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The Acoustical Society of America

ECHOES

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Harvey Fletcher

by William J. Strong and Jont B. Allen

Harvey Fletcher (1884-1981) was a founding member and first president of the Acoustical Society of America. He made important research contributions to electron physics, speech and hearing, communication acoustics, and musical acoustics. Among these were contributions in the development of the audiometer, electronic hearing aids, stereophonic sound, the artificial larynx, and sound in motion pictures. He, with his colleagues, introduced or quantified the concepts of articulation, loudness, and critical band. Along with his colleagues, Fletcher made many experimental measurements to define and support these new concepts. He has been described as "a singular intellectual force in the development of present-day communication acoustics and telephony."

Harvey Fletcher

Harvey Fletcher was born in Provo, Utah on September 11, 1884 and grew up in a family of five boys and three girls. The family enjoyed camping trips and father and sons enjoyed fishing. After a day of fishing success Harvey was challenged by a coyote on the trail back to camp. He stunned the coyote with a rock and ended the day with a large string of fish and a coyote.

He almost decided to forego school after the eighth grade but enrolled in the Brigham Young Academy (BYA) because he thought it would be fun to be with his schoolmates again. He neglected the assigned work and failed his first high school physics class, then repeated the class, received an A+, and became a lab assistant. He completed a three year B.S. degree at the BYA in 1907. During this time he and friends put their book learning to work by contracting trench digging for the Provo water supply, laying out the block "Y" on the east mountain, and surveying large sections of land for the government.

Harvey took his new bride to Chicago in the fall of 1908 to begin study for his Ph.D. where Robert Millikan had been using water droplets in an attempt to measure the charge on the electron. In the fall of 1909 Millikan told Fletcher that his thesis was to try a substance other than water in the study of the electron charge. He immediately went to a drugstore and bought an atomizer and watch oil. He assembled an apparatus that gave him fairly good results the first day. It took several days to draw Millikan's attention to his new results, but once Millikan saw what young Harvey had done, he worked with Fletcher every day over the next two years. Although Fletcher carried out much of the work on the oil-drop experiment and even wrote the papers, publication of the results listed only Millikan as author and was largely responsible for his Nobel Prize. Fletcher received his Ph.D. in physics "summa cum laude" in 1911.

After graduation he was offered a position in research at the Western Electric Company. However, he felt an obligation to return to Brigham Young University (BYU) where he served as head of the Dept. of Physics and taught and carried out research for the next five years. During this time he mentored Carl F. Eyring, Wayne B. Hales, and Vern O. Knudsen. Finally, he responded to Jewitt's yearly importuning in 1916 and accepted a position at Western Electric. His first years there were spent installing telephones, repairing telephone equipment, and working on wartime acoustic technology.

Immediately following World War I Fletcher was able to get his research in communication acoustics underway. The newly created vacuum tube electronic technology enabled a renaissance in acoustics research. More precise measurements were made of the threshold of audibility. Since the commodity being delivered by the telephone business was reproduced speech, it was necessary to measure the effectiveness of different telephone systems. Fletcher's articulation theory quantified the transmission properties of a transmission system without the need for time consuming speech recognition testing. Articulation was defined as the probability of correctly trans-

continued on page 16

We hear that...

• **Brian C. J. Moore** has been selected to receive the 2004 International Award in Hearing from the American Academy of Audiology. He was cited for his pioneering works focusing on the mechanisms of normal and impaired hearing, speech perception, and advancement of technology for individuals with hearing impairment.

• **William A. Kuperman**, Scripps Institution of Oceanography, University of California, San Diego, has been elected to the National Academy of Engineering. He was cited for international leadership in the development and application of computational methods for ocean acoustics

• **Dick Botteldooren**, Ghent University, is the new editor-in-chief of *Acustica/Acta Acustica*, succeeding Michael Vorländer, who served in that position from 1998-2003. **Michael Möser** is the new editor for *General Linear Acoustics*, and **Jian Kang** is the new editor for *Environmental Acoustics*. Special issues in Musical Acoustics and Spatial and Binaural Hearing are planned during 2004.

Sean Wu, professor of mechanical engineering at Wayne State University, received the 2004 graduate mentor award in natural sciences and engineering at Wayne State.

• A joint meeting of **ASA** and **EAA** (European Acoustics Association) is being planned for Paris, June 22-28, 2008.

• **Gerald Kidd, Armin Kohlrausch, David Dowling, T. Douglas Mast** and **James A. Simmons** have been appointed associate editors of JASA.

• **Theodore M. Farabee**, Naval Surface Warfare Center, has been named a Fellow of ASME (American Society of Mechanical Engineers).

History, History, History

I guess by now even our newest members realize that this year ASA is 75 years old. A history of the Society is in publication, and we will hear lots about the "early years" at our Anniversary Meeting in New York, but this issue of *ECHOES* includes several reminders of the past, as well.

ECHOES

Newsletter of the Acoustical Society of America

Provided as a benefit of membership to ASA members

The Acoustical Society of America was organized in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.

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Our cover story is a biography of Harvey Fletcher, our first president, written by his colleagues Bill Strong and Jont Allen. This is the sixth in our series of biographies about our founders: Dayton Miller, Wallace Waterfall, Frederick Saunders, Floyd Watson, and Vern Knudsen have been similarly honored in previous issues of *ECHOES*. We hope you have enjoyed these biographical sketches. We have certainly enjoyed putting the series together.

A section in this issue entitled "Looking back" includes recollections by Leo Beranek (ASA president 50 years ago), Jim Flanagan (president 25 years ago), Bob Beyer, Allan Pierce, and Rhona Hellman. Several other long-time members were invited to reminisce but declined the honor. Rhona was the only person who answered our plea for recollections in the last issue (are other readers too modest or too forgetful?) Gary Elko made a trip to the site at which ASA was founded and took a photograph. At any rate this issue has an historical theme.

Having been given permission to include a color centerfold, your editor stubbornly stayed with that idea even when photos did not pour in as he had hoped. Of course color photos were not so common 50 and 25 years ago, so many of the photos are from my own collection of photos at ASA meetings in more recent years.

Although I was born the same year as ASA, I didn't join the Society until 1975. I served on the technical program committee for the St. Louis meeting in 1975, and later that year I presented my first ASA papers at the meeting in San Francisco. I began teaching musical acoustics (at St. Olaf College) in 1957, but I didn't begin research in acoustics until the early 70s. What an enjoyable 29 years it has been!

To the Editor

Addition to the Knudsen story

Congratulations on another superb issue of Echoes. Your Fall 2004 opus is packed full of useful news items on contemporary acoustical topics, reviews of items from other journals, "echoes" from Austin, and, most interestingly, Bob Gales story on Vern Knudsen, an excellent continuation of your series on the founding fathers of our Society.

I'd like to point out one omission in the Knudsen story. I recall that David Lubman was deeply involved in the compilation of the collected papers (ref 4) as well as in establishing the Vern O. Knudsen Distinguished Lecture series sponsored by the Technical Committee on Architectural Acoustics and which has continued every year or so at regular meetings of the Society since Isadore Rudnick presented the very first one in 1980.

I look forward to the forthcoming 75th ASA Anniversary issue of *ECHOES* and to future issues. Keep up the good work

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75th Anniversary Celebration in New York

An event not to be missed is the gala 75th anniversary meeting of the Acoustical Society to take place in New York, 24-28 May, 2004. In addition to an outstanding technical program, there will be a celebration with the theme "Glorious Past—Looking Forward."

The celebration will begin on Tuesday night with a banquet which will feature a video covering highlights from the Society's "Glorious past"—its first 75 years—including interviews with past presidents and some footage from the 25th Anniversary meeting.

This will be followed by day of celebration on Wednesday beginning at the City Center with a Plenary Session which includes the presentation of two silver medals, the R. Bruce Lindsay Award, and the Gold Medal to Chester McKinney. Nine of the younger members will give brief views on how the Society should be "Looking forward," followed by real music by a virtual orchestra. A variety of tours, organ concerts, and other interesting events have been scheduled around New York for the balance of the day (see the ASA website <http://asa.aip.org> for details).

The technical program includes more than 40 special sessions, many with an historical flavor, plus lecture and poster sessions (see report from the Technical Program Committee below). A tutorial lecture on Listening to the Acoustics in Concert Halls will be presented by Leo Beranek and David Griesinger on Monday, 24 May at 7:00 pm. Distinguished lectures on "Communication Acoustics" (Jens Blauert) and "Noise: My 62 Years of It" (Laymon Miller) are on the program.

Attendees should note that Friday will have a full program of technical papers, and it would be wise to plan for an extra night in New York. After all, ASA turns 75 only once!

Back Row (L to R): Natalia Sidorovskaia, Gary Elko, Elisa Konofagou, Glenis Long, John Erdreich, Fredericka Bell-Berti, James Simmons, Ron Roy, Vic Sparrow, Ellen Livingston, James Preisig, Katherine Sawicki, Kyle Becker, Zoi Heleni Michalopoulou, Robert Kull, Brigitte Shulte-Fortkamp, Damian Doria. Front Row (L to R) Jeffrey Ketterling, Laura Koenig, Carr Everbach, Geoffrey Edelson, Courtney Burroughs, Bennett Brooks (not pictured Ilene Busch-Vishniac, Elaine Moran and Charles Schmid)

Technical Committee performs a miracle

Twenty six ASA members gathered on February 6-7 to sort over 1200 abstracts for the New York meeting. Their task was to fit this large number of papers into 4 days of the meeting week, and they ended up with 101 sessions. This will be the 4th largest meeting in ASA history, but the largest that is not a joint meeting. The Berlin meeting (joint with EAA) had 1955 papers, followed by Seattle (joint with ICA) with 1504 papers and Honolulu (joint with ASJ) with 1335.

The Technical Program Chair, Gary Elko, and Co-Chair, Damian Doria, are to be congratulated for leading the 22 technical representatives in arranging the sessions. Kathy Sawicki assisted Damian Doria with room assignments. The number of abstracts in each of the technical areas is roughly as follows:

	Invited	Contributed		Invited	Contributed
Acoustical oceanography	14	51	Noise	45	35
Animal bioacoustics	25	42	Physical acoustics	16	90
Architectural acoustics	40	174	Psych. & Physiol. acoustics	16	120
Biomed. ultrasound/Bioresponse	22	74	Signal processing	7	45
Speech communication	13	218	Structural acoustics	4	37
Education in acoustics	11	5	Underwater acoustics	7	92
Engineering acoustics	1	20	Standards	6	2
Tutorial	1		Musical acoustics	18	21

Looking back

Acoustical Society of America: A transition period 1954-1960

by Leo L. Beranek

The Acoustical Society of America had just completed the celebration of its 25th Anniversary when I took office as its sixteenth president. The New York meeting boasted 548 registrants, 151 papers (65% more than at any previous meeting) presented in three parallel sessions. A 4-hour banquet, film-recorded, was held with 90 at the head table and with words by nearly all of the Society's prominent members. The Society's membership totaled 1850 and about 1200 pages were published annually in JASA. This article is largely a presentation of my service to the Society from 1954 to 1960. Reference to a chart of "Growth of Society Members," contained in the *Membership Directory and Handbook of the Acoustical Society of America*, reveals that those years spanned the most rapid period of growth of membership of the Society in the post-World War II era.

Before the end of World War II, the Acoustical Society resembled a club. There were no competing parallel sessions, every one could attend all papers, and even university graduate students could personally get to know the great names in acoustics, e. g., Harvey Fletcher, Vern Knudsen, Floyd Watson, E. C. Wente, John Steinberg, Floyd Firestone, etc. By 1954, apparent to many of us, cracks were beginning to show in the structure. With parallel sessions, the psychologists and physiologists were becoming separated from engineers and physicists. The tenure of presidents was only one year and before 1948 there was no position of president-elect. The Society was de facto governed by the Secretary and the Treasurer each of whom held office for many years.

Glaringly apparent was the recent founding of the Audio Engineering Society and the Professional Group on Audio and Electroacoustics of the Institute of Electrical and Electronic Engineers. There were rumblings of a new psychologist and physiologist society. The most heard reason for separate organizations was that the ASA's elected officers and council were primarily interested in physical acoustics.

As President, I introduced, with strength of purpose, the subject of "Restructuring the Society" at my first business meeting in Austin, Texas. As a result of a long and unexpected floor discussion that very week the Council voted to form a "Committee on Organization and Development" with Bruce Lindsay as chair. Its charge was to determine whether to (a) expand the membership in places; (b) establish regional chapters; (c) increase its effectiveness in contiguous fields; (d) satisfy in additional ways the needs of various groups; and (d) change the Society's setup so as to adequately handle the needs of its membership. At the next meeting, in Penn State, this committee met all day "to discuss the various ways in which the Society could serve its members more effectively." At the business meeting, Lindsay recommended, and later the Council voted, "to strengthen and to extend the committee system to include ten areas of acoustics and to outline thoroughly the duties and responsibilities of the technical committees." The Council also requested that "this committee prepare a 'white paper' on this subject for mid-winter publication in order to stimulate wider discussion of the central question of whither acoustics and the Acoustical Society." The committee's report was prepared and was mailed October 28, 1955. It can be found in JASA, Vol. 28, 504-505 (1956).

Immediately after the issuance of this report, ASA Chapters were established in San Diego, Los Angeles and Delaware Valley. More followed in succeeding years. The committee structure was enlarged and the Council asked the committees to take a more aggressive part in the operation of the Society. By the end of my presidential year, six technical committees were in existence, Architectural Acoustics, Musical Acoustics, Noise, Psychological and Physiological Acoustics, Speech Communication, and Ultrasonic Engineering.

By November 1956 there were ten Technical Committees, the new ones being Audio Engineering and Electroacoustics, Physical Acoustics, Shock and Vibration Acoustics, and Underwater Acoustics. In May 1958, for the first time, meetings of the Technical Committees were open to general attendance. Today there are thirteen technical committees.

Thus, ended my initiation of "Restructuring the Society" that occurred at my first business meeting in Austin, Texas, November 1954.

Three activities of the Acoustical Society, to which I devoted considerable effort, were related to noise, standards and architectural acoustics. In regard to noise, legal court actions in several states made progressive damage to hearing compensable. Previous law had held that employers were responsible only for traumatic damage. Some industries whose operations involved intense noise levels were faced with potential claims of billions of dollars from those who were exposed to noise in their operations for long periods of time. To meet the sudden demand for information, several consulting firms, including Bolt Beranek and Newman, of which I was President, urged the Society to take a more active part in noise and its control. In response, the Society initiated publication of a magazine, *NOISE Control* in 1952. An advanced printing of the first issue was handed out the November 1954 meeting of the ASA in Austin, Texas.

In regard to acoustical standards, writing of them had been around since 1932 under a committee named "Sectional Committee Z-24" with Vern Knudsen as Chairman. When I assumed chairmanship of Z-24 in 1950, five standards had been completed: acoustical terminology, noise measurement, sound level meters, standard microphones, and calibration of standard microphones and earphones. I instituted a new system of operation. The Sectional Committee on standards met in a session with open attendance twice a year with power to start new projects, to approve drafts of standards, and to discharge projects either after completion or failure to perform. Two entities were instituted, exploratory groups and writing groups. An exploratory group was to investigate whether a subject was ready for standardization, with a term of one year. A writing group was to

produce a written standard for approval by Sectional Committee Z-24, with a nominal term of three years. The plenary sessions, under my chairmanship, were circuses and were heavily attended. Many persons attempted to introduce standard activities and the needs or forms of them were hotly debated. Some said those sessions were the most interesting of the week-long meetings. I resigned the chairmanship in 1954 upon election to the office of president. By then, twelve standards were available (for 50 or 75 cents each) and twenty-three writing projects were underway. Lawrence Batchelder was named the succeeding chairman, a position he held until 1973. In December 1955, an Acoustical Standards Board of the American National Standards Institute was formed with me as chairman, Wallace Waterfall, vice-Chairman and S. David Hoffman, Secretary. In June 1956, the Board voted to divide Z-24 into three new Sectional Committees dealing with bioacoustics, physical acoustics, and shock and vibration.

Finally, for fourteen years, starting in 1945 I served as Associate Editor of the *Journal* for Architectural Acoustics. A letter of appreciation was carried in the December 1959 issue of *JASA*, Vol. 31, p. 1686.

A peculiar situation arose during my watch as President, following the publication of Acoustical Society News in the March 1955 issue of *JASA*.This news piece was written by Floyd Firestone, Editor-in-Chief of the Society. I quote Firestone's own description of the affair in the September 1955 issue under the heading 'Reverberation': "The editor has heard some comment, both pro and con, on the breezy style of his reporting…In the future, my reports will be reviewed by some other member of the Council. Furthermore, I have been directed by the Council to apologize publicly for the use of a substandard term in a poem. Some…have also expressed disapproval of my judgment and taste in placing the photograph of the dancing girls on the cover of our program, and in the publication of an unflattering photograph of an esteemed member…I sincerely apologize…" Nevertheless, Floyd Firestone received, at the Penn State meeting in May 1955, the third Gold Medal Award of the Society. Partly because of the "Reverberation" affair, Firestone resigned the Office of Editor-in-Chief in June 1957. Except for the 50th Anniversary Meeting in Cambridge in May 1979, Firestone did not appear at another meeting of the Society, a great loss to all of us.

Today, at each meeting of the Society, I regularly attend the evening meetings of the Architectural Acoustics (TCAA) and Noise (TCN) Technical Committees. The chairpersons have a carefully prepared schedule of topics to be presented and discussed, which often include new technologies, research, outreach to the public, students and education, publications, awards, membership, other professional organizations, and Society issues. Financial concerns are also discussed, such as funding of certain technical initiatives that can range from student competitions to public outreach; since each proposal must be submitted to the Society's Executive Council for approval, each is carefully considered and sometimes debated into a form which typically ensures approval.

Most important at these committee meetings is the planning of technical sessions for future Society meetings on a variety of subjects that are current and for which someone will assume chairmanship and responsibility for obtaining invited papers. Much of the success of this approach is due to the generosity and enthusiasm of the committee members, who quickly volunteer, and who can be confident of gracious cooperation from all of the other members. This procedure has led to sessions at subsequent meetings that have papers broad in scope and presented by those heavily involved in the subjects. Perhaps surprising for a scientific society, most of the members of these committees are not primarily involved in fundamental research, but are consultants, teachers, manufacturers of acoustical products, or others who usually emphasize applications over well-funded research.

Previous to the evening meetings, and typically the first day of the Society's week-long meeting, the chairpersons have attended a Technical Council meeting, which is comprised of the chairpersons of all the technical committees, and is presided over by the Vice President of the Society. Guests, such as members of related societies or representatives of various activities, also attend to discuss issues of possible concern to the Society. The chairpersons are informed of actions previously taken by the Executive Council, and are requested to respond to questions raised in that Council meeting or to bring items for deliberation to their committees. Society-wide budget considerations are presented and discussed, as well as proposed technical sessions, various publications, seminars, administrative matters, business issues, and satellite meetings.

Similarly, the Technical Council meets again after the evening meetings of the committees, typically on the last day of the Society's meeting, and their requests for financial needs and other considerations are collected and passed on to the Executive Council, which meets immediately thereafter. This procedure induces a general feeling that the thirteen technical committees are having a say in the Society's governance and that they are well informed on Society-wide activities and concerns. No longer does the Society need to be governed by a few perennial officers.

Leo Beranek is best known for his books on acoustical measurements, electroacoustics, noise and vibration control, and concert hall and opera house acoustics. A past-president of the Acoustical Society of America, he received, along with seven others, the National Medal of Science Award from the President of the United States in November 2003 (see page 10).

Recollection of the 50th Anniversary meeting

My foremost recollection of the 50 year ASA meeting was the receiving line for Dr. Harvey Fletcher that was held at the Boston Museum of Science. As I remember it, at one point it was 2 floors in length. Unfortunately, I did not have my camera with me on that day.

Rhona Hellman

1979 – An ASA Year to Remember

by James L. Flanagan

As we approach the 75th anniversary of the founding of the Acoustical Society of America, Editor Rossing invites recollections from past activities. My assignment was to look back 25 years to the 1979 frame, during which I had the great privilege of serving ASA as President.

I consider that I had, literally, the "best of times." My administration commenced following the Providence meeting May 15-19, 1978. As incoming president I had the traditional honor or presenting the iconic ASA tuning fork to outgoing President John Snowdon as a memento of his term. Regrettably John was ill at the time, and outgoing Vice President Tony Embleton accepted on his behalf.

Ringing down the curtain on ASA's 50th anniversary celebration, incoming president Henning von Gierke presents the ASA tuning fork to outgoing president Jim Flanagan.

Both of the ASA meetings over which I presided were singular. The November 27-December 1, 1978 conference was planned as the first joint meeting with the Acoustical Society of Japan. An appropriate venue, equidistant between our respective land masses, was chosen – Honolulu, Hawaii! This idyllic and hospitable environment of varied cultures proved enormously popular with scientists from both ASA and ASJ. (The only negative for those of us in industry at the time was convincing management that the conference was a truly serious one, and that we were totally justified in sending so many researchers to present papers at the meeting!)

The first joint meeting was exceptional in attendance and technical program. Some 800 scientific papers crowded the agenda, with each country making its strongest efforts in representing its diverse research in acoustics. As President I was provided luxurious quarters on the "penthouse floor" of the Sheraton Waikiki, as was my fellow President of ASJ, Dr. T. Nimura. Each of us strove to be the best host in reciprocally entertaining foreign visitors and notable colleagues.

The awards banquet was a "double-header" highlight, with ASA Silver Medals being presented in Engineering Acoustics and in Noise, followed by the prestigious Trent-Crede Medal. In turn President Nimura presented the Sato Medals of the ASJ to Japanese scientists. Newly-elected Fellows of ASA were recognized, and, in a special action, the ASA Executive Council used the occasion to honor new Fellows from Japan, some seven in number. Finally, in a pleasant and surprising move, President Nimura called upon President Flanagan and meeting Cochairman John Burgess to receive special awards from the ASJ. The follow-on evening's entertainment reflected the best of Hawaiian culture.

This stellar event was followed six months later by our celebration of the Society's 50th anniversary, held June 10-15, 1979 in Cambridge, Mass., making use of MIT's Kresge auditorium for the plenary sessions. This unique convocation boasted some 700 technical papers, attendance by a dozen charter members of the Society, and varied conviviality and musical diversions arranged by MIT leaders Dick Bolt, Leo Beranek, and their associates. At the opening plenary, I had the pleasure of reporting numerous congratulatory messages received from both our country and from around the world. These included the President of the United States, the Presidents of both our National Academies, the Governor of Massachusetts, the Czechoslovak Academy, officers of ASJ, the European Federation of Acoustical Societies (some 20 countries), the Acousticians of the French language, and the Institute of Noise Control Engineering.

This singular meeting also chose to honor, with the Society's Gold Medal, one of our leading and most influential acousticians – Dick Bolt. Leo Beranek wrote the elegant encomium summarizing Dick's career, and introduced the honoree to the awards convocation. (For me it was a special time to recollect our recent service together on the federal panel to study the Watergate tapes.) At the closing plenary, incoming President Henning von Gierke presented to me the inscribed ASA tuning fork which has occupied a prominent place in my study since that date. As if I needed an additional reminder of a unique year in the administration of our Society, I cherish this memento and the recollection of the grand events of which I was privileged to be a part.

Jim Flanagan is Vice President for Research at Rutgers University, and also serves as Board of Governors Professor in Electrical and Computer Engineering and Director of the Rutgers Center for Advanced Information Processing (CAIP). Flanagan joined Rutgers in 1990 after completing a 30-year tenure in research and research management at Bell Laboratories, where he was Director of Information Principles Research. He received the National Medal of Science in 1996.

ASA was born at the Bell Telephone Laboratories

by Gary W. Elko

The Acoustical Society will celebrate its 75th anniversary in New York City where the Society was organized and held its first meeting. The history of the original organization of the Society is well documented by Wallace Waterfall in the first issue of the *Journal*. The venue for the meeting called to organize the society in 1928 was the Bell Telephone Laboratories at 463 West Street in Manhattan. Bell Labs also hosted the first meeting of the Society in May 1929. The building at 463 West Street was initially built as a factory along with general administration for AT&T. A photograph of the building from the West Street side shows part of the whole complex of AT&T buildings that filled an entire city block.

AT&T centralized their engineering staffs from Boston and Chicago in this building around 1920. It was not until 1925 when the engineering staff had grown to more than 1000 members, that Bell Labs was formally incorporated. Bell Labs mission was to supply the parent company with research and development. In 1928, Dr. Fletcher was a director of the now famous Acoustics Research Department at Bell Labs. It was at the invitation of Dr. Fletcher in response to initial inquiries from F.R. Watson, Vern Knudsen and Wallace Waterfall, that the first meetings of the society were held at the West Street Bell Labs location. The first meeting of the society was held on May 10-11 and H. D. Arnold of Bell Labs presented the first paper entitled "Acoustic Facsimile," (Arnold is credited with perfecting the vacuum tube amplifier that enabled coast-to-coast long distance telephony). Bell Labs staff members presented approximately one-third of the 25 papers presented at the meeting. According to records of the meeting, there were 165 attendees. For the 75th anniversary this May, there will be almost 1300 papers presented in four days. It is clear from the number of papers and the estimated attendance of over 2000 for the 147th meeting that the society has grown and flourished. The founders of the Society would undoubtedly be delighted by the success of their leadership and vision as demonstrated by the diversity and amount of papers that are scheduled for the 75th anniversary meeting in New York.

Bell Telephone Laboratories headquarters at 463 West Street in New York City circa 1950. The first meeting of the Acoustical Society was held in the auditorium in this building from May 10-11, 1929.

Gary Elko joined the Acoustics Research Department at AT&T Bell Labs in 1984. He joined Avaya in 2002 when it split off from Lucent (then the parent of Bell Labs), where he continues to work in acoustic signal processing related to telecommunication.

Some reminiscences of our Society

by Robert T. Beyer

It seems to me that, when I was young, I was always an uneducated wanderer in the academic field. Whether it was in graduate school or as a young faculty member at Brown, I didn't know anybody important and I didn't know much about my subject, whether in physical electronics, where I started, or in acoustics and ultrasonics, where I wound up. In the first three years of my career at Brown I thought of myself as a physicist rather than an acoustician. I went mainly to meetings of the American Physical Society (APS). But acoustics and acousticians gradually became more important to me, and the ASA won out over the APS.

Why was that? I think that in large measure it was the congeniality of ASA members. Betty Goodfriend once filled out a job description when she was our Secretary, saying that, among her other duties, she provided *gemuetlichkeit* to the Society. (If your German is weak, the word means all such things as congeniality, warmth, concern, friendliness). Then there is the legendary story (told to me by Betty) that there once was a business man from somewhere around Cleveland who happened by chance to enter the hotel at which ASA was meeting. He joined in with the flow of members, and found them so congenial that he became an associate member, and whenever we met in Cleveland, he came to the social end of our gatherings even though his work had nothing to do with acoustics.

The Society has always been lively and never stuffy. I remember a meeting at MIT more than fifty years ago, where an impromptu orchestra entertained us. I think it included Leo Beranek and Dick Bolt and other "dignitaries." And then there was a meeting in Washington DC, where I encountered a wild looking man, with a very large nose and hair that hung down everywhere. He was busy waving his hand violently while talking with two ASA members. Then he suddenly reached up, pulled off his nose and the hair, revealing a reasonable dignified, nearly bald member of some prominence (whose name eludes me).

A very important event began at the Austin meeting in the fall of 1954. I had become an associate editor of JASA, handling "References to Contemporary Acoustical Literature." And probably for that role (a very minor one in those days—200 references in every other issue of JASA) I was invited by Leo Beranek, the new president, to attend a special gathering on the day before the meeting. Apparently the growth of the Society had slowed, and Leo feared for its future. Out of our discussions (to which I don't think I added much) came the formation of technical committees. Looking back over fifty years, I think that this was the most significant nontechnical event in our history. I recall that there were great discussions as to whether to call the groups divisions or committees. Someone, possibly Walter Rosenblith, argued that divisions were divisive by their very name, whereas committees represented a "coming together." The term Technical Committees (TCs) won out, and history indicates that the TCs have played a vital role of bringing new members into the affairs of the Society. Oh yes, I had my first Margarita at that meeting.

And then there were the social hours. Let me review their history. At the earlier meetings, there was always a sit-down dinner, to which fewer and fewer members were coming. At the meeting in Salt Lake City in 1979, the Executive Council thought that the price being charged by the hotel was much too high for our members, and it agreed to subsidize the meal by setting the price of the tickets four dollars below the hotel charge. It didn't draw a great crowd (about 200), but it made things a little easier.

Before the next meeting, its chair, Dick Stern, called me (I was then Treasurer) and said that he didn't want a formal dinner, but rather a social hour. Would I allow support of food cost at four dollars a person? Here I made the fortunate mistake of saying yes, thinking that was a matter of four dollars times 200 or $800. But Dick thought it was four dollars times 1000 attendees or $4000. And, of course, everybody came.

Then at the meeting in Orlando, Joe Blue, the local chair, wanted two social hours, and the Executive Council allowed $4000 for the two occasions. If you attended that meeting, you know that the first evening was an extremely successful one—steamboat rounds of beef were sliced up for all, it was a great occasion, and so we all expected a repeat performance for the second evening.

But then Joe told me that he had used up $3000 for #1, leaving only $1000 for #2 and a menu of peanuts and potato chips. I told Joe the members would run him out of town with such servings, and so another two thousand was appropriated. And so it has continued. I'm glad that I don't know the total costs today, but I do know that the membership would give up almost anything else at the meeting rather than have the socials eliminated.

Bob Morse, our president nearly forty years ago, once remarked that when the ASA began, subject matter and the methods of treating it were such that most of the members could understand the papers in all fields. As time passed, although fewer and fewer members could follow what was going on in all fields, the established congeniality kept us together. He wonders whether at that time (1965), it would have been possible to create such a society.

More recently, Ilene Busch-Vishniac, our current president, tells the story of her first ASA meeting. Her hotel room was located between that of the Editor and his wife, and the Treasurer and his wife. She didn't know any of them, but she was impressed by their kindness to her. And so it goes. The Society remains open to and solicitous of the new and the old. Long may it live and so behave!

Robert T. Beyer, Hazard Professor of Physics Emeritus at Brown University, has worked in the field of acoustics for more than fifty years, mainly in ultrasonics and nonlinear acoustics. He served as treasurer of ASA for 20 years and was its president in 1968-69. He has also been a translator of German and Russian technical literature.

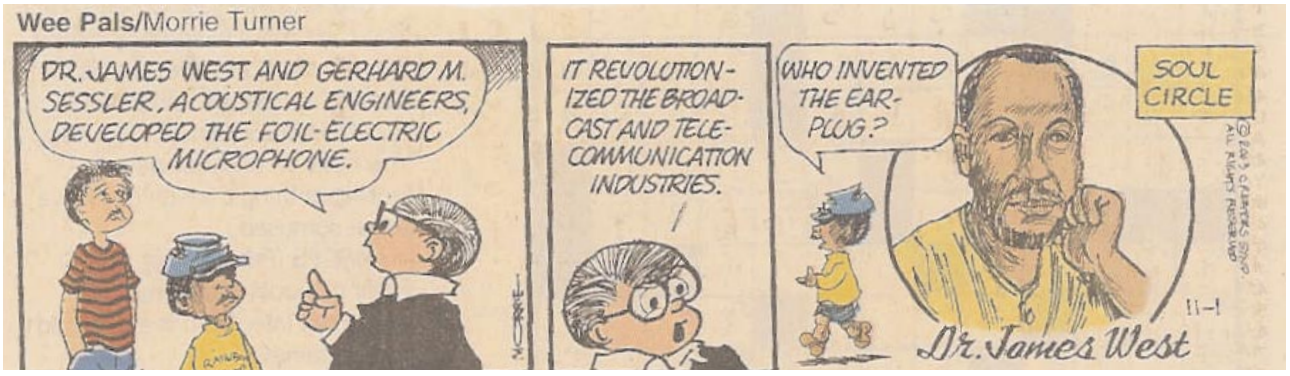
Notes about the Society's publications

by Allan D. Pierce, Editor-in-Chief

A fairly extensive account of the history of all the ASA's publications should appear in the 75th Anniversary Volume that should be available by the time of the New York meeting. The *Journal* is as old as the Society itself, and its growth has been roughly proportional to the membership of the Society. It is now possible, because of all of the back issues of JASA being on CD-ROM's, for anyone to own a complete set of JASA. The CD-ROM's for the first 100 volumes are such that one can literally read each issue, ads and all, from cover to cover. Browsing through these old issues is recommended as a good rainy day pastime. There is a lot of history there: one of this writer's favorite photos in the *Journal* is one of a man holding a sound level meter that must have weighed a full thirty pounds. The *Journal* did carry ads, between 1950 and 1970, and these make nostalgic reading. The meeting programs, which have always been part of the *Journal* have always had ads within them, and reading these as well as the titles and abstracts of old papers is also fun. One of the things which intrigues this writer is the apparent quick time in the early years between an editor receiving an article and its appearing in print. Six months would have on the longish side during the first 20 years. Can we ever get back to that rapidity with our present peer review system? Probably not, but with the electronic aids we have available to us now, we might be able to do a lot better than our more recent average of 18 months.

Probably, for most of us, checking on the *Journal* and its contents for the past seven years is most easily done via a desktop or laptop computer with an internet connection. Any member can access the online version of JASA by first going to the ASA webpage and doing the appropiate mouse clicks. And you don't even have to be a member to do this for ARLO, and its articles are easily digestible because of their brevity. If you are doing good research but suffer from writer's cramps, consider sending a paper online to ARLO. For that matter, if you have a longer paper, do so with JASA. It is a lot more fun now than it was in the old days. You just sit at your computer terminal, and you need no white-out and you don't need to retype pages, and when you are done, you don't need to find a big envelope and to have someone weigh it for postage — you just click a few buttons and type some more stuff on your computer, and presto! An electronic file of your manuscript and figures is on a computer in Melville, New York, and a sophisticated computer system is speeding your manuscript towards a (hopefully favorable) decision and eventual publication.

Creating the Books Plus program is, in this writer's opinion, one of the best things the Society ever did. Commercial publishers tend to let books go out of print fairly quickly, partly because of the way the US government collects taxes on recently printed books. Consequently, the vast majority of the great books in acoustics were either out of print or about to go out in print back in 1983. Then the Books Plus Committee was charged to change things, and the ASA got into the book publishing business. The books that have been republished so far have, for the most part, been classics, and the prices are generally much less than a meal in a New York restaurant.



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Current Year

Executive Council 2004

Back row (left to right): David Feit, Anthony Atchley, William Yost, George Frisk, Charles Schmid, Willian Kuperman, Mark Hamilton, Whitlow Au, Allan Pierce. Front row (left to right): Paul Schomer, Richard Stern, Ronald Roy, Ilene Busch-Vishniac, Winifred Strange, Mardi Hastings, Steven Brown.

Leo Beranek receives the 2003 National Medal of Science from President Bush

Student Council

(left to right) David Bradley (Chair), Erica Bowden, Alexandra Loubeau, Tessa Bent, Geoffrey Edlmann

Gary Elko (Technical Program Chair), Katharine Sawicki (Asst. to Co-Chairs) and Damian Doria (Co-Chair) relax after completing the two day New York Technical Program Organizing Meeting with room and time assignments for 101 sessions behind them

Scenes from ASA Meetings

Bill Hartmann presents the ASA President's tuning fork to Katherine Harris

Chicago-area teachers do acoustics demonstration experiments

Murray Korman

Uwe Hansen and high school student

Earl Blodgett and high school students

Carr Everbach and students

The ASA Family

Chris and Bill Hartmann

Christmas carol sing

Eric Ungar

Grandpa's book

Murray Campbell demonstrates the acoustics of a serpent

Tom Rossing, Manfred and Anny Schroeder, Adrian Houtsma

Freddie Bell-Berti and Laura Koenig got out for a walk in New York City between two days of organizing hundreds of abstracts for Speech Communication. Photo by C. Schmid

Hardening and softening nonlinear behavior in acoustic resonators

by Bart Lipkens

We have found that it is possible to create very large amplitude shock-free standing waves in shaped acoustic resonators. Overpressures of 400% of ambient pressure have been measured. An interesting nonlinear behavior is observed when measuring the frequency response functions of these shaped cavities.

First we introduce some of the terminology related to nonlinear oscillations by referring to the mechanical vibrations of a simple mass-spring system. Then we take a closer look at the nonlinear behavior of the shaped acoustic resonators.

Nonlinear or amplitude dependent, behavior of a mechanical oscillator such as a simple mass-spring system can be demonstrated by considering an amplitude dependent spring stiffness. A hardening spring behavior is observed when spring stiffness increases with displacement amplitude, whereas softening corresponds to a spring stiffness that decreases with amplitude. The Duffing equation is the standard equation that describes this nonlinear spring behavior. The frequency response function of a hardening spring is amplitude dependent. With increasing amplitude the resonance frequency increases. The response curve becomes asymmetric and "leans" towards higher frequencies. Eventually, the curve becomes multi-valued and hysteresis occurs. A similar curve is obtained for the softening spring, but this time "leaning" is towards lower frequency values.

Now let's look at the nonlinear behavior of acoustic standing waves in cavities. First let's focus on a cylindrical cavity. It is well known that at elevated amplitudes the propagation is nonlinear. An initially sinusoidal waveform distorts at elevated amplitudes and eventually becomes a sawtooth waveform, i.e., a shock followed by a smooth expansion. Once shock formation occurs, the peak pressure of the sawtooth saturates, i.e., reaches a maximum value. Any additional energy supplied to the wave is dissipated as heat across the shock front. Saturation occurs in a cylinder at peak levels of about 10% of ambient. Insight into this behavior is gained from inspection of the modal spectrum of the cylinder. For a cylinder the modal spectrum is consonant, i.e., the higher order modes are all integer multiples of the fundamental resonance frequency. For the cylinder the harmonic frequencies generated by nonlinearity for an excitation at the fundamental resonance frequency are coincident with the modal frequencies. This enables efficient transfer of energy from the fundamental frequency to the higher harmonics, and ultimately leads to shock formation. The frequency response curves for a cylinder are symmetric and do not show any hardening or softening behavior.

Now let's take a look at shaped resonators. For shaped resonators the modal spectrum is dissonant, i.e., the higher order modal frequencies are no longer multiples of the fundamental frequency. Two resonators were used in this study, the first is a cone, and the second is a bulb-shape. For the measurements the resonators were filled with refrigerant R-134a. Since the modal spectrum is dissonant, it follows that the harmonic frequencies are not coincident with the modal frequencies of the cavity. The growth of the harmonic amplitudes is therefore less than that for the cylinder. The frequency response function of the conical resonator is shown in *Fig. 1*. The response is that of a hardening nonlinearity, i.e., resonance frequency increases with amplitude and the curve "leans" towards higher frequencies. At high amplitudes the curve becomes multi-valued and hysteresis effects occur. The frequency response function for the bulb resonator is shown in *Fig. 2*. A softening behavior is observed for the bulb.

The interesting fact is that whereas for the mechanical system we had to change the material property to change the nonlinear behavior, it is sufficient to change the boundary of the resonator to alter the nonlinear behavior of the cavity. An

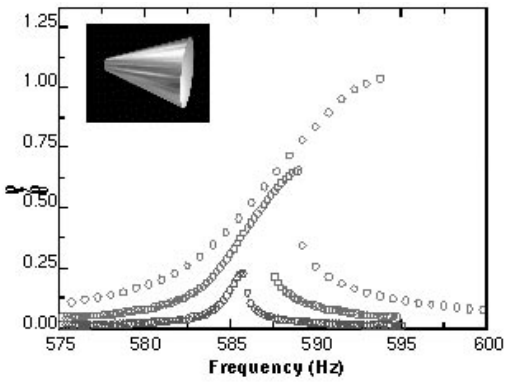

Fig. 1: Frequency response functions of the conical resonator. The relative pressure amplitude of the fundamental frequency component is shown versus frequency for three excitation levels. This is an example of a hardening behavior

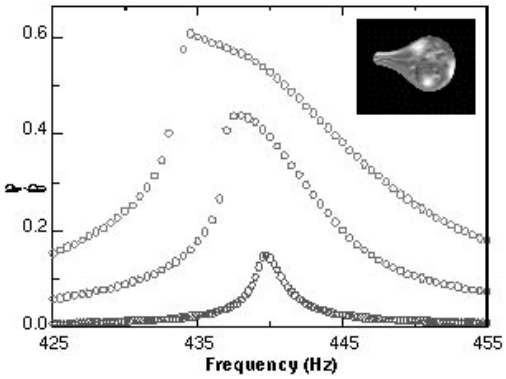

Fig. 2: Frequency response functions of the bulb resonator. The relative pressure amplitude of the fundamental frequency component is shown versus frequency for three excitation levels. This is an example of a softening behavior

continued on page 14

continued from page 13

explanation of the behavior is gained from an inspection of the modal spectrum. For the cone resonator the growth of the second harmonic is dominated by the contribution of the second mode. This typically creates a u-shaped waveform with narrow peaks and broad valleys. This wave shape exhibits hardening behavior. On the contrary, for the bulb resonator the second harmonic is dominated by the third mode and this creates an m-shaped waveform, i.e., broad peaks and sharp minima. Usually, softening behavior is observed.

In conclusion, frequency response curves of acoustic resonators are discussed. Both hardening and softening nonlinear behavior of acoustic resonators is reported. Changing resonator shape can change the nonlinear behavior as shown by the frequency response curves.

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The law is not science: The validity of voice identification.

by Peter Ladefoged

People often wonder about the accuracy with which one voice can be distinguished from another. Perhaps more important from a forensic point of view is the reverse of this question: not how accurately can voices be distinguished but how reliably can they be said to be the same. This is the question that is at the heart of many court cases. Is the voice that has been recorded on a tapped telephone really that of the accused or not? Unfortunately at the moment we do not know how reliably such judgments can be made. The main reason for this is that voices can differ from each other in so many ways. Even if we assume that there are two equally good recordings of the voices in question, that both speakers are talking for a reasonable amount of time, say, a full minute each, that they are using many of the same words, that they are both talking naturally, neither being excited nor bored nor amorous nor angry, and that there is no question of disguise or deliberate imitation of one voice by the other, even given all these factors we cannot estimate the degree of certainty of an opinion that two voices are the same.

Voices can differ in so many ways, or sometimes hardly differ at all. In a group of 30 people — say, the members of an office, or a school reunion, or an army platoon — there may be several voices that are similar, a number that differ somewhat, and one or two that are strikingly different from all the others because they have a drink-sodden whispery creak or a paralyzed vocal fold. Of course, even the latter speakers would not stand out if the group were all recovering alcoholics or patients in a speech pathology group. Having a distinguishable voice depends on many things.

A further factor preventing certainty in many voice identification questions is the possibility of confusion between close relatives. My father and I had so similar voices that neither of us could tell who had said what in recordings of us chatting. It was very easy to confuse my mother with her sisters. Even long-term friends from high school till years later can sound so alike that their families find it hard to tell them apart.

The forensic situation is further compounded by the fact that evidence in a case is not like data in an experiment. Scientists are used to gathering data in controlled situations and then drawing inferences from it. But every court case is like an experiment in which there are only one or two observations, made under unique circumstances. As a result, phoneticians, experts in the science of speech, do not know how to respond when they are asked to give evidence on speaker identification. They generally agree that it is possible for a trained observer to offer a valid professional opinion on the degree of similarity between two voices, each on a 15-minute studio recording. But they usually find it impossible to judge the degree of similarity between two voices on noisy three second bomb threats. Court cases can be like either of these situations or anywhere in between. There is no one way of considering the data that can be applied in all cases. Forensic phoneticians are like medical doctors giving prognoses. They make many tests that provide useful clues, but their opinions are inevitably based on their own experience of similar situations rather than on rigorous scientific procedures. Like doctors, their opinions should certainly be noted. They have evidential value. But they are not established scientific truth.

In many court cases one voice has been recorded by an unknown speaker on a telephone answering machine and the other somehow obtained from a suspect. This is not always the case, however. On one occasion I was asked to offer an opinion as to whether Mr. L. Ron Hubbard, the founder of the Church of Scientology, was dead, as some members of his church submitted, or alive but in seclusion, as others main-

tained. (He was at the time being sought by the IRS in connection with possible tax evasion). The evidence in the case included the studio recordings of two Christmas messages he had sent to his followers, one from the current year and one from the previous year. Both referred to events of the time, and the earlier message was acknowledged to be by him. If the later message was made by the same voice it was evidence that he was alive at that time. Each message was about 15 minutes long, and contained many similar words and phrases. After careful listening and acoustic analysis it was clear to me that they were highly likely to have been made by the same speaker. (It turned out that Mr. Hubbard was in fact alive at the time. His death was reported some time later.)

When an expert gives an opinion the court should be told that they do not know how reliable it is. It all depends on the circumstances. We will consider a few of the points that have to be taken into account.

(1) Were the physical conditions similar? Both recordings may have been made over telephone lines, but these lines may have had different characteristics. In addition some home recording devices preserve much more of the characteristics of the speaker than others. Many identification questions concern 911 calls that are recorded on a system that saves one whole day at a time at a comparatively low fidelity. I have one case in which a police officer allegedly got out of his squad car and made a 911 call from a pay phone reporting the presence of a man with a gun. This 911 call was his justification for later making an arrest. The identification of his voice on the 911 call was complicated by the low fidelity of the recording system.

(2) Were both the speakers talking in the same style? People committing crimes may be more tense or agitated. When suspects provide samples of their voices they are often in quite a different mood. It is hard to compare two voices when one is scaring the life out of someone and the other is leaving an innocuous telephone message about feeding the dog, with no words or phrases in common with the threatening message.

(3) Was one speaker trying for a disguise? Fortunately for us, most criminals are not very smart and forget that they are making a recording that might be used to identify them. When they do try to disguise their voices they seldom try to do so by imitating another person's voice so that an innocent man might become charged with an offense. In over 100 cases of comparing voices for legal purposes I have never come across this happening. A guilty person might go free because of a successful disguise, but it is most unlikely that a recording of one person's disguised voice will be sufficiently like that of another person's voice to be the cause of that innocent person being convicted. I might add that I have never encountered anyone trying to defend themselves by saying "That's not my voice, it's someone imitating me."

(4) Was there any background noise? Studio recordings are rare in voice identification cases (though, living in Los Angeles, the entertainment capital of the world, I have been involved in a few cases in addition to the L. Ron Hubbard matter). The main problem in comparing most recordings of voices is the amount of noise on the recording. The speaker may not be talking directly into the phone (in one case I was asked to identify a murderer muttering while walking away from the dangling phone on which the victim had made a 911 call), or there may be noise from the busy street outside, or shouting bystanders. Recordings made by undercover police engaged in drug busts are often full of extraneous noises. They are seldom high enough quality to make an identification of the drug dealer (who usually makes only monosyllabic remarks).

(5) How long was the recording? A five second bomb threat on a noisy phone line almost certainly does not have enough distinct information about the speaker. But even on a very short but clear recording there might be features that have evidential value. If the speaker had a very unusual voice even a word or two might be indicative of a possible suspect.

(6) Does the suspect have family or friends with very similar voices? I know of two cases in which a suspect was wrongly charged with making a telephone call. In one case her sister confessed to making the call, and in the other a college roommate admitted that he was responsible. Very often in court cases the expert has no knowledge as to whether there are other people who might have made the recording and can only report that the two voices are very similar and highly likely to be the same individual or two close relatives or friends.

A scientist giving an opinion on whether two recordings are likely to have been made by the same speaker would like to do so by reference to recordings that were of the same quality and length, and were made by similar speakers in similar circumstances, saying similar things. But it would be almost impossible to set up a valid experiment that can take all these (and many other) variables into account. Lawyers often try to assist juries by asking for numbers indicating the degree of certainty of an identification. When I am asked how likely is it that I have made an error, I can only answer that I have never had a case exactly like this one, so I do not know. It would take enormous resources to do all the experimentation required to quantify the reliability of an opinion that any two recordings that might be presented in a court case were likely to have been made by the same speaker. We certainly cannot say that voice identification by experts should always be allowed or never be allowed. Sometimes expert opinion has evidential value, and sometimes it does not. Judges often have to make rulings about whether a given recording is acceptable as evidence, Unfortunately there is no scientific data on which they can base their rulings because every case is different. We just have to rely on the court's good common sense. It's not science, but it's the law.

Peter Ladefoged is an Emeritus Professor of Phonetics at UCLA. He has been concerned with forensic phonetic issues since 1965, when he was an expert witness in the first case involving voice identification through spectrographic techniques in California. (See paper 3pAA3 at the 146th ASA meeting in Austin).

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Echoes from Austin

Exposure Smart Protector: New Technology to Prevent Noise-Induced Hearing Loss

by Kevin Michael and Tom Frank

In spite of the near-universal use of personal hearing protection over the last 30 years, workers continue to experience an unacceptably high incidence of noise-induced hearing loss (NIHL). Hearing conservation programs traditionally have relied on limited noise exposure measurements and laboratory estimates of hearing protector device (HPD) performance to predict individual exposure levels. There are many well-documented problems associated with this approach. First, the on-the-shoulder noise exposure estimates are typically performed on only a small percentage of the workforce, once or twice a year. Since individual noise exposures can vary widely from day-to-day, applying these data to other individuals based on job type increases the potential for inaccuracy. Second, the attenuation provided by HPDs to individuals in actual workplaces is impossible to predict using any laboratory measurements. Individual efficacy is affected by many factors, including the type of HPD, the quality of the fitting and the duration it is worn during the noise exposure.

A new approach to hearing conservation has been developed utilizing a unique device called the Exposure Smart Protector (ESP). The ESP measures actual exposure, taking into consideration all of the factors that can compromise HP performance. Thus, unlike current hearing conservation programs that serve mainly to detect and document NIHL after it has occurred, the ESP can actually ensure upstream prevention of NIHL.

The ESP is a HPD uniquely integrated with a personal noise dosimeter. Unlike conventional hearing protection for which the effectiveness can only be determined in a laboratory environment, the ESP provides information that completely removes the ambiguity associated with the efficacy of personal hearing protection utilized by individual workers in real workplaces. The ESP provides instantaneous and cumulative warnings of excessive noise exposure to the user. In addition, a software program has been developed to identify employees wearing an ESP who need intervention so that their daily noise exposure levels will be within a safe level.

The obvious goal of hearing conservation is prevention of NIHL. This can be achieved if individual workers maintain their daily noise doses below a safe level. For workers, the role of the ESP is to protect them to safe levels, monitor their daily noise exposures, and provide feedback for good decision-making about individual hearing protector use. In essence, the ESP empowers workers with information; with the ESP, efficacy is under a worker's control since fit and wearing time can be tailored to achieve a balance between personal needs for protection and communication. Field studies provide compelling evidence that when a worker receives individual, quantitative feedback every day on his/her noise exposure, the worker is capable of balancing protection and communication, and effectively managing his/her own exposure to a safe level.

Kevin Michael has been working in the area of preventing noise-induced hearing loss for several years. His research interests include developing and testing state-of-the-art technology for preventing and/or reducing the occurrence of noise-induced hearing loss.

Tom Frank is a professor of Communication Sciences and Disorders at Penn State. His research interests include preventing noise-induced hearing loss and speech perception in noise.

This paper is partly based on paper 2aPP8 at the 146th ASA meeting in Austin, Texas.

Fletcher *continued from page 1*

mitting nonsense speech sounds through a telephone channel. Fletcher showed that high and low frequency articulation bands could be made additive after a nonlinear transformation. Fletcher and colleagues defined an articulation index for which temporal fluctuations in the speech signal, in contiguous frequency bands, contributed independently to articulation, and the separate contributions were additive. Calculation of the articulation index took level, frequency distortion, and noise into account for each band

Loudness of speech as a perceptual quantity was important in telephony so Fletcher and colleagues made an effort to determine the dependence of loudness on physical quantities. In a classic 1933 paper Fletcher and W. A. Munson defined loudness, presented equal-loudness level contours (expressed in phons), and provided loudness units (proportional to sones) having direct correspondence to perception. They expressed loudness of single tones in terms of the one-third power of intensity. They demonstrated that loudness is additive for frequency components in separate critical bands or in separate ears. They further demonstrated that loudness is additive when masking is present, if the masked loudness contributions are properly weighted. They devised an innovative technique for the measurement of loudness, based on his observation of the additivity of loudness.

The critical band concept had its genesis in the 1933 paper. Fletcher could see that loudness added for "non-interacting" frequencies. For "interacting" frequencies masking intervened and weighted loudnesses added because these interacting frequencies were competing for many of the same hair cells. They showed that partial loudness and masking are closely related. Details of the critical band were worked out from 1934-38 to provide loudness summation schemes for speech and noise where masking is always an issue.

Fletcher published five papers in the area of atomic physics, two of which were coauthored with Robert A. Millikan. He published numerous papers, several of which were coauthored with W. A. Munson, J. C. Steinberg, and R. L. Wegel, in the broad area of human hearing and communication. In addition to his research publications and patents, Fletcher attempted to integrate then current knowledge in his 1929 *Speech and Hearing* and in his 1953 *Speech and Hearing in Communication*.

Fletcher had a lifetime interest in people with speaking and hearing problems. (His own father suddenly lost his hearing at age 55.) He and co-workers used the electronic technology of the time to develop instruments useful to this community. Various versions of the audiometer were developed and made available to clinicians and schools. A vacuum tube hearing aid was developed for Alfred Dupont, later versions of which were made available to Thomas Edison. (Fletcher had many interesting stories to tell about hearing aids and the people to whom they were introduced.) An artificial larynx was developed for a Mr. Mapes. Western Electric manufactured audiometers, hearing aids, and artificial larynges after these developments. A group hearing system with 100 headsets was developed for meetings of hard of hearing persons at the League for the Hard of Hearing in New York City.

A meeting was held December 27, 1928 at the Bell Labs to consider the organization of an acoustical society. Much discussion ensued among the forty persons present and the decision was made to organize the Acoustical Society of America. A committee was appointed to prepare a constitution. At the first official meeting of the ASA held May 10-11, 1929, Fletcher was elected first president of the Society. He was the ASA representative to the organization of the American Institute of Physics in 1932, an Institute to which the ASA belongs as a Member Society.

After Fletcher met Leopold Stokowski they jointly made tests of stereophonic sound and settled on a three channel system: left, right, and center. They demonstrated this system on April 27, 1933 with the Philadelphia Orchestra on stage at the Academy of Music in Philadelphia and the reproduction in Washington, D.C. Mr. Stokowski was at the controls in Washington. There were many dignitaries in attendance and the demonstration was considered a tremendous success. Many acoustic tricks were used to impress the crowd. At one point a tap dancing tenor split into two people, with the physical body going in one direction and his sound going in another, which caused the audience to gasp in disbelief.

During his time at Bell Labs Fletcher was appointed Director of Acoustical Research in 1928 and Director of Physical Research in 1933. During World War II he had charge of groups in acoustics at six universities along with several at Bell Labs. He retired from Bell Labs in 1949 and started an acoustics program at Columbia University while in the Electrical Engineering Department during 1950-1951. He returned to BYU in 1952 as director of research. He later helped organize the engineering program and served as Dean of the College of Physical and Engineering Sciences from 1954 to 1958. He taught mathematics and acoustics for two years and then turned his attention to research in musical acoustics.

Fletcher had a longtime interest in musical acoustics as evidenced by early (1924) publications on perceptual aspects of musical tones. However, his active involvement in musical acoustics research came only after his multiple retirements. He and co-workers set about to determine the physical attributes of musical instrument tones that are most strongly correlated with their perceptual attributes. The general approach in these studies was to record instrumental tones, analyze these tones to determine their spectral content, and then synthesize the tones with the 100-oscillator tone synthesizer. He published four papers on piano, organ, and bowed string tones. He also published a paper on frequencies of stiff piano strings. His final paper in 1978 was on the bass drum, with Irvin Bassett.

Fletcher received numerous honors for his scientific contributions, including honorary doctorates from six institutions of higher learning and gold medals from four professional societies. He served as president of the Utah Academy of Science, the American Hearing Society, and the American Physical Society and was a member of the Noise Abatement Commission of New York City. He served the Church of Jesus Christ of Latter-day Saints as president (pastor/priest) of its New York Branch (congregation) for ten years and as president (bishop) of its New York Stake (diocese) for six years. He coauthored a book, Science and *Your Faith in God*. He influenced the spiritual lives of thousands of young people.

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William Strong received B.S. and M.S. degrees from Brigham Young University, where he took an acoustics course with Fletcher, and a PhD from MIT. He recently retired from BYU, where he taught physics and did acoustics research for 34 years. william_strong@byu.edu.

Jont Allen received a BS in EE from the University of Illinois and a PhD from the University of Pennsylvania. After 34 years at Bell Labs and AT&T, he joined the ECE faculty at Illinois. His research is on human perception, cochlear function, and speech perception. jba@auditorymodels.org.

Scanning the Journals

Thomas D. Rossing

• A resource letter on **thermoacoustic engines and refrigerators** by Steven Garrett appears in the January issue of *American Journal of Physics*. Resource letters, commissioned by the American Association of Physics Teachers, are intended to guide college physics teachers and students to some of the most important papers in various fields of physics. Thermoacoustic engines and refrigerators incorporate acoustical components and networks to produce mechanical power or to pump heat, or both, with the the use of traditional mechanical contrivances such as pistons, linkages, and valves. One of the 106 papers cited is "Build an Acoustic Laser" which appeared in the Fall 2000 issue of *ECHOES*.

• When sopranos sing at frequencies that are higher than the lowest resonance (formant) of their vocal tract, their vocal power is reduced. To increase the loudness and uniformity of tone, sopranos learn to **tune their formants** to the frequency of the sung note. New data on formant tuning by sopranos appears in a communication in the 8 January issue of *Nature*. Vocal tract resonances were measured directly for five sung vowels. The large shift in formant frequencies at high sung pitch helps to explain the difficulty in identifying words sung in the high range by sopranos.

• A novel technique applied to **auditory nerve fibers** to reconstruct the phase and gain of high-frequency fibers for which fine-structure phase-locking is lost, according to a brief communication in the 8 October issue of *Journal of Neuroscience*. Ordinarily the nonlinear characteristic of neural coding causes low-frequency interactions among the components of multitone stimuli, but a novel stimulus, in which these interactions take a particularly systematic form, was used and the response of the auditory nerve to this stimulus was recorded.

• Elevators in the world's tallest tower, Taiwan's new Taipei 101 tower, are also the world's fastest, reaching a peak speed of 3314 ft. per minute. Yet with a cabin noise level of just 45 dBA, the Taipei 101 **elevators are quieter** than most automobiles would be at that speed, according to an article in the March issue of *Popular Mechanics*. In order to avoid rapid changes in pressure which might cause discomfort or injury to ears, twin exhaust/pressure turbines began adjusting the car's air pressure as soon as the doors close, then continue working as the car accelerates.

• The 23 February issue of *Journal of Sound and Vibration* is a special issue with papers from the 2002 **I.M.A. Conference on Computational Aeroacoustics** held in London, April 9-11, 2002.

• The January issue of *Acoustical Science and Technology* is a special issue in commemoration of the **China-Japan Joint Conference on Acoustics** (JCA2002) held in Nanjing Nov. 14-17, 2002. The theme of the conference was "Acoustics in Digitalized Era," and the special issue is edited by co-chairpersons of JCA2002, Yôiti Suzuki and Jing Tian.

• **"Infrasonic Symphony"** is the title of an article about infrasound in the January 10 issue of *Science News*. It begins with a riddle: what do rhinoceroses, supersonic aircraft and hurricanes have in common? The answer, of course, is that they all generate infrasound below 20 Hz. Scientists first detected infrasonic waves in 1883 when the eruption of the Krakatoa volcano sent inaudible sound waves around the world, affecting barometric readings. Just as seismic waves travel through Earth, infrasonic waves travel through the air, and the lower the frequency, the farther they can travel. Infrasound is also generated by aurora, which is caused by charged particles in the air.

Student Council Update

by Andrew Morrison

The Student Council has delivered on its commitment to keeping students informed and giving power to the voice of the students in ASA. An integral component of the Council's mission is the recently unveiled Student Website, located at http://www.acosoc.org/student. Additionally, the Council is working hard to communicate to students through an e-zine which is periodically emailed to students.

At the Austin meeting, the Council distributed information fliers and nomination forms for the new Mentoring Award. The first Award will be presented at the San Diego meeting. Details regarding the Award are available at the website. The Austin meeting featured an improved bulletin board, and the Council encourages all students to check the board at meetings for meeting-specific information such as social events and outings. The reception for students was extremely well attended and provided an excellent networking opportunity for students to interact with ASA members.

We expect to see many students at the New York meeting. Look for an improved student bulletin board, detailing the activities of the Student Council. Students attending the meeting should receive a packet from the Student Council at registration. See you in New York!

Best student paper awards (Austin meeting)

Acoustical Oceanography
First: Deanelle Symonds, MIT
Second: Ioannis Bertsatos, MIT

Musical Acoustics
First: Todd Bigelow, Utah State University
Second: Ammon Paquette, Augustana College

Noise
Meghan Saweikis, Purdue University

Speech Communication
First: Carolyn Richie, Indiana University
Second: Madhavi L. Basu, Purdue University

Underwater Acoustics
First: Geoffrey F. Edelmann, Scripps Institute of Oceanography
Second: Donald A. Outing Rensselaer Polytechnic Institute

Scanning the Journals

Electricity heats atmospheric gases and the warmed molecules spread out and increase air pressure.

• **Ferroelectrics**, new soft electroactive foams for transducers, are described in the February issue of *Physics Today*. They can potentially be used to convert acoustical signals to electrical signals and vice versa in microphones and underwater sound generators, for example. They are thin and lightweight and can easily be made in almost any size or shape. Furthermore, the can be readily handled and are relatively inexpensive.

• A new experiment may help to resolve the debate between the place theory and the periodicity (time) **theory of pitch**, according to a report in the 17 January issue of *New Scientist*. A high-frequency carrier wave is used to stimulate the part of the basilar membrane tuned to such vibrations, but the wave is broken into tight pulses to make the nerves fire as if hit by a low-frequency tone. In experiments with such "transposed tones" some groups have found that volunteers can localize the tones even when the carrier frequency is higher than the range within which we can detect the direction of a sound. This suggests that transposed tones really do trigger nerve signals characteristic of a much lower frequency, and it does not matter exactly where in the cochlea the signals originate. The results seem to establish that location plays a role in pitch perception.

• Integrating **microphones** and **speakers** on a silicon chip is a new application for microelectromechanical systems (MEMS) technology, according to an article in the February issue of *Scientific American*. Both microphones and speakers make use of vibrating membranes up to half a millimeter square (large for MEMS devices). Membrane fabrication takes place by building up thin layers of conducting or insulating materials (typically silicon dioxide) on a silicon substrate and then etching them away to create a mesh of metal wires with silicon dioxide filling the space between them. The crafting of the membrane occurs in tandem with that of the signal-processing electronics.

• A new endoscope made of a single optical fiber just half a millimeter wide could aid doctors doing **cochlear implants**, according to a story in 24 January issue of *New Scientist*. Cochlear implants cannot always be fitted because of unexpected obstructions in the inner ear. To fit the implant, an array of electrodes is fed down the cochlea around one and a half turns of its coiled structure. Surgeons do this work "by feel," and if they hit an obstacle the operation has to be abandoned. What they need is a miniature endoscope that would allow them to see around the obstruction, but standard endoscopes are about 5 millimeters wide.

• Sony has patented a new technique that increases the **storage capacity** of its MiniDisc from 177 megabyte to 1 gigabyte, according to a note in the 24 January issue of *New Scientist*. The new Minidisc has three magnetic layers. A laser warms the outer switching layer which temporarily loses its magnetism. This results in the domain in the displacement layer swelling to a readable size. A 1- GB disc can hold 6000 high-quality still photos or five two-hour moives compressed to the MPEG4 standard.

• Insomniac Hawaiian islanders are hopping mad over a tiny frog whose **shrill mating call** disturbs their sleep, according to a note in the January issue of *Smithsonian* magazine. Although no larger than a quarter, the male coqui frog creates a shrill screeching sound by forcing air through its balloonlike vocal sac. Sound levels apparently reach as high as 90 dB.

• Computer simulations that create maps of European cities in color are at the core of a plan to restore peace and quiet to a population driven to distraction by traffic noise, according to an article in the 5 February issue of *Nature*. Legislation passed last year by the European Union (EU) requires member states to make, by 2007, regular **noise maps** of all major cities, roads, railways, airports and industrial sites. These maps are a powerful way to visualize noise pollution. Noise mappers in Paris have made use of "virtual microphones," each of which is a point in a computer model that reports what the sound level would be at a certain place under given circumstances. In total, the 3D representation of Paris contains 26 million virtual microphones. The Paris map uses software called MITHRA developed by the French Scientific Centre for Building Physics. It models sound as rays and calculates how they interact with different surfaces.

Acoustics in the News

• Two Canadian mathematicians have designed a Y-shaped guitar called a tritar, according to a note in the 23 January issue of *Science*. The mathematicians at the University of Moncton, while working on a problem involving infinite sums called p series, invented a series of hyperimaginary numbers lying on a Y-shaped number line. They wondered how waves would behave on a Y-shaped string. To find out, they built a model tritar and took it to a guitar builder, who made a playable version. Plucking each three-ended string creates unpredictable overtones quite unlike the usual ones of a guitar.

• Newly developed software turns compatible camera phones into visual aids for the blind by changing images snapped by the camera into sounds that the user's brain can reconstruct into mental pictures, according to a story in the February issue of *IEEE Spectrum*. Once per second, the computer scans a 64x64-pixel frame from left to right, one column at a time. Each pixel in a column produces a wave whose frequency indicates its position; the highest frequencies are at the top. Amplitude is based on the brightness of the pixel on a 16-tone gray scale. Frequency is then translated into pitch and amplitude into volume; what a listener hears is a musical chord of up to 64 notes. There is evidence that the part of the brain responsible for sight, the visual cortex will, after some training, respond to changes in pitch.

continued on page 20

Acoustics in the News

continued from page 19

• By means of massive digital signal processing, an electric guitar called Variax can model 50 historic guitars, according to a story in the February issue of *IEEE Spectrum*. The instrument, being played by such stars as Pete Townsend, Steve Howe and Joe Walsh, can reconstruct the distinct twang of the Fender Stratocaster or the singing sustain of the Gibson Les Paul.

• Two deaf women in the United States have become the first people to undergo the risky procedure of having implants in their brainstems, according to a news note in the 10 January issue of *New Scientist*. The devices are designed to restore hearing by directly stimulating nerves. Implants that sit outside the brainstem do not work as well. Cochlear implants bypass the hair cells and stimulate the auditory nerve directly, but they cannot help people with a damaged cochlea or auditory nerve. At the moment, the only way to restore hearing to people with type II neurofibromatosis (NF2) is to stimulate the brainstem directly. But the procedure is very risky because at the brainstem level every neuron that is damaged can have serious consequences.

• A microphone that imitates the remarkably acute hearing of a tiny fly may one day help wearers of hearing aids understand conversation in a busy restaurant, according to a story in the December 11 *New York Times*. The microphone structure is based on the ears of the fly *Ormia ochracea*. The female of this species uses her fine hearing to pick out the sound of distant crickets, which serve as hosts on which she can deposit larvae. The two membranes on the fly's hearing organ are close together and are mechanically coupled by a piece of tissue. Imitating this design in silicon and using optical sensors gives a directional microphone.

• Carleen Maley Hutchins, now 92 years old, made her first viola at age 35, according to a story in the September 4 issue of *Granite State News* (New Hampshire). A major milestone in her career came when she was introduced to Frederick Saunders, retired Harvard physics professor, who continued his violin research in Mt. Holyoke, Massachusetts (see *ECHOES*, Spring 1997 and Summer 2003). Another important event occurred when Henry Brant, professor of musical composition at Bennington College in Vermont, encouraged her to make a set of seven graduated-size string instruments. Thus was born the New Violin Family (aka the Hutchins Violin Octet) of eight scaled instruments, which appeared in a "splendiferous" concert in Wolfeboro, New Hampshire on September 20. Carleen received the Silver Medal in Musical Acoustics from ASA in 1981 and became an Honorary Fellow of the Society in 1998.

• An experimental sonar, that uses frequencies above the hearing range of whales, has been used to detect Pacific Gray whales without causing them to break away from their migratory path or show signs of injury, according to a February 2 story on *Newsday.com*. It has also invoked new debate. Supporters say a reliable high-frequency sonar could help protect whales from a variety of ocean hazards, such as long-range military sonar, collisions with ships, underwater demolitions, and sesmic mapping by oil and gas companies. Opponents worry that the sonar could distress the whales, drive them from their habitat, or separate migrating calves from their mothers.

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