to a bid request offered by the Advanced Research Projects Agency ("ARPA") of the U.S. Department of Defense to invent and build a network that would connect together 19 large main-frame computers, of a number of different

makes, which ARPA had already supplied to various universities and laboratories. Thirteen companies responded to the bid request and ARPA soon narrowed them down to two, Raytheon and BBN. In December 1968, BBN was awarded the contract to build the ARPA network. The network consisted of 19 "Interface Message Processors (IMP)", each of which was associated with a main-frame computer. The network signals traveled from one IMP to another, and each IMP acted as the interpreter of messages that went to and from its associated main-frame computer. The first message between two computers and their IMP's was sent in September 1969. In 1970 BBN invented e-mail as we know it today. The ARPA network grew and when it reached about 500 users it was split in two and joined by the TCP/IP protocol. This occurred on January 1, 1983, the official birthdate of the INTERNET.

10. Tanglewood [Serge Koussevitzky] Music Shed in Lenox, Massachusetts

The Tanglewood Music Shed was completed in 1938 within an unbelievably low budget. It was in fact a big fan-shaped barn with a ceiling held up by exposed girders whose lower side-walls were open to the outside allowing the music to be heard by an audience of up to 10,000 seated on the lawns. The stage was dragged to the front from a previous tent enclosure. Music lovers and music critics said that the Shed was too muddy, too reverberant and with little clarity. Singers and pianists fared the worst. BBN was asked to improve the acoustics and under Beranek's leadership the BBN staff developed a canopy of triangular shaped, 50% open, panels that started from the space above the stage and stopped about 1/3 of the distance to the rear of the shed. A new stage, wider and with undulating sidewalls, was designed. The hall seats 5,000 on un-upholstered chairs. The redesigned hall opened in 1959 and remains a widely acclaimed success.

11. Forming WCVB, "Probably the Nation's Best Television Station"

As a result of long-standing investigations by the Federal Communications Commission ("FCC"), WHDH Channel 5-TV in Boston, which at the time was owned by the Herald Traveler Corporation, was granted only a short-term license to operate, and the FCC invited new applicants for the license. In 1963 a group of thirty citizens in Greater Boston, calling themselves Boston Broadcasters, Inc. ("BBI") with Beranek as its President, applied for the license to operate Channel 5. There were three other applicants, one of which was WHDH. The FCC appointed an "Examiner" to conduct hearings. All of the members of the four groups appeared before him in a courtroom in Washington D.C. The hearings ended in July 1965. The Examiner ruled in favor of WHDH, but in January 1969, the FCC reversed that decision and awarded the right to broadcast on channel 5 to BBI. The present operators, WHDH, contested this decision in the Federal Court System (including the Supreme Court of the United States three times). BBI won all times and the station went on the air March 19, 1972 with the call letters WCVB. This station was so successful that a full page 1981 article appeared in the *New York Times* bearing the headline "Some say this is America's best TV station," touting WCVB's innovative local programming. BBI sold the WCVB license to Metromedia in May 1982.

12. Five Highly Successful Concert Halls and an Opera House in Japan

With his foray into broadcasting concluded, Beranek returned to his acoustical engineering roots and consulted on five concert halls and an opera house in Japan. Among them was the Tokyo Opera City Concert Hall, on which Beranek was the Principal Acoustic Consultant, which was hailed by the *New York Times* [4/18/2000] as an acoustical "miracle." The hall, which opened in September 1997, is now considered one of the five best concert halls acoustically in the world.

For the New National Theater Opera House in Tokyo, which also opened in 1997, Beranek introduced a new concept in opera houses, namely, to employ surfaces at the sides and above the proscenium to act as a 'horn' to project the singers' voices at higher levels than usual making it easier for them to sing above the music from the pit orchestra.

Beranek was also consultant for three other concert halls and a drama theater in Japan, all of which have been successful. During this same period, he published two additional books, *Concert and Opera Halls: How They Sound* (1996), and *Concert Halls and Opera Houses: Music, Acoustics and Architecture* (2004).

13. Final Scientific Paper. "Concert Hall Acoustics, Recent Findings"

The final scientific paper written by Beranek was published in the April 2016 issue of the Journal of the Acoustical Society of America, (Volume 139, Pages 1548-1558). He was 101 years old at the time of publication. The paper, entitled *Concert hall acoustics: Recent findings,* synthesized the findings of a number of recent papers published in a variety of technical publications globally that dealt with both the physical and the psychological aspects of the acoustics of concert halls and related the findings to what Beranek and others have measured and observed in existing halls of various sizes, shapes, and details. The paper rank ordered acoustically a large number of the world's concert halls and presented physical and measured technical data that explained the differences in their rank orderings, with the intention of providing a more definitive guide for achieving future successful design results.

14. Public Service Activities

In about 1965, Beranek became President of the Cambridge Society for Early Music. He hired a new music director and the Society, along with one in New York, was responsible for the renaissance of early music performances. This led to his becoming a charter member of the Boston Symphony Orchestra's Board of Overseers in 1968. He became Chairman of the Overseers and rose to become a Trustee. In 1993 he

became Chairman of the Board of Trustees. The BSO was in financial difficulty and Beranek was responsible for starting them on the way to becoming today the orchestra with the largest endowment. He served for five years as President of the World's Affair Council of Boston. From 1989 to 1994 he was nearly-fulltime, unpaid, president of the American Academy of Arts and Sciences. In 1984, the alumni of Harvard University voted him a member of their senior governing body, the Board of Overseers, a position he held for the normal term of six years. Beranek is a Life Trustee of the Massachusetts Historical Society. He also served as President of the Acoustical Society of America and President of the Audio Engineering Society.

15. Honors and Awards

Honors: Phi Beta Kappa, Sigma Xi, Eta Kappa Nu. Member National Academy of Engineering; Fellow Institute of IEEE; Fellow American Physical Society; Fellow American Academy of Arts and Sciences; Honorary member Acoustical Society of America; Honorary Member Audio Engineering Society; Honorary Member International Institute of Acoustics and Vibration; Fellow Institute of Acoustics (England); Honorary member of American Institute of Architects. U. S. A.; Presidential Certificate of Merit for World War II effort. (President H. S. Truman).

Awards: 2003 National Medal of Science; IEEE Founders Medal; Acoustical Society of America Gold Medal; Audio Engineering Society Gold Medal; American Academy of Arts and Sciences Scholar-Patriot Distinguished Service Award; American Society of Mechanical Engineers Gold Medal,; Eta Kappa Nu Vladimir Karapetoff Outstanding Technical Achievement Award; Institute of Acoustics, Peter Barnett Memorial Award, International Commission on Acoustics: Lifetime Achievement Award, Institute of Acoustics Rayleigh Medal; Mexican Acoustical Society Lord Rayleigh Medal, European Acoustical Association, E.A A. Award;, Eta Kappa Nu Award for Outstanding Achievement; Spanish Acoustical Society *Caracola de la Sac* Award, Radio and TV Commission, Abe Lincoln TV Award (Top USA Award for TV Management)

Honorary Doctorates: Doctor of Science, Cornell College (Iowa); Doctor of Engineering, Worcester Polytechnic Institute; Doctor of Commercial Sciences, Suffolk University; Doctor of Laws, Emerson College, Boston; Doctor of Public Service, Northeastern University.