The newsletter of
The Acoustical Society of America

ECHOES

Biomedical Ultrasound–Past, Present, and Future

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Historical evidence suggests that as far back as 250 BCE, captains of Ancient Greek ships would drop lead weights called "sounders" overboard and count up until a thud was heard. The counts provided a measurement of water depth; from this practice we have an early use of propagation time to estimate depth and the origin of the phrase "sounding something out."

Fig. 1. Medical ultrasound is increasingly using the information from tissue nonlinearities to help diagnose illness. Shown is an ultrasound scan of a kidney.

Sonar developed soon after the sinking of the *Titanic*, and was given a boost by the subsequent discovery of piezoelectric materials that could function as acoustic sources as well as receivers. The familiar sonar "ping" allowed vessels to use time-of-flight measurements of echoes, as bats and dolphins do, to estimate target range and size. Modern biomedical ultrasound got its start during World War II as an extension of sonar to higher frequencies and to the human body. (See Fig. 1)

Early ultrasound technology of the 1950s utilized a single piezoelectric crystal in contact with layers of human tissue. An acoustic wave was launched into the tissue consisting of several cycles at a frequency above human hearing (~20 kHz). A series of reflections returned to the crystal due to mismatches of acoustic impedance and the resulting reflections at each interface. The echoes were represented in "A-mode" (amplitude) displays as a vertical deflection on an oscilloscope screen. If the speed of sound in human soft tissues is assumed to be constant at 1540 m/s, the times between reflections could be interpreted as the distances between layers as shown in Fig. 2.

If A-mode amplitudes, however, are represented by the brightness of dots on a phosphor screen and the transducer is scanned across the tissue, a "B-mode" (brightness) image results (Fig. 3). Assuming a constant speed of sound allows quantitative

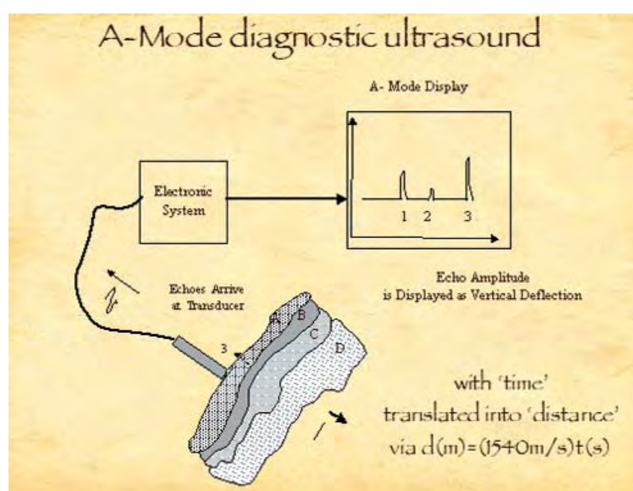

Fig. 2. Schematic description of early ultrasound technology of the 1950s. A single piezoelectric crystal in contact with layers of human tissue launches an acoustic wave consisting of several cycles at a frequency above human hearing (20 kHz).

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We hear that...

• **Joseph Curtin** and **Emily Thompson** were among the winners of MacArthur Foundation Fellowships. Curtin, a violin maker in Ann Arbor, was a workshop leader at the ASA workshop on Design and Construction of String Instruments at Vancouver. Thompson, who teaches history at the University of California, San Diego, won the 2002 ASA science writing award for her book *The Soundscape of Modernity*. [See page 55 of this issue.]

• **James Berryman** received the 2005 Maurice A. Biot medal for "outstanding contributions in poromechanics, granular materials, random composite media, tomography and inverse problems, and seismology" from the American Society of Civil Engineers. The award was presented in Norman, Oklahoma during the 3rd Biot Conference on Poromechanics. Jim is a physicist at the Lawrence Livermore National Laboratory.

• 2005 was the last year of publication of *ARLO* (*Acoustics Research Letters Online*) as an independent journal. The replacement for *ARLO* will be a new section of *JASA* called ***JASA Express Letters***, abbreviated *JASA-EL*. The new section will continue *ARLO*'s style of rapid publication with articles published online as soon as they're accepted. The format of all *JASA-EL* articles will be the same as that presently used for *ARLO* (single column) which is easier to read on a computer screen. A mandatory $350 page charge will be charged for all papers accepted for publication in *JASA-EL*, which is what was previously charged for *ARLO*. Authors will be given the option to pay the color artwork charges for figures to appear in color in the printed edition. If color artwork charges are not paid, color figures will appear in color online and on the CD ROM, but in black and white in the printed edition.

Murray Korman helps a student team with an experiment at the hands-on workshop session at the Minneapolis ASA meeting. (Photo by Tom Rossing.)

From the Student Council

Andrew Ganse

The Student Council kicked off its Minneapolis meeting with its new president, Brian Monson, and welcomed in new council representatives as well. Be sure to check them all out along with the other student information on the ASA's student website: www.acosoc.org/student.

Top student issues discussed at the Council meeting included: planning for the grant proposal writing workshop at the upcoming ASA meeting in Providence, feedback from the student community on the topic of the possible new registration fees for student members of ASA, and voting for the next recipient of the ASA Student Mentor Award. Please stay tuned to the following issue of *ECHOES* for the announcement of the recipients of both the Student Mentor Award and the Fall meeting's Student Paper Awards (not yet available at the time of this publication).

Just over 100 members, both students and non-students, attended the Student Reception in Minneapolis. The Student Reception offers a more structured opportunity for students to meet researchers and other students in their field while enjoying a buffet dinner and drinks. Afterwards most of those students joined the Student Outing to the nearby Rock Bottom Brewery to continue the socializing and networking.

The Student Council encourages students to consider starting a local student chapter of the ASA at their universities. Local student chapters can serve as a common meeting ground for both students and researchers in various departments at a university who share an interest in acoustics. The ASA provides funding for local student chapter events; please contact your Student Council representative for more information.

Student Council members can be recognized by the labels on their name badges at ASA meetings—look for us at the next meeting in Providence!

Andrew Ganse is a seismology graduate student at the University of Washington and the student representative for Underwater Acoustics.

ECHOES ECHOES

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imaging of deep tissues. Today, modern ultrasound scanners use the linear superposition of spherical or cylindrical wavefronts of arrays of tiny piezoelectric elements to produce waveforms that can be steered or focused based upon the timing of element excitations. Beam forming can occur in both the emitted and received waveforms, and there is a great deal of engineering that goes into obtaining the images of, for instance, the fetus that may be the parents' first glimpse of a new child. Nevertheless, the basic image is formed via sonar techniques not too much different from those employed in the 1960s.

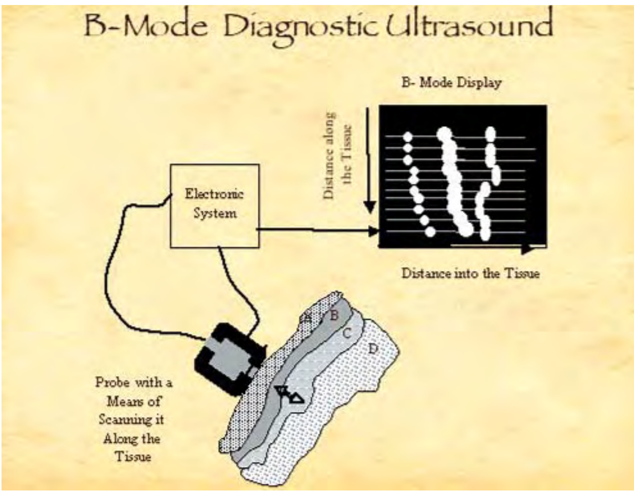


Fig. 3. If A-mode amplitudes are represented by the brightness of dots on a phosphor screen and the transducer is scanned across the tissue, a B-mode (brightness) image results. Assuming a constant speed of sound allows quantitative imaging of deep tissues.

Of more recent interest are techniques that rely upon the essential nonlinearity of human tissue as a propagation medium (see Atchley's Nonlinear Acoustics Primer, *Acoustics Today*, pp. 19-24, October 2005). Figure 4 shows a typical imaging pulse from one element of an array transducer. If an array element is excited at the same time with the inverse of this signal, the two pulses will mostly cancel each other's fundamental frequency in the focal region. Tissue nonlinearities that give rise to waveform distortion, however, will result in the moving of energy from the fundamental frequency to the second harmonic (twice the fundamental frequency). The second harmonic components will not cancel, but rather add together, producing a pulse with spatial resolution twice that of its B-mode equivalent and with improved signal-to-noise. This technique is called tissue harmonic imaging, and most ultrasound scanners in hospitals today transmit signals at one frequency but "listen" to the returning echoes at twice that frequency.

The ability of the essential nonlinearity of tissues to produce waveform distortion gives rise to sum and difference frequencies when two frequencies overlap in space and time. Since the nonlinearity parameter known as *B/A* varies with greater dynamic range in soft tissues than do acoustic impedance mismatches, a method of imaging this nonlinearity may provide important additional clinical information. To accomplish nonlinear imaging, one can measure the strength of the sum frequency or difference frequency by scanning a point of intersection of two different-frequency pulses around the tissue volume.

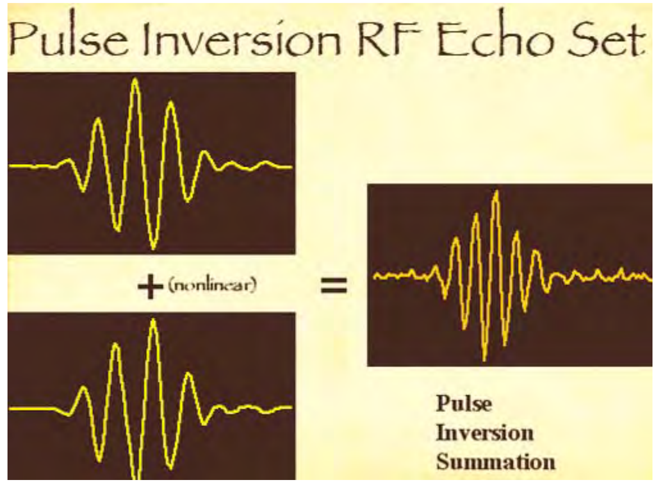


Fig. 4. Addition of pulses with their inverse would cancel entirely if it were not for nonlinear addition of second-harmonic (and other) components.

A main limitation is the requirement to have large-amplitude, highly localized pulses intersecting within the tissue. Recently, a technique known as Time Reversal Acoustics (TRA) has provided a new tool to accomplish this goal. In TRA, an acoustic source located within the tissue produces a pulse that propagates along many different rays to a receiver, producing a complicated impulse response at the receiver. If the pattern of pulse arrivals at the receiver is then time-reversed, and the receiver now acts as a transmitter, the pulses follow the same rays in reverse, coinciding at the original source location as a highly spatially and tem-

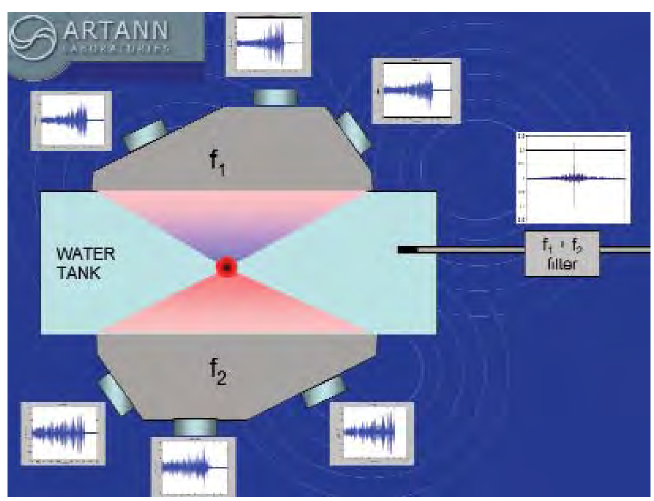


Fig. 5. Time-reversed signals sent from each transducer coincide at a common location in space and time, allowing generation of sum and difference frequencies that can be used to image tissue nonlinearities.

porarily focused pulse. In effect, the time-reversed signal at the receiver acts as an optimum filter to deliver sub-wavelength focusing at the (original) source location.

In practice, TRA requires that a source be placed in the body, although this source could be the tip of a biopsy needle used to reflect incident ultrasound. If the receiver is not one, but many (reciprocal) transducers mounted on a surface, a highly focused spot can be generated at the site of the original source. For imaging the nonlinear parameter of tissues, two resonators may be used, each holding reciprocal transducers of either frequency f_1 or f_2. If Time-Reversal Acoustics techniques are used to place the focal spot of both resonators at the same spatial point, the sum or difference frequency due to the nonlinear interaction of these two waves can be measured as seen in Fig. 5.

Due to the TRA focusing of both frequency signals, the resulting large amplitudes allow "synchronized stirring" of f_1 and f_2. The inherent nonlinearity of tissue produces sum and difference frequencies. The sum or difference signal can be filtered and detected by a probe, and the location of the coincident spot moved to a new location to image the rest of the tissue volume. The amplitude of the signal is proportional to the tissue nonlinearity parameter at each point.

In conclusion, modern ultrasound images rely upon tissue nonlinearities to produce clearer pictures of tissues. New techniques are emerging that make even greater use of nonlinear acoustics for imaging and therapy.

Acknowledgments: The author would like to thank Pierre D. Mourad and Shahram Vaezey (University of Washington, Seattle, WA), Armen Sarvazyan (Artann Laboratories, NJ), Christy Holland (Univ. of Cincinnati, OH), and Mickael Tanter (Laboratoire Ondes et Acoustique, ESPCI, France) for use of their figures.

E. Carr Everbach, Associate Professor of Engineering at Swarthmore College, is the former chair of the ASA Biomedical Ultrasound/Bioresponse to Vibration technical committee. This article is based on his tutorial lecture presented at the 150th ASA meeting in Minneapolis.

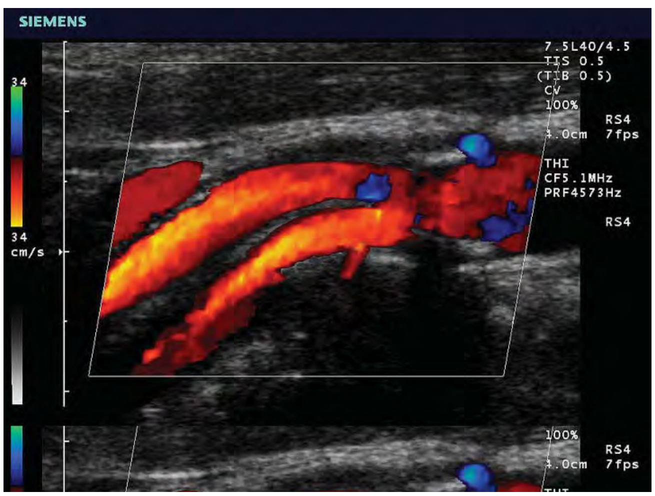


Fig. 6. Doppler scan of an artery showing blood flow.

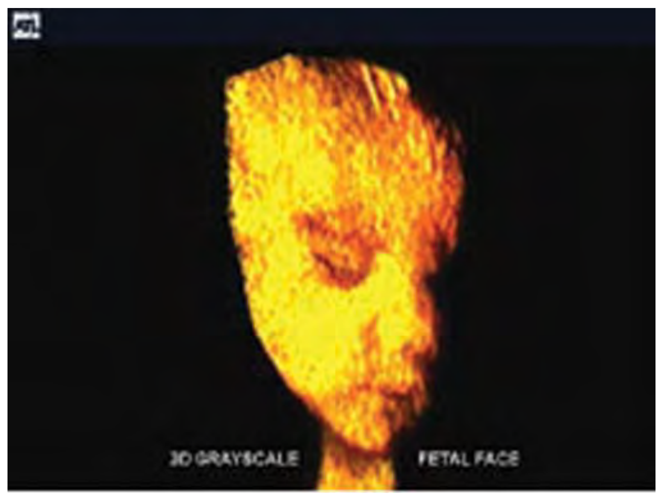


Fig. 7. Ultrasound reconstructed image of a baby's face in the womb

Echoes from Minneapolis

Thomas D. Rossing

Oh sun and skies and clouds of June
And flowers of June together
You can not rival for one hour
October's bright blue weather

This poem by Helen Hunt Jackson could easily have been written especially for the 150th meeting of the Acoustical Society of America in Minneapolis, October 17 to 21, 2005. With clear blue skies and brilliant fall foliage outside, it was hard to stay inside, except that there were many fascinating papers, lectures, concerts and demonstration experiments to keep us inside. This joint meeting with NOISE-CON 2005 was certainly one to be enjoyed.

I found the two musical events particularly enjoyable. On Tuesday, we were invited to attend a rehearsal of the Minnesota Orchestra under the baton of Osmo Vänskä with violinist Christian Tetzlaff as soloist. After the rehearsal, maestro Vänskä and Cyril Harris, the acoustical designer of Orchestra Hall, discussed its acoustics.

Central Lutheran Church, Minneapolis. (Photo by Tom Rossing.)

Minnesota orchestra rehearsal in Orchestra Hall. (Photo by Tom Rossing.)

Osmo Vänskä and Cyril Harris discuss the acoustics of Orchestra Hall. (Photo by Tom Rossing.)

On Thursday, we heard a concert by the St. Olaf Cantorei, a ninety-voice liturgical choir directed by John Ferguson, in nearby Central Lutheran Church. The Cantorei, which earlier had made a unique recording in an anechoic room, was accompanied by Professor Ferguson at the organ, brass instruments, and handbells. During the panel discussion which preceded the concert, we had a chance to hear excerpts from the Cantorei's anechoic recording played through the sound system in the highly reverberant church ("sonic convolution").

Some 112 of the 779 technical papers have been posted by their authors, and these can be accessed through the ASA website as can lay language versions of a number of the papers. As a sampling, we have included two short articles based on a paper and a tutorial presented at Minneapolis.

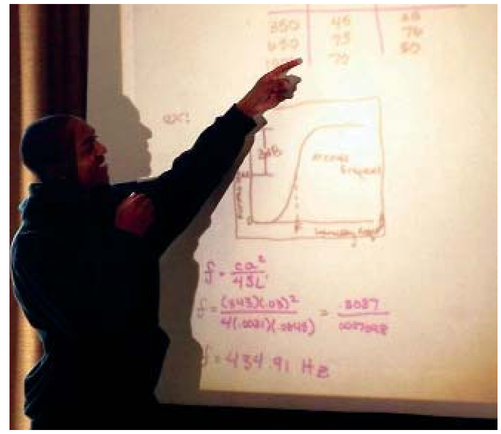
"Acts of Sound," a hands-on workshop for high school students, exposed students from an inner-city high school to the excitement of doing acoustics experiments. Eight teams of three worked for 30 minutes at their own stations guided by ASA mentors. The students recorded data and tried to come up with their own "discoveries" and then prepared transparencies for a presentation to the other teams.

Another educational event was "The Physics Force," a program of physics demonstrations (with an emphasis on acoustics), presented by a team from the University of Minnesota. Attendees will not soon forget a ping-pong ball passing through two soda cans or the implosion of a steel barrel with reduced air pressure inside.

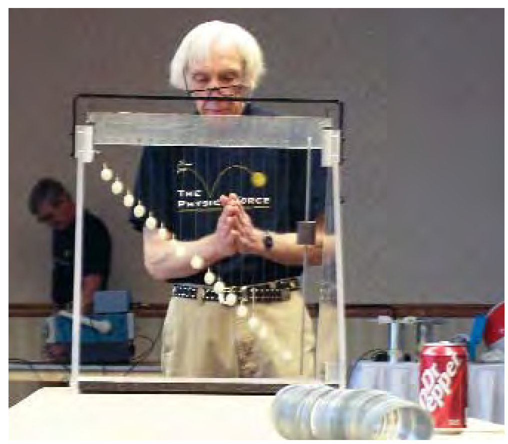
Echoes from Minneapolis

Andy Morrison helps a student team with an experiment on acoustic impedance of pipes. (Photo by Tom Rossing.)

Workshop student presents a report on his group's experiment. (Photo by Tom Rossing.)



Bob Keolian mentors a student team at the hands-on workshop. (Photo by Tom Rossing.)



The Physics Force team presented a program of physics/acoustics demonstrations. (Photo by Tom Rossing.)

Ping-pong ball driven by atmospheric pressure passes through two soda cans following explosive shock heating. (Photo by Tom Rossing.)

New ASA Fellows. (Photo by Charles Schmid.)

Echoes from Minneapolis

What Do We Know About Noise in Hospitals?

James E. West and Ilene J. Busch-Vishniac

The importance of noise in health care has been recognized for years but little work has been done to characterize and reduce hospital noise even though it routinely ranks among the top complaints of hospital patients, visitors and staff. There are a small number of hospital noise surveys in the scientific literature. This body of literature suggests that a significant problem exists, and that it is generally getting worse rather than better, even in new construction.

Noise in hospitals is important for a number of reasons in addition to the obvious issue of annoyance. There is evidence that the high sound levels in the hospital contribute to stress and burn-out in hospital staff. Further, there is some evidence that noise negatively affects the speed of wound healing. Additionally, there is legitimate concern that hospital noise could negatively affect speech communication and cause increased numbers of medical errors.

We reviewed the literature carefully to enable us to answer the following basic questions: Is there any indication that hospital noise levels are changing over time? Do hospital noise levels vary dramatically from hospital to hospital? Do hospital noise levels vary significantly with type of unit?

The graph below shows the results of our compilation of existing noise studies by showing the A-weighted equivalent sound level as a function of the year of publication of the study. A-weighting corrects for the pitch response characteristics of humans, and equivalent sound pressure levels are the sound levels that would be produced if time-varying sound instead had a constant level producing the same total sound energy.

There are three interesting points raised by this literature survey. First, not one published result shows a hospital which complies with established standards for hospital noise. These standards were developed to define maximum noise levels commensurate with health care purposes. Most of the data, particularly that which is recent, shows sound levels 20-40 dB(A) higher, i.e. 2 – 4 orders of magnitude more energetic than the standards suggest. Second, there is a clear trend for rising hospital noise levels consistently since 1960. A straight line fit to the data (included in the figure) shows an increase, on average, of 0.38 dB per year for daytime levels. Thus, the situation has been steadily worsening. Third, the figure shows remarkably little variation given that the results are for widely different sorts of hospitals (major research facilities to community hospitals) located throughout the

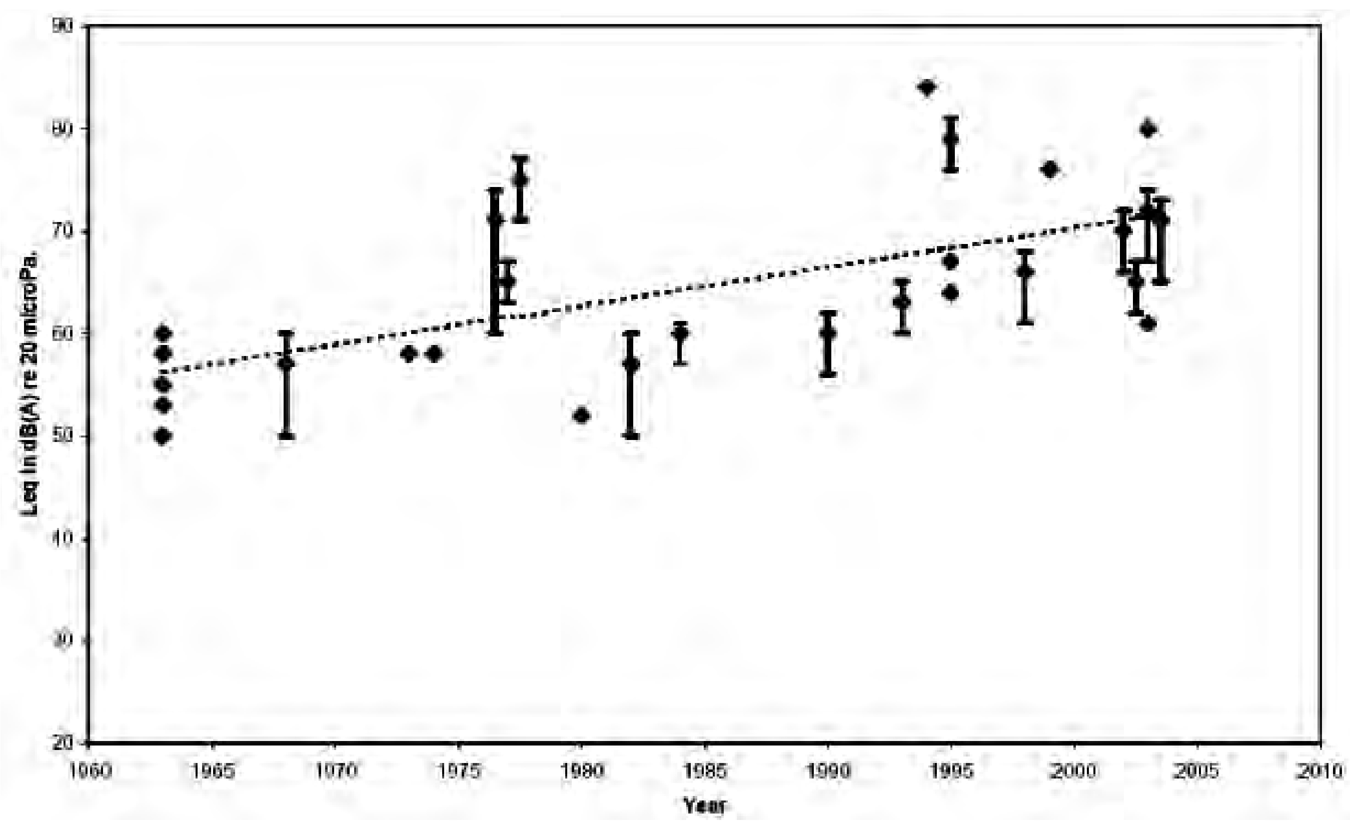


Fig. 1. A-weighted equivalent sound pressure levels measured in hospitals during the day as a function of the year of study publication

world. This suggests that the problem of hospital noise is universal, and that noise control techniques might also be expected to be applicable broadly.

There are only a couple of noise control studies in hospitals and most of these focus on administrative controls such as asking staff to speak softly and to close patient room doors. Historically administrative noise controls have had very limited effectiveness because of the need for constant attention. We recently took a different approach to the problem and studied the impact of adding sound absorbing material to a hospital unit. Hospitals tend to have hard floors and walls, and increasingly they are choosing not to use acoustical ceiling tiles because of concern that bacteria will become trapped in the small holes found in such tiles. We created sound absorbing panels from fabric-covered construction fiberglass (a very good sound absorber). The fabric was a special anti-bacterial material. The results of placing these tiles on the ceilings were very encouraging. The reverberation time in the hallways was cut in half, meaning that noise died out much faster. We also saw a drop in the unit ambient noise, and most importantly, surveys of staff and patients indicated immediate awareness and approval of the change. The study was sufficiently successful in quieting the unit that hospital leaders are now discussing how to provide similar noise relief throughout the hospital.

There is still much work to be done on quieting hospitals. For instance, while we are beginning to understand how loud the hospital environment is, we haven't yet determined the significance of each of the major noise sources. Nor have we adequately studied tonal qualities of hospital noises that would let us better predict human reactions to them. However, it is reassuring to begin to have clear directions in which to move to address this series of important problems.

Jim West, is a Research Professor at Johns Hopkins University in the Department of Electrical and Computer Engineering. He retired as a Bell Laboratories Fellow, Lucent Technologies in 2001. He served as ASA president in 1998-99 and received the Silver Medal in Engineering Acoustics in 1995. He will be awarded the ASA Gold Medal in June 2006.

Ilene Busch-Vishniac is Professor of Engineering at Johns Hopkins University. She was ASA President in 2003-04, received the ASA Biennial Award in 1987 and the ASA Silver Medal in Engineering Acoustics in 2001.

Minneapolis skyline as seen from Loring Park near the Hilton. (Photo by Tom Rossing.)

Minneapolis near the Hilton. (Photo by Tom Rossing.)

Scanning the journals

Thomas D. Rossing

- The male cub-winged manakin, a tiny red-headed bird, literally **sings with its wings**, according to an article in the 29 July issue of *Science* (see also "Acoustics in the News" in the Fall issue of *ECHOES*). In an effort to attract the attention of females, the bird rakes its feathers back and forth over one another, using an acoustic trick that also allows crickets to sing. While the technique is common among insects, it has never been documented before in vertebrates. When the bird raises its wings over its back, it shakes them back and forth over 100 times a second. The frequency of the sound by raking the feathers, however, is around 1400 Hz. The rapid pronation and adduction of the wings and the collision between the right and left secondaries is thought to produce an impulsive mechanical excitation that induces the enlarged, hollow sixth and seventh feathers to resonate. The sound is reported to be loud and clear, not unlike the sound of a violin.
- **Scanning near-field ultrasound holography** (SNFUH), a non-destructive imaging technique, is described in the 7 October issue of *Science*. SNFUH provides depth information as well as spatial resolution at the 10- to 100-nameter scale. It has a finer resolution than the scanning acoustic microscope and is especially valuable in subsurface imaging, whether integrated circuits or biological systems. Typical frequencies are in the 2-MHz range. In SNFUH, acoustic waves are launched on both the probe tip and the sample at slightly different frequencies, and the interference of these two waves forms a surface acoustic standing wave which is altered by subsurface features such as voids.
- The July issue of *Acoustical Science and Technology* includes a tutorial on "**Expressive speech**: Production, perception and applications to speech synthesis." It discusses some of the current problems with data collection, labeling, techniques for analyzing voice quality and applying speech synthesis as an analysis tool. Directions for future work in order to improve synthesis of expressive speech are suggested.
- When a dry strand of spaghetti is bent beyond its limit of curvature, it does not usually break in half but instead into several pieces, from as few as three to as many as ten, according to a paper in *Phys. Rev. Lett.* **95** 095505. Apparently **flexural waves** travel along the length of the rod just after the initial break. These waves increase the local curvature of the rod and trigger an avalanche of new breakages, which in turn initiate more waves, thus causing the rod to fragment. This phenomenon, which has been confirmed by high-speed images of individual strands of spaghetti as they break, can be applied to other materials such as fiberglass.
- Continuing **analysis of sound recordings** made in Arkansas (see "Acoustics in the News" in the Fall issue of *ECHOES*) have not yet settled the question of whether the ivory-billed woodpecker is alive or extinct, according to a news feature in the 8 September issue of *Nature*. A team of ornithologists from Cornell University published an article in *Science* **308**, 1460 (2005) stating that the woodpecker was alive and well, and the Secretaries of the Interior and Agriculture held a press conference on April 28 hailing the rediscovery as a rare piece of good news for the Bush administration, smarting from criticism over its environmental policies. There are doubters, however. "Remote sound recordings are notoriously deceptive," one of them points out. The team was scheduled to return to the Arkansas woods in November with more observers, more acoustic recorders and an expected $200,000 in federal funds.
- **Baryonic acoustic oscillations** are a promising way to study dark energy in the universe, according to an article in the 2 September issue of *Science*. Like sound waves in a slide whistle that shift to lower pitches as the whistle's plunger descends, the wavelength of light increases more quickly if space is stretching faster. So to accumulate a given amount of stretch or redshift, light would have had to travel longer and farther if the universe had expanded more slowly billions of years ago than if the universe had always expanded at its current rate. Because of baryon acoustic oscillations, galaxies show a slight tendency to space themselves at a specific distance. That distance, about 500 million light years, is determined by how far sound waves traveled in the plasma that filled the primordial universe before atoms formed (see *ECHOES*, Fall 2004). Prior to recombination, the baryons in the universe were locked to photons of the cosmic microwave background, and the photon pressure interacting against the gravitational instability produced a series of sound waves in the plasma.
- A **single-molecule torsional pendulum** is described in the 2 September issue of *Science*. The molecule is a single-wall carbon nanotube grown on a silicon substrate by chemical vapor deposition. The resonance frequency for the torsional oscillations is calculated to be 0.1 MHz.
- Audio information stored in the grooves of **cylinder or disk phonograph records** can be reconstructed, without contact using optical metrology methods (see "Acoustics in the News" in the Fall 2004 issue of *ECHOES*), according to a paper in the June issue of the *Journal of the Audio Engineering Society*. The first three-dimensional reconstruction of recorded sound from a mechanical carrier is reported. The source material, a celluloid cylinder, was scanned using color-coded confocal microscopy techniques. Three-dimensional measurement is required in order reconstruct vertically modulated carriers such as a cylinder.
- **Pitch perception** is critical for identifying and segregating auditory objects in both music and speech. Pitch is not unique to humans and has been demonstrated in several animal species as well. A paper in the 25 August issue of *Nature* reports finding neurons in the auditory cortex of marmoset monkeys that respond to both pure tones and missing fundamental harmonic complex sounds having the same fundamental frequency. These pitch-selective neurons are located in near the anterolateral border of the primary auditory cortex, which is consistent with the location of a pitch-selective area in humans.
- Small drops can bounce indefinitely on a bath of the same liquid if the container is oscillated vertically at a sufficiently high acceleration. According to a brief communication in the 8 September issue of *Nature*, these **bouncing droplets** can be

Scanning the journals

made to "walk" at constant horizontal velocity on the liquid surface by increasing this acceleration. This transition, which occurs slightly below the Faraday instability (where the surface becomes spontaneously wavy), yields a new type of localized state with particle-wave duality. When two walkers come close, they interact through their waves and this "collision" causes the two walkers to orbit around each other.

- An optical **vibration sensor** which uses a 1550-nm laser diode as a source and an InGaAs photodiode as a receiver, is sensitive to accelerations as low as 0.01 m/s2, according to a note in the September issue of *Photonics Spectra*. The device, which is fabricated by creating a waveguide in glass using femtosecond pulses from a Ti:sapphire laser, has a linear response over frequencies from 20 to 2000 Hz.
- A new backpack device makes use of an oscillating mass and spring to harvest **energy from walking** according to a brief paper in the 9 September issue of *Science*. The resulting electrical energy could be used to recharge cell phone batteries or power a global positioning system while the subject walks. A 20-kg unit can generate more than 2 W of electrical power, while a 38-kg unit can produce more than 7 W. The oscillating device results in a considerable saving in metabolic energy as compared to a device with a fixed payload.
- Ultrasound can be used to control the viscosity of gelatinous organ fluids, according to a paper in *J. Am. Chemical Soc.* **176**, 9324 (2005). Molecules containing platinum are dissolved in acetone, resulting in an oily liquid that turns into a white gel when zapped with ultrasound at 40 kHz. The gel can be reversed back into a liquid by heating or by another burst of ultrasound. This is believed to be the first demonstration of the instant and remote control of stable so-gel phases.
- The recent Sumatra **tsunami** that produced devastation around the Indian Ocean traveled several times around the globe before dissipating, according to a report in the 23 September issue of *Science*. The history is recorded in a global tide-gauge network and an ocean model is used to understand the global propagation of this tsunami. Large waves were recorded in such places as Peru, Antarctica, and Nova Scotia, probably guided by Earth's mid-ocean ridge system.
- According to a letter in the 29 September issue of *Nature*, crescent-shaped dunes called **barchans** behave more like plane propagating waves than like solitary waves. The nucleation and propagation of such waves on a sand bed is governed by the interaction between the bed profile and the sand transport. The instability mechanism is directly related to the asymmetry of the wind flow which originates in the nonlinear inertial term of the Navier-Stokes equations.
- "Heavenly" is the title of an article on cosmology in the August issue of *Scientific American*. When scientists "listen" to the **music of the cosmos** played in the cosmic microwave background (CMB), the strains first sound harmonious but then as they listen more carefully they note that something is off key. As with a sound wave, CMB fluctuations can be analyzed by splitting them into their component harmonics. The temperature fluctuations are analyzed in terms of spherical harmonics.
- "Coherent signal amplification in bistable nanomechanical oscillators by **stochastic resonance**" is the title of a paper in the 13 October issue of *Nature*. Stochastic resonance is the addition of noise to a noisy system to induce coherent amplification of its response. It runs rather counter to intuition. This paper describes its observation in nanomechanical silicon oscillators consisting of beams that are clamped at each end and driven into transverse oscillation with the use of a radiofrequency source. The "Euler instability" in buckled beams dictates that a slender elastic object, clamped at either end, will move transversely if subjected to a longitudinal compressive force beyond a critical value.
- "**Modal Analysis Versus Finite-Element Analysis**" is the title of an informative editorial in the September issue of *Sound and Vibration*. Experimental modal analysis (EMA) or modal testing is used to validate finite element analysis (FEA), but it is also used for trouble shooting noise and vibration problems in the field. Each mode is defined by three different kinds of parameters: its modal frequency, its modal damping, and its mode shape. There are a number of reasons why experimental mode shapes don't match analytical shapes. A significant one is that the boundary conditions may be different between the EMA and FEA. Damping can't be easily modeled, so it's not included in most FEA models. Also, experimental mode shapes tend to have fewer degrees of freedom (DOFs) than analytical shapes.