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The Acoustical Society of America

ECHOES

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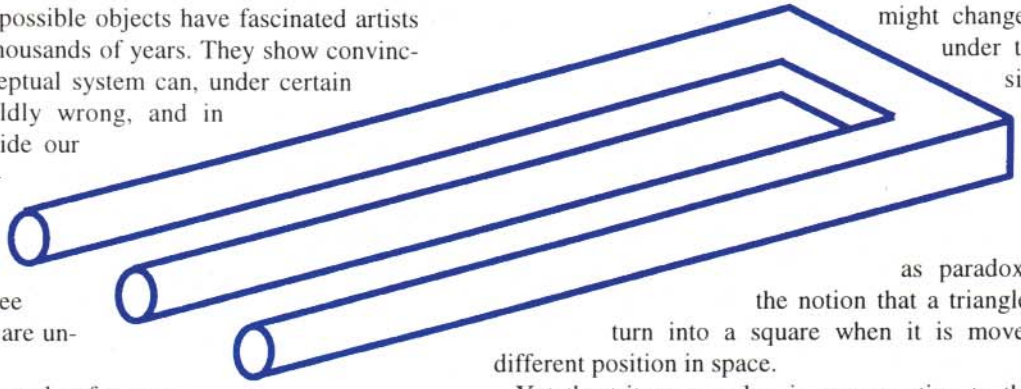
Paradoxical Music

by Diana Deutsch

This "impossible object" is sometimes called "the Devil's trident." We cannot see it correctly, or even view it in a logically consistent fashion. When we look at the left part of the figure we see three prongs. When we look at the right part we see only two. Yet neither interpretation is correct.

Illusory and impossible objects have fascinated artists and scientists for thousands of years. They show convincingly that the perceptual system can, under certain conditions, go wildly wrong, and in ways that are outside our control. For example, however long or hard we stare at these prongs and try to see them correctly, we are unable to do so.



In the past, the study of perceptual paradoxes was confined largely to vision; it was virtually impossible to generate complex sounds with sufficient versatility and precision. However, the advent of powerful computers has now enabled us to produce any sound imaginable. Capitalizing on this new technology, auditory researchers have produced some surprising and paradoxical findings; these have implications for fields ranging from psychoacoustics to music theory and composition to speech perception.

One strange perceptual phenomenon that I discovered is called the tritone paradox. The basic pattern that produces this curious effect consists of two computer-produced tones that are related by a half-octave, or tritone. When one tone of a pair is played, followed by the second, some people hear an ascending pattern. Yet other people, when presented with the same set of tones, hear a descending pattern instead. (This can be very bewildering to a group of musicians who are all quite certain of their judgments and yet disagree entirely as to whether such an apparently simple pair of tones is rising or falling in pitch.)

The tritone paradox has another surprising aspect. Ordinarily, when a melody is played in one key, and it is then transposed to another key, the perceived relations between the tones remain the same. The idea that a melody might change shape under transposition is as paradoxical as the notion that a triangle might turn into a square when it is moved to a different position in space.

Yet the tritone paradox is an exception to this rule. When a listener is played one of these tone pairs (say, D followed by G#), he or she might hear an ascending pattern. Yet when a different tone pair is played (say, A followed by D#), the same listener hears a descending pattern instead. (Another listener might hear the D-G# pattern as descending and the A-D# pattern as ascending.)

To produce the tritone paradox, I use computer-generated tones which are so constructed that their note names (C, D#, F and so on) are clearly defined, but their octave placement is ambiguous. For instance, one tone is clearly an A, but it could in principle be concert A or the A an octave above or the A an octave below. This ambiguity is a property of the tones themselves, so that when someone is asked to judge whether the tone pair, say E-A#, is rising or falling in pitch there is literally no correct answer. (Each tone is composed of a series of sinusoidal components that stand in octave relation, and whose amplitudes are determined by a bell-shaped spectral envelope.

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We hear that...

Two ASA awards will be presented at the upcoming meeting in Honolulu: The Trent-Crede Medal will be awarded to **Preston W. Smith, Jr.** for his pioneering contributions to statistical energy analysis and structural acoustic interaction; and the Distinguished Service Citation will be presented to **John C. Burgess** for his contributions to international cooperation through the organization of joint meetings with the Acoustical Society of Japan.

Ronald L. Eshleman, a resident of Clarendon Hills, Illinois and President of the Vibration Institute, has been named a Fellow of the American Society of Mechanical Engineers.

At its annual honors ceremony in June, the Institute of Electrical and Electronics Engineers (IEEE) awarded its Edison Medal to **Floyd Dunn** for his "contributions to ultrasonic propagation in and interactions with biological media."

The Institute of Noise Control Engineering (INCE) has elected **Richard J. Peppin** President-Elect and Executive Vice President.

Maurice M. Sevik, Associate Technical Director and Head, Signatures Directorate at the Carderock Division, Naval Surface Warfare Center in Bethesda, Maryland, received the Captain Robert Dexter Conrad Award, the Navy's highest honor for scientific achievement.

The John S. Guggenheim Memorial Foundation has awarded a fellowship to **George R. Wodicka**, Associate Professor of Electrical Engineering at Purdue University. With the fellowship, Wodicka will pursue the evaluation of a technique he devised using acoustics to guide the placement of breathing tubes in pre-term infants.

ECHOES 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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Sessions on acoustics at upcoming AAAS meeting

The ASA will co-sponsor two sessions at the February 13-18 meeting of the American Association for the Advancement of Science (AAAS). One is the session, "Communication: Neurobiological and Environmental Approaches," organized by Diana Deutsch and Patricia Kuhl. The other, "Acoustics Demonstrations," is organized by James Sabatier and Logan Hargrove.

NATO conference on Sonochemistry and Sonoluminescence

NATO's Advanced Study Institute will conduct a conference co-sponsored by the ASA on Sonochemistry and Sonoluminescence August 18-29, 1997 at the Sleeping Lady Conference Center in Leavenworth, Washington. The conference is also supported by the U.S. Office of Naval Research and the Applied Physics Laboratory of the University of Washington.

The objective is to bridge the knowledge gap between these disciplines by bringing together physicists with expertise in acoustic cavitation and bubble dynamics, and chemists with expertise in electron transfer, chemical reactions, and spectroscopy. Attendance will be limited to 60 participants, who will be asked to contribute $300 toward room and board. The deadline for application is December 15, 1996.

Further information: Nancy Penrose, Univ. Washington APL (206)543-1275, e-mail:SONO-ASI@apl.washington.edu.

ASA receives matching funds from AIP

The ASA received $50,000 in funds from the American Institute of Physics for the project "Consideration of Online Publishing in ASA's Future" and an additional $10,000 to develop a "Guide for Acoustical Resources on CD ROM." The online publishing project will be led by ASA Past President Robert Apfel, who will work with the AIP to consider such topics as:

- Processes for handling pre-prints.
- An all-electronic approach for manuscript submission, review, and publishing, with efforts directed toward rapid communications publication.
- Site-license development for non-member subscribers (methods for libraries to distribute the *Journal* electronically).

The guide for acoustical resources project is being lead by Executive Director Charles Schmid, and will provide a searchable database for organizations working in acoustics, including non-profit groups, standards associations, government agencies, universities and colleges, consultants, and commercial firms.

The AIP funded a total of four projects from all the member societies that submitted proposals, two of which were awarded to ASA. The others went to the American Geophysical Union to demonstrate the feasibility of a low-cost method for broadcasting meeting presentations via the internet, and to the Optical Society of America to develop a quality optical database.

Aloha ASA, ASJ

The Acoustical Society of America will jointly sponsor its fall meeting with the Acoustical Society of Japan on December 2-6. The meeting promises to be packed with interesting technical sessions and there will be entertainment as well. A large paper-sorting committee composed of ASA and ASJ members worked diligently to squeeze in some 1340 abstracts. ASA's John Burgess has done yeoman's work to organize this large and complex meeting.

There will be a "Colloquy Room," complete with tables, coffee, and tea, for those wishing a quiet place for discussion. As at the two earlier Joint ASA/ASJ Meetings, there will be a buffet social on Tuesday evening and a banquet on Thursday evening. Another attractive feature of the meeting will be the printed proceedings of ASJ's 358 papers, which will be offered for sale in the registration area.

ASA Vice-President Patricia Kuhl and President Stanley Ehrlich take time out from the paper-sorting session to breathe some Hawaiian air.

WW press room

Once again, the ASA will host its World Wide Press Room on the internet (http://www.sdrm.org/asa2). This will provide access to popular versions of selected papers, as well as links to other types of ASA information, such as paper abstracts and special events (such as concerts, lectures, etc.) The complete meeting program with full abstracts can be viewed now on the ASA Home Page at http://asa.aip.org. A laptop computer will be available at the meeting to access both the WW Press Room and the ASA Home Page.

Opening session

The usual afternoon Plenary Session is being replaced by an Opening Session on Monday morning from 8:00 to 10:00 a.m., (awards to be presented later at the banquet). The Opening Session will begin with short welcoming remarks by ASA President Stanley Ehrlich and ASJ President Hideki Tachibana. These will be followed by two speakers: Robert Beyer will speak on "Nonlinear Threads in the Coat of Acoustics" and Zyun-iti Maekawa will give an "Environmental Acoustics Update."

Awards

There will be a banquet on Thursday evening, Dec. 5, at which there will be entertainment with a Hawaiian flavor. Tickets may be purchased at the registration desk. The awards ceremony will take place after the dinner. In addition to the Trent-Crede Medal and the Distinguished Service Citation (See "We hear that..."), Special Distinguished Service Certificates will be presented by the ASA to four members of the ASJ for their outstanding contributions to the friendship between the two Societies: Juichi Igarashi, Sonoko Kuwano, Seiichiro Namba, and Hideki Tachibana. In recognition of the same kinds of contributions, the ASJ will present Medals of Special Merit to ASA members Robert Apfel, John Burgess, Stanley Ehrlich, Tony Embleton, Patricia Kuhl, and Jiri Tichy. In addition, certificates will be awarded to thirty new ASA Fellows.

The ASA Science Writing Awards will also be presented at the banquet. The award for journalists will be given to A. Richard Immel for his article in *Smithsonian*, "Shh–those peculiar people are watching," and the award for professionals in acoustics will go to Peter Narins for his article, "Frog Communication" in *Scientific American*.

Music

Attendees at the Honolulu meeting will not lack for music. Following the custom of combining at least one technical session with a musical performance, Session 4aMUb on Traditional Instruments of Japan and the Americas, arranged by Professors Isao Nakamura and Thomas Rossing, will conclude with an informal concert on several traditional instruments. These include Satsuma biwa, Chikuzen biwa, hammered dulcimer, and Native American instruments. Performers will include Kakuryo Kyokusumi Tohnais, David and Donna Peterson, and Stephen Duncan. Plans call for other informal concerts during the week, such as at the open meeting of the Technical Committee on Musical Acoustics.

Auralization

A Short Course on Auralization, which was not described in the Call for Papers, will be presented after the Honolulu meeting on Saturday and Sunday, Dec. 7 and 8. Auralization is defined as an acoustic "visualization" process, or acoustic rendering analogous to the visual rendering process used by architects and interior designers. The sound field of sources in a hall or some other space is made audible by physical or mathematical modeling in such a way as to simulate a binaural listening experience at a given position in the hall. The course will include samples of auralization of various auditoria and concert halls, and will enable participants to judge the audibility of various approximations needed to make auralization feasible on today's personal computers. Instructors will be Mendel Kleiner and Peter Svensson of Chalmers University in Gothenburg, Sweden. The deadline for registration is Nov. 18. Contact the ASA office in Woodbury, NY: ph (516)576-2360, fax (516)576-2377, e-mail asa@aip.org.

(Paradoxical Music, continued from page 1)

Ambiguous tones similar to these were first used by Roger Shepard and Jean-Claude Risset in the 1960s to create different illusions.)

As a further surprise, the way any one person hears the tritone paradox depends in an orderly fashion on the names of the notes that are played. Our musical scale is produced by dividing the octave into twelve semitone steps, and each tone is given a name (C, C#, D, and so on.) The entire scale consists of the repeating occurrence of this series of note names across successive octaves.

Tones that stand in an octave relation are, in a sense, perceptually equivalent -- all Cs sound in a sense alike, all C#s, and so on. So we can think of pitch as varying both along a monotonic dimension of height, and also along a circular dimension of pitch class, a term that music theorists use to describe note name (Figure 1).

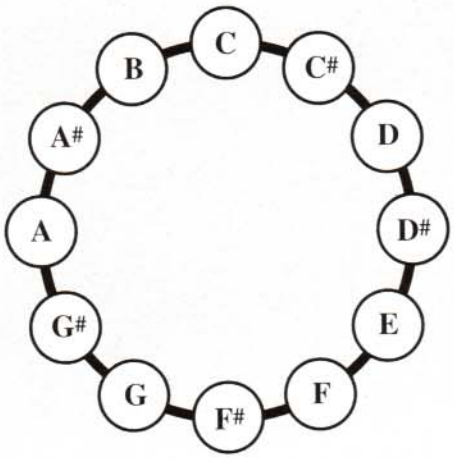

Figure 1. The pitch class circle comprises the twelve pitch classes within the octave. To produce the tritone paradox, pairs of tones are played that are in opposite positions along the circle; for example the tone C is played followed by F#, or A followed by D#.

In considering how the tritone paradox is perceived, I conjectured that people mentally arrange pitch classes as a circular map, like a clockface. One person might orient his or her clockface so that C is in the 12:00 position, C# in the 1:00 position, and so on around the circle. This person would hear the pattern C-F# (and also B-F and C#-G) as falling, and the pattern F#-C, (and also F-B and G-C#) as rising. Another person might orient this clockface so that F# is in the 12:00 position instead. He or she would then hear the pattern C-F# as rising and F#-C as falling. Other listeners would place yet different pitch classes in the 12:00 position, and so produce different patterns of response. So how any one individual hears the tritone paradox would reflect how he or she orients the pitch class circle with respect to height.

To test this conjecture, I played subjects just such tritone pairs, and they reported in each case whether they heard an ascending or descending pattern. Then I plotted the percentage of times that a subject heard a descending pattern as a function of the pitch class of the first tone of the pair. The results supported my conjecture: The judgments of most subjects varied systematically as a function of the positions of the tones along the pitch class circle: Tones in one region of the circle were heard as higher and those in the opposite region as lower. However, subjects differed radically in terms of which tones they heard as higher and which as lower, and so in terms of how they oriented the pitch class circle with respect to height.

The judgments made by four different subjects are shown in Figure 2. For example, the subject on the upper right heard pitch classes E, F, F#, G, G#, and A as higher and A#, B, C, C#, D, and D# as lower. So for this subject, the peak pitch classes (those defining the 12:00 position along the circle) were F# and G. In contrast, the subject on the lower right heard pitch classes A#, B, C, C#, D, and D# as higher and E, F, F#, G, G#, and A as lower. So for this subject, the peak pitch classes were C and C# instead.

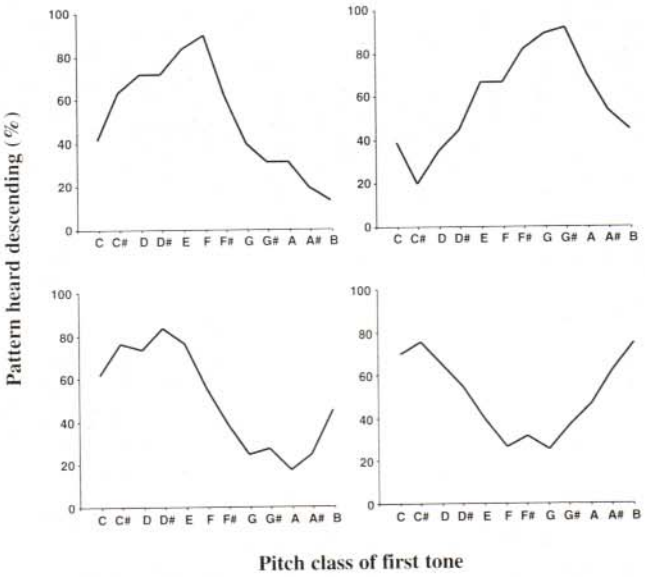

Figure 2. Perception of the tritone paradox differs considerably from one listener to another. Each graph plots the percentage of times that a subject heard a descending pattern, as a function of the pitch class of the first tone of the pair.

Why do people orient their maps of the pitch class circle in such dissimilar ways? I conjectured that the answer might lie in the pitch ranges of the speaking voices that we hear around us. In one study, which I carried out with Tom North and Lee Ray, a significant correlation was indeed found between the pitch range of a person's speaking voice and how he or she perceived this pattern.

In another study I found evidence that perception of

(Continued on next page)

(Paradoxical Music, continued from previous page)
the tritone paradox varies with the language or dialect to which the listener had been exposed. Two groups of subjects were compared: those in the first group had grown up in California and those in the second group had grown up in the south of England. These two groups differed statistically in terms of how they heard the tritone paradox: often when a Californian subject heard the pattern as ascending, a subject from the south of England heard it as descending, and vice versa. Figure 3 shows the distributions of peak pitch classes for these two groups of subjects.

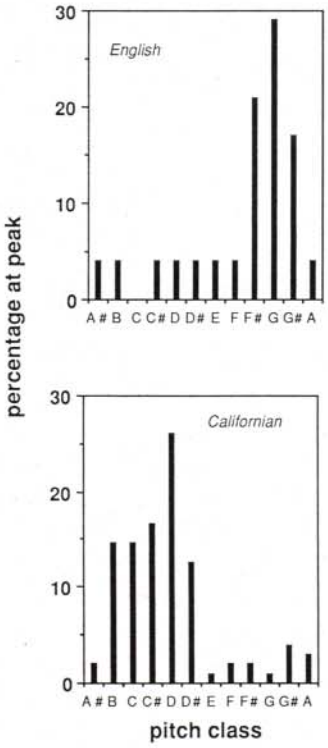

Figure 3. The tritone paradox as perceived by a group of subjects from California, and a group from the south of England. The graphs show the distributions of peak pitch classes (those defining the 12:00 position along the pitch class circle) for these two groups of subjects. In general, when the Californian group tended to hear an ascending pattern, the English group tended to hear a descending one, and vice versa.

Recently, Janice Giangrande found that a group of listeners at Florida Atlantic University produced a distribution of peak pitch classes that was similar to the one obtained by my Californian subjects. In another experiment, Lloyd Dawe, John Platt, and Eydra Welsh studied a group of students at McMaster University in Ontario, Canada, and obtained a distribution that was quite similar to that produced by my English subjects. It will be very interesting to discover how this curious pattern is heard by listeners in other regions around the globe.

Frank Ragozzine and I discovered a regional difference within the United States in how this musical paradox is perceived: Among subjects who had grown up in the area of Youngstown, Ohio, those whose parents had also grown up in this area heard the pattern differently from those whose parents had grown up elsewhere within the United States (*J. Acoust. Soc. Am.*, 1993, *94*, p. 1860). This study indicated that such perception is based on a template that is formed in childhood. Most recently, I obtained a significant correlation between the way a child hears this pattern and the way his or her mother hears it (*J. Acoust. Soc. Am.*, 1996, *99*, p. 2482). This correlation held even for children whose mothers had grown up in a different region. For example, the perception of a seven year old Californian girl was similar to that of her English mother, rather than following the typical Californian pattern.

Why should such a speech-related template have evolved? Since the pitch of speech varies with emotional state, such a template could provide a means whereby we can evaluate the emotional state of other speakers. It could also be used in communicating syntactic elements of speech.

What are the implications of the tritone paradox for listening to everyday music? It is tempting to speculate that effects of this sort might enter into the perception of live musical performances, particularly in passages of orchestral music where the composer has deliberately introduced ambiguities. Such passages occur, for example, in the orchestral music of Debussy and Ravel. Indeed, the striking individual differences found here lead to the conjecture that some disagreements between music critics are based on perceptual differences that have not yet been documented. At all events, this musical paradox has now enabled composers to produce music that sounds radically different from one listener to another, and even from one audience to another.

The tritone paradox strongly suggests that a connection exists between speech and music, a connection that has been hypothesized by philosophers and musicians since the time of the ancient Greeks. The composer Mussorgsky, who argued in favor of such a relationship, wrote: "My music must be an artistic reproduction of human speech in all its finest shades, that is, the sounds of human speech ... without exaggeration or violence, become true, accurate music."

Diana Deutsch, Ph.D. is Professor of Psychology at the University of California at San Diego. She holds fellowship in several societies, including the Society of Experimental Psychologists, the Audio Engineering Society, and the AAAS. She has recently published the compact disk, "Musical Illusions and Paradoxes," which contains the patterns for a full experiment on the tritone paradox. It is available through Philomel Records, P.O. Box 12189, La Jolla, CA 92039.

Opinion

Tuning up classroom acoustics

by Buzz Towne

The changing face of education

The headlines have called for an "educational revolution" for the last decade. Declining achievement scores and increasing educational and behavioral problems have become a recognized thorn in the side of educators. Depending upon the geographic area, it is not unusual for classrooms to have 10 to 50 percent of the total number of students who do not speak English at home.

Rising numbers of learning disabled students attend school who have been drug dependent or who have suffered other disorders from their first breath of life. The most recent educational practice, called "inclusion" has included children with mild and moderate learning delays in the regular education setting. For example, a child with a first grade ability to identify a letter of the alphabet and associate some sounds can now be found in a third grade classroom, struggling to understand as much information as the teacher has time to give. The TV generation comes to school with less respect for authority and increased incidents of defiant or uncontrolled behavior. Providing a good education to the young people of today may well be our nation's greatest challenge.

In addition to large numbers of students with special needs entering the classroom, we now know that people with normal hearing are often challenged by listening conditions that are less than optimal. For example, young children and older adults with hearing thresholds within the normal range and individuals with speech and learning disorders not related to hearing loss, in addition to hearing-impaired persons of all ages, do not understand speech as well as normal-hearing young adults under ideal conditions. This fact should be taken into account in designing the acoustics of environments where these populations study, work, and play.

A call for change

Interest at the most recent meeting of the Acoustical Society of America was sparked by information that has become available on children's ability to perceive and understand speech in the classroom environment. The ASA, in response to this information, has developed a task force with the purpose of defining new acoustical standards for classrooms.

Professionals designing HVAC systems for educational spaces are key participants in designing the primary acoustical elements that can interfere with adequate speech communication in classrooms. If these engineers are not aware of the most current acoustical and speech perception data related to educational spaces (and continue to design today's schools much like those of the 1960s), their practices are outdated and not consistent with the development of an effective educational environment.

New construction or the remodeling of kindergarten through 12th grade school buildings is now recommended after three decades of relatively little activity. But current design guidelines are drawn from the last major construction period, which predated the scientific knowledge that has been gained in the area of children's speech perception and related learning problems. For good communication conditions to exist in classrooms, children must be able to hear clearly and comprehend what teachers are saying. Unfortunately, no current architectural guidelines exist to define good communication conditions between teachers and students. The ASA task force is in the process of responding to this challenge.

Soundings

Impulse analysis helps TV audience understand Flight 800 noises

On July 17, the cockpit voice recorder of TWA Flight 800 stopped moments after a loud impulsive sound was recorded by four microphones. The content and interrelationship of these microphone signals provide clues as to the origin of the sound.

To help TV viewers understand how these signals might be analyzed, ABC World News Tonight with Peter Jennings approached RH Lyon Corp. for assistance. On July 24, viewers saw two types of impulsive sound being tape recorded by David Bowen and Gladys Unger in a cabin-sized space: the noise from the impact of two aluminum parts and the noise from the bursting of a balloon. Immediately afterward, the time histories and spectra of the two signals were displayed on a computer screen. While these traces were being drawn and the echo structure revealed, viewers simultaneously heard the impulsive sounds slowed down by a factor of ten. The narrator explained some technical aspects of the processes that were demonstrated.

Can you name this pioneer in acoustics?

She assisted E.P. Fowler, C.C. Bunch, P.E. Sabine, and Fred Krantz in determining the percentage loss of useful hearing, and she assisted A. Pohlman, Fred Krantz, and Paul Sabine in the development of hearing aids. Once recognized by the Council of Physical Therapy of the American Medical Association as a primary contributor to the development of hearing tests and hearing aids, she also assisted in the formation of various papers that were presented to the American Academy of Ophthalmology and Otolaryngology. Her name was recognized by many leading otologists of the 1930s and 1940s.

Answer:

Elmira Riverbank
Like her famous partner, Elmer Riverbank, Elmira is a mannequin, serving as an artificial head on many tests of hearing measurement. As recent as 1991 Elmira was used in a field test by an acoustical consultant. When asked how Elmira did, the consultant stated that Elmira's hearing hasn't changed a bit since the 1940s!
She stands proudly in the Riverbank Acoustical Laboratory's Museum. Unfortunately, Elmira lost her partner, Elmer, when a graduate student accidentally knocked him off the shipping dock and a truck ran over him.
May he rest in pieces.
Riverbank Acoustical Laboratories' manager John Kopec stated that Elmira never gives him any trouble, doesn't require a salary or benefits, occupies only 1 square foot of space, and always does her job.

Reactions to "Chain Reaction"

Not long ago, Ben Stein and Phil Schewe of the American Institute of Physics created a fact sheet for the WWW anticipating the new movie, "Chain Reaction." The fact sheet states: "Keanu Reeves will talk about some real physics. He and Morgan Freeman play members of a scientific team which devises a way to produce significant amounts of energy from a mysterious process known as 'sonoluminescence.'" It explains that sonoluminescence will not generate lots of energy any time soon, but that some scientists suspect that it may someday have the potential to create small amounts of fusion energy. The fact sheet then describes sonoluminescence very cogently and outlines some of the theories of its causation. See http://www.aip.org/physnews/preview/1996/chain/.

Following a special preview of "Chain Reaction," reporter Jim Dawson wrote an article for the August 3 issue of *The Minneapolis Star Tribune*: "Science of 'Chain Reaction' a mysterious phenomenon." He describes sonoluminescence expert Seth Putterman as being uncomfortable with his kind of research being portrayed as potentially dangerous.

Dawson goes on to explain that "...despite what you see in 'Chain Reaction,' sonoluminescence can't trigger a chain reaction, nor can it extract hydrogen from water. It also can't blow up eight blocks of the South Side of Chicago. What you see early in the film is a simple, although gigantic hydrogen explosion, not a little sonoluminescent bubble run amok."

Another sonoluminescence expert, ASA President-Elect Lawrence Crum, was also less than impressed by the film. In his opinion, "the science was terrible, the plot was totally implausible, and the chase scenes just went on and on ad nauseam." He allows, however, that "Morgan Freeman was excellent, the ending was unsuspected, and the movie did keep my attention." His biggest complaint is that no one seems to care if the science is anywhere near to being plausible. He contrasts it to "2001 Space Odyssey," which had almost no scientific mistakes. "When they make a movie about doctors or lawyers, they work hard to make sure that everything is just right, but when they do one that involves physics or chemistry -- anything is possible. That's not good."

Acoustics in the News

Newspapers

Community noise or "noise pollution" continues to be a popular theme. An April 14 article in *The Seattle Times* by Jack Broom, "Group's plea: Silence for its own sake," discusses the effects of noise and suggestions on how to reduce it. The article refers to "International Noise Awareness Day," which took place on April 24. Another piece about community noise appeared in *The Newport* (R.I.) *Daily News* on July 22. The article, "People, cars as noisy as nightclubs' music," by Susan Cover, describes noise measurements by David Browning and Steven Letcher and their results, as well as the local city council's consideration of lowering the allowable noise limits.

The *San Francisco Chronicle* ran an article by Carl Nolte, "New Way to Chart Waters At Dangerous Golden Gate," on June 11. The author describes the use of an instrument known as an "acoustic Doppler current profiler" to enhance navigation safety by providing information about tides, currents, the weather, and the depth and salinity of the water in the treacherous Golden Gate Bridge area.

Concert hall acoustics are also a frequent subject in the media. In *The New York Times* article (9-3-96), "Now It's City Opera's Turn to Fiddle With the Sound," reporter Allan Kozinn writes about acoustical renovations at the New York City Opera, housed in the New York State Theater at Lincoln Center. Undertaken mainly because of problems with singers being heard above the orchestra, plywood panels are already in place at each side of the stage, at the orchestra level, and in the balconies. Lawrence Kirkegaard is in charge of the project.

Magazines

Two topics of current interest to acousticians appear in recent issues of scientific and technical publications. In the August issue of *Physics World*, Lawrence Crum and Kullervo Hynynen present a clear and comprehensive review of the medical uses of ultrasound in "Sound Therapy." The discussion includes ultrasound for such treatments as glaucoma and prostate surgery, and breaking up kidney stones; also new applications, such as reduction of internal bleeding and the destruction of blood clots. (See also the feature article by Ron Roy in the previous issue of *Echoes*, Vol. 6, No. 3.)

Another topic covered in *this* issue of *Echoes* is that of musical illusions. Feature author Diana Deutsch has published a lengthier article, "Illusions in sound and music," in the August 20 issue of *Sound & Video Contractor*, which discusses illusions of sound localization as well as music.

Science News carried a short piece in its "Earth Science" section by Richard Monastersky entitled, "A sound way to spot tornadoes" (9-7-96). It describes the use by Alfred Bedard and his colleagues at NOAA of an acoustical sensing system, previously used to detect avalanches, to recognize the low-frequency sounds characteristic of tornadoes.

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