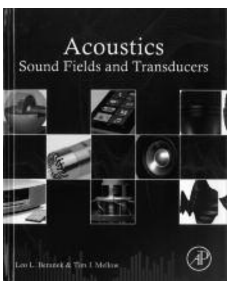
# Book reviews

**The story behind "Acoustics, Sound Fields and Transducers". Leo Beranek and Tim Mellow. Academic Press, 600 pp. 2012.**




If you ask any engineer or academic working in the field of electroacoustics which is their favorite text book, the reply will nearly always be *Acoustics* by Leo Beranek [1]. Why is a book published in 1954 without revisions still so popular? There are many reasons: It deals mainly with fundamental principles which have not changed. It is well structured. The author's passion for the subject is infectious – the opening sentence is "Acoustics is a most fascinating subject". Wave propagation is explained pictorially before diving into mathematics. Electrical circuit analogies are used to provide insight into the operation of transducers. Formulas are given to help readers to work out their own designs. It is hardly surprising that *Acoustics* has become one of the most cited books on the subject.

My background was in electrical engineering, so naturally Leo's circuit analogies sparked my interest in acoustics and his book was my bible for many years. I was always fascinated by the plots of directivity patters and radiation impedances for pistons with and without baffles. In fact Lord Rayleigh (John W. Strutt) had derived an elegant closed-form formula for the radiation impedance of a piston in an infinite baffle in 1894 [2], long before the direct radiator loudspeaker had been invented.

However, I had much more difficulty in reproducing the impedance of a piston without a baffle. In 2002, I looked up the paper that Leo cited in the footnotes [3] expecting to find an equation that I could simply enter into my computer and use to plot the result. It wasn't there. I had to go right back to Christoffel Bouwkamp's 1941 PhD thesis [4], which is 25 pages long, but contains no final equation that can be used. Every step is needed. At the end, the author states "The time-consuming computation of eigenvalues, eigenfunctions, and other quantities important for the physical interpretation was done on a small hand-driven Brunsviga desk calculator". This was certainly a heroic achievement at the time and I imagine that he burnt much midnight oil.

At about the same time, I discovered a paper [5] by another Dutch researcher, Hans Streng, which used more powerful boundary integral methods [6] to determine the sound radiated from a circular electrostatic loudspeaker membrane. I then met a Finnish colleague (coincidentally with the same forename as the author of my favorite book), Leo Kärkkäinen, who was working at Nokia Research Center in Helsinki. When I showed him Streng's paper, he was quite excited about it because he could see that it could be used to describe any surface velocity distribution such as that of a piston in a circular baffle. This led to our first published paper [7]. With his physics background, Leo became my mentor in wave theory and mathematical methods. He even modified the Streng method in order to avoid the use of collocation and thus calculate everything directly. In my second paper [8] I applied this method to the Bouwkamp problem of waves diffracted through a circular aperture. Meanwhile, I had been busy creating my own document of everything I had learnt about wave theory starting from first principles until one day, when I showed it to Leo Kärkkäinen, he said "This would make a nice book. Have you thought of publishing it?"

A few years later, on 23rd April 2007 to be exact, I was thinking that what the world of engineering acoustics needed was a text book that covered everything from lumped-element theory using circuit analogies, as covered in Leo Beranek's book, to wave theory and sound radiation/scattering problems. However, I could not cover the fundamental principles any better than Leo had already done and I did not want to plagiarize anything. The idea of writing an updated version of *Acoustics* suddenly hit me like a thunderbolt. It seemed like completely the right thing to do even if it would involve a huge amount of work. The reason I know the date so exactly is that in my excitement I immediately fired off an email to Leo Kärkkäinen!

I wrote to Leo Beranek who amazingly wrote back informing me that he held the copyright and that I could use anything I liked. However, he was not keen on being a coauthor because he was too busy contributing to the current literature on concert hall acoustics, even if I wrote all the new material and he simply reviewed it. This was hardly surprising since at the time since I was completely unknown with only a handful of published papers to my name [7, 8, 9]. However, as time went on, Leo became more enthusiastic about the project and contributed much new material, including two whole chapters on sound in enclosures and rooms for loudspeaker listening. I was certainly delighted when he eventually decided he would like to have his name on it as that was the best possible endorsement of all the hard work involved.

The first task was to obtain an optical scan of the original book as a Word document. Unfortunately it then took me a year to correct it because, in addition to numerous scanning errors, the software did not recognize any mathematical symbols or Greek letters. I also had the formidable task of reproducing the figures by drawing over PDFs of them in Word, rather like virtual tracing paper. I first met Leo Beranek face to face at the 2007 ICA meeting in Madrid. We also met a few times in London, Boston and at the 2008 ASA meeting in Miami but, because of the distance between Surrey and Boston, most of our collaboration was done via email. While working on the new text, we were answering all of the questions that I had collected in my mind over the years. For example: What are the independent constituent variables that determine the efficiency of a loudspeaker? How is the radiated sound pressure of an unbaffled loudspeaker determined from its equivalent circuit? How does a finite open or closed baffle affect the frequency response? Can we design a simple crossover which does not produce time-delay waveform distortion? What are the 2-port networks for horns of different profiles? How much radiated sound power is needed to reproduce music or speech in an auditorium of a given size? How does the shape of the radiator affect the response? Is there a difference between flat, convex or concave radiators? Where does the Kirchhoff-Helmholtz boundary integral come from and what does it mean? Can we have a unified approach to sound radiation/scattering instead of the current patchwork of different methods? What is the equivalent circuit of a very narrow tube with viscous and thermal losses and a slip boundary condition?

Leo paid particular attention to the ordering of contents and specifically asked me to include a new section on transmission-line loudspeakers because so many had asked him about how the Bose Wave system worked. He also requested a new chapter on cellphone acoustics because he was curious as to how so much sound could be produced by something the size of a deck of cards and felt that it would bring the book right up to date. Because I had worked for Nokia for so many years, I was too close to the subject to explain it clearly to the lay person and Leo's input here proved invaluable. I am also indebted to my colleague Enrico Pascucci for his marvelous photographs and many useful suggestions for the chapter.

Leo wanted a new title which indicated direct lineage with the original while reflecting the change in emphasis and suggested "Acoustics: Transducers and airborne acoustics". Although "airborne" was intended to indicate "non-structural", I suggested replacing it with "sound fields" in order to sound less "outdoors". Also, the term sound field is fairly general as it can mean either a free field or sound in an enclosure. He then suggested putting "sound fields" before "transducers" because that is the order in which the two subjects are introduced and we settled for that.

A new version of *Acoustics* had to include the work of Neville Thiele [10] and Richard Small [11]. They proposed just six parameters to completely describe the low-frequency behavior of a loudspeaker, which are now commonly known as the Thiele-Small parameters, and Small showed how to obtain them from the input impedance [12]. Also, they produced tables/charts which enable anybody to choose a frequency response shape for a given drive unit and engineer the cabinet and bass-reflex port accordingly. Leo is rightly proud of the fact that these authors used his book as their starting point and that it led to the development of smaller loudspeakers using the acoustic suspension principle [13].

During my previous experience as an analogue filter designer, the Thiele/Small approach was standard. One would never design a filter by messing around with component values until it "looked about right". If standard tables/charts were not available for the element values of a particular circuit, I had to derive the transfer function by hand and solve for the polynomial coefficients in terms of the circuit element labels. This was a very laborious process which often involved many pages of algebra, so I fully understood the significance of Thiele and Small's work.

Virtually no circuit simulation tools use the transfer function. Instead they calculate all the node voltages at every frequency step. I had been interested in deriving transfer functions back in the 1980s for studying the transient responses and stability of amplifiers. Back then, computers could only do such calculations numerically. In order to solve for circuit element values, symbolic computation was needed, but at the time, Maple was the only software which did this and it was only available in universities. It was shortly after joining Nokia in 1999 that Noel Lobo introduced me to the numerical and symbolic power of Mathematica and taught me how to use it effectively.

Another Nokia colleague, Andrew Bright, had the foresight to ask me to write a program that could derive a polynomial transfer function from the net list of a circuit. I started with the method described in a recent book by Robert Boyd [14], but extended it to include ideal voltage sources, current sources, transformers and gyrators. Using Mathematica, I was able to create two versions: one numeric and the other symbolic. This proved invaluable for creating complicated acoustical designs such as a combined call and handsfree loudspeaker. I have described this computation method in the final chapter of the book. If one day someone were to use it to create a proper software tool with a nice GUI, it would really make my day.

I should also mention Juha Backman who has provided much support and encouragement over the years as well as introducing me to many people and important literature.

It has certainly been rewarding working with someone as eminent as Leo Beranek. What both Leo's share is a generosity of nature, energy and passion for acoustics as a subject that makes it seem more like fun than work. I hope that the new book inspires future generations of students, engineers and academics as the original inspired me. It really is a most fascinating subject and there is still plenty to explore.

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**"Microphone arrays for stereo and multichannel sound recording". Vol. 2. Michael Williams. Editrice Il Rostro, 2013.**

We have waited a long time (nine years) for the second volume to be published, but the wait was well worth it. Michael Williams has brought together a complete presentation of his research and development work into microphone array systems that covers the period from 1984 right up to the present day.

The first volume was designed to encourage the recording engineer to make experiments in recording and listening without necessarily having any theoretical background that would influence his judgment during the listening process. The second volume deals in some detail with the theoretical and psychoacoustical background that we need to develop a real understanding of the many microphone arrays that are now available for sound recording. This volume covers the development of microphone arrays for stereo sound recording through the multichannel and Blu-Ray era, right up to the most recent developments in 3D array recording and reproduction.

One of the attractive characteristics of this book is the number of illustrations that help the reader to understand some of the complex principles of array design, together with only a limited amount of mathematics. This book should be a basic textbook for anyone studying sound engineering, and is a 'must' for any sound recording engineer already working in the field of microphone array recording.

Umberto Nicolao

**Assistant Professor of Audio Engineering Technology**

MIKE CURB COLLEGE of ENTERTAINMENT and MUSIC BUSINESS
BELMONT UNIVERSITY

The Mike Curb College of Entertainment and Music Business at Belmont University is seeking applications for a tenure-track faculty position at the rank of Assistant Professor beginning August 1, 2013.

Job responsibilities include teaching undergraduate and graduate audio engineering and music production courses specifically oriented toward application and research in audio/sound production, acoustics/psychoacoustics, advanced audio analog/DSP technology, or sound reinforcement and concert production. Additional responsibilities include academic advising, student mentoring, scholarly activity, and college and university service. An earned Ph.D. or terminal degree in the discipline is preferred; master's degree and teaching experience is required. As all Belmont undergraduates complete an innovative general education program with significant interdisciplinary components, Belmont University is particularly seeking applicants who can demonstrate the interest and ability to work collaboratively in course design and to teach interdisciplinary and topical courses in this program.

For additional information about the position and to complete the online application, candidates are directed to **https://jobs.belmont.edu**. An electronic version of a Cover Letter, Curriculum Vitae, and List of References with contact information must be attached in order to complete the online application.

The university seeks a person of Christian faith and commitment to the mission of the university. During the application process, applicants will be asked to respond to Belmont's mission, vision, and values statements, articulating how the candidate's knowledge, experience, and beliefs have prepared him/her to contribute to a Christian community of learning and service and give a brief statement of teaching philosophy.

Belmont seeks to attract an active, culturally and academically diverse faculty of the highest caliber skilled in the scholarship of teaching, discovery, application, and integration of faith. Belmont is among the fastest growing universities in the nation. Ranked No. 7 in the Regional Universities South category and named for the fourth consecutive year as one of the top "Up-and-Comer" universities by U.S. News & World Report, Belmont University consists of approximately 6,400 students who come from every state and 25 countries. Committed to being a leader among teaching universities, Belmont brings together the best of liberal arts and professional education in a Christian community of learning and service. The university's purpose is to help students explore their passions and develop their talents to meet the world's needs. With more than 75 areas of study, 20 master's programs and four doctoral degrees, there is no limit to the ways Belmont University can expand an individual's horizon.

A comprehensive, coeducational university located in Nashville, Tennessee, Belmont is a student-centered Christian university focusing on academic excellence. Belmont University is an equal opportunity employer committed to fostering a diverse learning community of committed Christians from all racial and ethnic backgrounds. Women and minorities are encouraged to apply.

Review of applications will begin immediately and continue until the position is filled.

The selected candidate for this position will be required to complete a background check satisfactory to the University.

# Obituaries

## Willard (Bill) Merrill 1926–2012

Willard Curtis Merrill died peacefully at home after a long illness from cancer. He was a pioneer in sound design for the Broadway theater. Known professionally as Bill Merrill, he introduced the wireless microphone to Broadway in the late 1950's and was instrumental in turning sound into a credited design element alongside set design, costume design and lighting design.

A sound design prodigy, with no formal training, he had not actually intended to be a sound designer. He came to New York City, as a young man in the 1950's, with his two best friends, Jim McKenzie (ACT San Francisco & Executive Producer Westport Country Playhouse) and Spofford Beadle (a producer and also House Manager of Phantom of the Opera for 17 years).

The three friends intended to produce shows. But the young Bill Merrill had a natural instinct for the principles of sound engineering and how to put them to work in the theater, which caused him to see and take advantage of an opportunity. He had found his entree into the Broadway world he loved. He saw a need and met it. Asked the secret to his success in the sound business, he said it was his ears. His ability to hear things that others couldn't.

From 1965 until his death he was president of Port-O-Vox Enterprises, which he founded. The shows he designed included original productions of *The Music Man*, *How to Succeed in Business Without Really Trying*, *Carnival*, *Peter Pan*, and *An evening with Nichols & May*. In the early days, Port-O-Vox manufactured their own wireless microphones.

In addition to designing specific shows, he also provided custom services and specialized electronics for the performing arts, and designed sound systems for numerous theaters around the country whose venues had to accommodate a variety of shows.

He worked with many legendary performers. He wired Marlena Dietrich for her nightclub act at the Waldorf Astoria. When his parents visited from Wisconsin, Dietrich invited them backstage after the show, and to their delight and surprise, the great star made and served them tea in her dressing room. He like to tell how he put the wireless mike on Mary Martin for the flying sequences in "Peter Pan", and claimed that when she threw the fairy dust, he was standing under her just out of camera range and it landed on him. His longtime next door neighbor in New York City, is Sondra Lee, who played Tiger Lilly.

He enjoyed telling friends about the time he went to pitch the new wireless mike to Ethel Merman. He met her at her apartment. She was amused, but incredulous at the suggestion that she would need such a thing, and politely declined.

Willard Merrill was a member in good standing of the Audio Engineering Society from the 1950s until his death. In October of 1960 he presented a paper at the AES 12th Convention entitled, "The Integrated Use of Miniature RF Microphones in Television Studio Production Versus Pre-Recording."

He last attended an AES meeting at Les Poisson Rouge in early 2009, at which the new sound system for the club was demonstrated. Les Poisson Rouge occupies the space that used to be the Village Gate, where, in 1968, Mr. Merrill had been the sound designer on the hit show "Jacques Brel Is Alive and Well and Living in Paris." He was delighted to be in the space again and had good conversations with many of the attendees about the acoustical challenges of the space.

Bill loved being a "sound man" and took as much pleasure working for university athletic departments as he did working on Broadway. His last gig was at the age of 84 at Villanova University.

Bill is survived by his loving, long-term partner, Michael Mullins, as well as by his sister-in-law Jacky Merrill, his nephews Patrick Merrill and CJ Merrill, and his nieces Susan Lepore and Christy Sopko.

Michael Mullins

## Frank D. Laico
## 1918–2013

Frank Laico, longtime Columbia Records engineer and one of the preeminent studio craftsmen of the last century, passed away at his residence in Shoreline, Washington on April 19. He was 94.

From 1946 until 1982, the New York-born Laico presided over scores of classic Columbia jazz sessions by Miles Davis, Thelonious Monk, Stan Getz, Bill Evans and others, while cutting pop hits for the likes of Tony Bennett ("I Left My Heart in San Francisco"), Bob Dylan ("Positively 4th Street") and Frank Sinatra ("Theme from New York, New York"), recorded mainly at New York's renowned 30th Street Studio. In the early '90s Laico reunited with his longtime friend Bennett for a string of projects that included Bennett's 1992 Grammy Award-winning comeback album, Perfectly Frank. The Audio Engineering Society honored Laico with its prestigious AES Honorary Member award in 2011.

The only engineer to begin recording on wax and end on digital multitracks, Laico came into the business with no formal training. One of seven children raised in Manhattan during the Depression, as a teenager Laico sacrificed schooling in order to help support his family. While working at a Bronx butcher shop in 1939, by chance Laico landed an apprenticeship at the World Broadcasting Corporation; by 1946, Laico had his first job at Columbia, wiring up microphones at the company's Studio A facility on 799 7th Avenue. With three years of service to his credit, Laico was well positioned when Columbia transformed an old Armenian church on East 30th Street into its newest recording facility in the fall of 1949.

Over the next 30 years, the signature sound that Laico would help develop at the palatial 30th Street Studio would become his lasting legacy. With its 100-foot high ceilings and an equally massive floor space, the studio, like nearby Webster Hall and the Pythian Temple uptown, helped promote the bigger-is-better recording ethos of the 1950s. Harnessing the enormous ambiance was not for the faint of heart, yet Laico's ability to capture on tape the excitement of a large, live performance within such a vast setting—using few gadgets but endless ingenuity—made him one of the acknowledged masters of his trade. Decades later, the subtleties of Miles Davis' 1957 classic "Round About Midnight", Tony Bennett's pulsating rendition of the Broadway standard "Toot, Toot, Tootsie! (Goodbye)" (from 1961's My Heart Sings), as well as thousands of other pivotal recordings from the time are testament to Laico's engineering excellence.

"Frank was one of the all-time great mixers—no question about it," affirmed producer/engineer Roy Halee, a colleague of Laico's at Columbia. "At 30th Street, you could whisper at one end and hear it all the way across the room, and that scared a lot of people. But not Frank—he could take anyone in there and get a really fine sound. He had that studio in his back pocket."

In 1990 at the age of 72, Laico was lured out of retirement by his friend Tony Bennett, who tapped Laico to handle the re-mix work for the Columbia compilation Forty Years: The Artistry Of Tony Bennett. With Bennett on the rebound, in 1992 Laico found himself back in the control room for the making of Bennett's Perfectly Frank, the Sinatra tribute album. More than 40 years had passed since Laico's first session with Bennett at 30th Street, making theirs the longest surviving artist-engineer relationship in history.

Though his name often went missing from album sleeves and liner notes over the years, Laico's skill as a studio craftsman was never lost on those who sought his services. Laico recalled a late '60s session with Frank Sinatra, who'd returned to New York for the making of the Cycles album with producer Don Costa. "After that first session, Sinatra came up to me and handed me this roll of bills, as a way of saying 'thank you,'" said Laico. "I told him, 'please, I can't accept the money—besides, it's more important that you just respect me the same way I do you.' He said, 'Well, I can appreciate that, but you're here most nights until midnight, and you probably don't get to see your wife and children that often as a result, right?' So he asked me if I would just give the money to my wife Colette, and have her pick out the best restaurant around so we could all go out and have a nice dinner, on him. I told him I could live with that—just this once!"

A U.S. Army veteran, Laico worked on the top-secret Bell Laboratories communications operation "SIGSALY" during World War II, and earned a Purple Heart.

He is survived by his wife Colette; his children, Frank (Joan) Laico and Annette Laico; and two grandchildren, Stephen Laico and Jennifer (Theran) Colwell.

The family would like to acknowledge Dan Mortensen and the Pacific Northwest Section of the Audio Engineering Society, as well as writer Dave Simons, whose book Studio Stories recalls Laico's remarkable career.

In lieu of flowers, please contribute to Paws, PO Box 1037, Lynnwood, WA 98046, www.paws.org.

Dan Mortensen