The newsletter of
The Acoustical Society of America

ECHOES

Volume 4, Number 2
Summer 1994

Simulating the mechanics of the human voice

By Ingo R. Titze

SYNTHETIC SPEECH is beginning to play a role in many facets of our everyday life. The familiar sounds of artificial voices can be heard in phone messages, warning signals, entertainment, and computerized self-instruction. There will be many more applications in the future: we will hear synthesizers with transformed personalities, with exaggerated and diminished emotions, with different dialects, and with voice qualities that go beyond the dimensions of the human voice.

Photo: Rodney White, Iowa City, IA

The author and his robot, Pavarobotti.

For many applications of synthetic speech, the only measures of success are intelligibility and naturalness. What comes out of the box is more important than what is in the box. Many coding, storage, and transmission strategies can be used to convert one form of speech to another, or text to speech. There are other applications, however, for which the final output is not the most important product; rather, the principal goal is an improved understanding of the mechanism of speech production. In these cases, what's in the box matters more than what comes out of the box. The speech may indeed be of lesser quality, but the investigator's primary intention is to focus on the physical and physiological processes in speech production.

It is useful to distinguish between *speech synthesis* and *speech simulation.* Speech synthesis is the broader term that includes all types of artificial speech, whereas speech simulation is geared towards illuminating physical and physiological function. The main applications for speech simulation are in medicine, speech/ language pathology, and music.

In medicine, the most exciting prospect is predicting the outcome of special types of head and neck surgery; that is, making a model of the entire mechanical process of speech production and then introducing a pathology, such as a vocal cord paralysis or the surgical removal of tissue. In this way, abnormal speech behavior can be quantified parametrically. Corrective surgery can then be tried out on the model before conducting these procedures on humans. Also, certain parameters in the speech production system can be exaggerated and distorted to find out what lies beyond the limits of normal production. This process can be very useful in predicting breakdowns in the human speech production system.

In the application of speech simulation to speech training and rehabilitation, we envision that a vocologist (a person who trains and modifies voices) can use simulation to alter a client's voice quality. In addition to giving examples with his or her own phonation, the vocologist can use a synthesizer to play variations of sound qualities, speech dialects, and emotions. This should be an improvement over the use of the human voice only, because it allows the changing of one variable at a time, enabling the client to hear the predicted outcome of a physiological change in his or her voice.

Speech simulation began with the early contributions by Flanagan and Landgraf at Bell Laboratories. Flanagan and his coworkers used a one-mass model of the vocal folds and a simplified vocal tract to show that, under some conditions, self-oscillatory behavior could be obtained. But it was the later two-mass model of Ishizaka and Flanagan that demonstrated the proper independence between the vocal source and the resonator. The two-mass model offered an extra degree of freedom that allowed the establishment of a key mode of vibration of the vocal fold tissue. This mode, represented by the out-of-phase movement of the two smaller masses,

Continued on pg. 4

We hear that . . .

Newly elected officers of the ASA are: President Elect **Robert E. Apfel;** Vice-President Elect **Lawrence A. Crum;** and to the Executive Council **Arthur B. Baggeroer** and **William J. Cavanaugh.**

Three ASA members were recently elected to the National Academy of Engineering **Ronald W. Schafer** of the Georgia Institute of Technology, **Maurice M. Sevik** of the Naval Surface Warfare Center in Bethesda, Md., and **Richard M. White** of the University of California, Berkeley.

Stephen H. Crandall, Ford Professor of Engineering at MIT was recently elected to membership in the National Academy of Sciences.

The Military Audiology Association has elected to Honorary Membership **Henning von Gierke,** Director Emeritus of the Biodynamics and Bioengineering Division of the Aerospace Medical Research Laboratory, for his contributions to the advancement of audiology and hearing conservation.

Professor Emeritus **Herbert Ribner** of the University of Toronto Institute for Aerospace Studies has been awarded the NASA Public Service Medal for his contributions to aeroacoustics and aerodynamics.

At its recent annual meeting, the American Academy of Otolaryngology–Head and Neck Surgery, presented Presidential Citations to three ASA members: **Charles I. Berlin,** Director of the Kresge Hearing Research Laboratory of the South; **Aram Glorig,** former Director of the Callier Center for Communication Disorders and more recently of the House Ear Institute; and **James Jerger,** Professor of Audiology at Baylor College of Medicine.

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.

Echoes Editor ..... Alice Suter
Publication Design ..... Linden Communications
Printing ..... Custom Printing
ASA Editor-in-Chief ..... Daniel Martin

Phone inquires: 516-576-2360. Article submissions and correspondence should be directed to *Echoes* Editor, Acoustical Society of America, 500 Sunnyside Boulevard, Woodbury, NY 11797.

Awards and Fellowships

Medals & awards to be presented in Austin

The Executive Council approved the report of the Medals and Awards Committee to present three of the Society's Silver Medals at the November meeting in Austin: in Noise to Kenneth M. Eldred, in Physical Acoustics to Julian D. Maynard, and in Speech Communication to Peter Ladefoged. Also, the Distinguished Service Citation will be presented to William J. Cavanaugh.

Newly elected Fellows

Fourteen new fellows were elected at the Cambridge meeting. They will be announced and asked to assemble on stage during the Plenary Session in Austin:

Robert D. Frisina
Christopher Harrison
Samuel W. Marshall
Michael B. Porter
Kenneth S. Suslick
Malvin C. Teich
Alexander G. Voronivich
Jean-Louis Guyader
William S. Hodgkiss
John M. Ozard
Juergen Schroeter
Alexandra I. Tolstoy
Dianne J. Van Tassell
Ross E. Williams

Student awards

During the Cambridge meeting four ASA technical committees selected students and young presenters for awards.

The Noise Committee announced the winner of its "Young Presenter" award, **Lisa Louie** of the U.S. Naval Surface Warfare Center in Bethesda, MD, for the paper "Active control of liquid-borne energy in a pipe with a uni-directional wave generator."

The award for best student paper in Engineering Acoustics was won by **Christopher C. Lawrenson** of the University of Mississippi for the paper "Theory and construction of the toroidal waveguide with active walls (the acoustitron)."

The first prize for best student paper in Structural Acoustics and Vibration went to **Joseph E. Bondaryk** of MIT's Ocean Engineering Department for "Forward modeling of mid-frequency wave propagation in shells."

Two second prizes were awarded: to **Andre Cote** of Sherbrooke University for "Forced vibration and acoustic response of an unbaffled rotating disk" and to **Michael J. Utschig** of Northwestern University for "Response of a submerged cylindrical shell with internals to an impulse line load."

The best student paper in Speech Communication was presented to **James Dembowski** of the University of Wisconsin, for the paper, coauthored with John Westbury, "What do speakers' tongues do with a suit in greasy wash water?"(!)

Continued on pg. 8

Cambridge meeting one of ASA's biggest and most successful

THE SPRING MEETING that ASA held in June on the MIT campus in Cambridge, Massachusetts, was the largest meeting ASA has held to date without joint sponsorship. Over 2000 registrants attended the sessions and participated in the many special events. Approximately 280 of them registered for the Sabine Centennial Symposium and more than 1100 tickets were sold for the Tokyo String Quartet concert. It was the largest attendance at a classical music concert in Kresge Auditorium for several years. As a result, more than $40,000 was collected for the production of a teaching video to be titled "Modern Acoustics."

Other highlights of the meeting included a clambake (which featured whole New England lobsters), and a new event, the Fellows Luncheon.

On Thursday, some 150 ASA Fellows congregated for a buffet luncheon and camaraderie. Each signed the "Fellows Book" with his or her name and the date that fellowship was conferred. Those who were not at the luncheon will have an opportunity to sign the book later, and it will eventually be bound.

The speaker for the event was Professor David Gordon Wilson of MIT's Department of Mechanical Engineering. He entertained the group with a lively description of human-powered vehicles down through the ages.

Tokyo String Quartet first violinist Peter Oundjian congratulates acoustician and master violin maker Carleen Hutchins. On right, Robert and Deena Spear, whose instruments were also used in the demonstrations.

Professor David Gordon Wilson lectures on human-powered vehicles at the Fellows Luncheon.

At the clam bake: "Let's see. . . . How do you do this?"

Robert Young, who joined the Society in the year of its birth (1929), signs the "Fellows Book."

"Must be like this!"

Simulating the Mechanics of the Human Voice

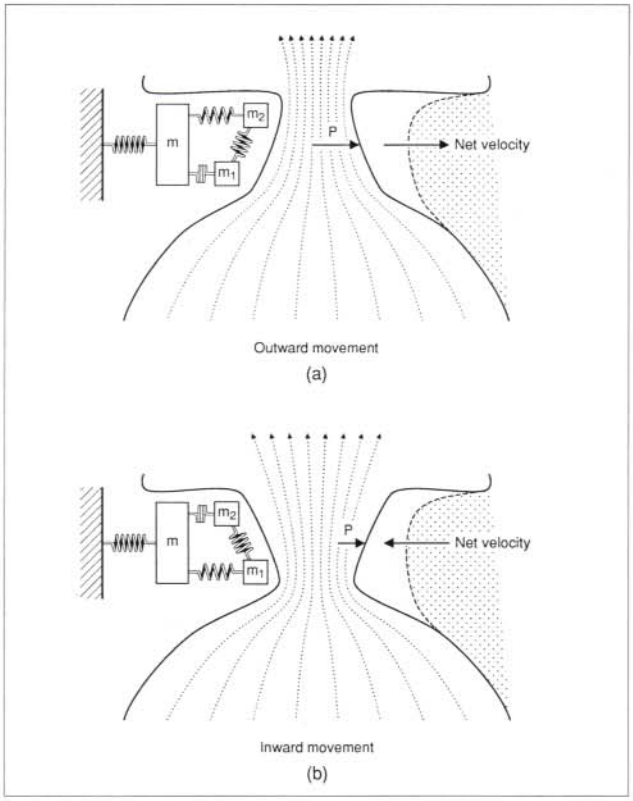

Figure 1. *A three-mass model of the vocal folds, including airflow and driving pressure in the glottis, the airspace between the vocal folds: (a) outward movement with a convergent glottis, (b) inward movement with a divergent glottis. Note the direction of the net velocity of the tissue in relation to the pressure P.*

HUMAN VOICE*—from pg. 1*

coupled easily to the airflow. A third, larger mass, can then be added to represent the main body of the vocal folds, the previous two masses consisting of the thin, non-muscular layer. (See Figure 1)

It was later shown by the author that the human vocal fold, as any vibrating continuum, has an infinite number of degrees of freedom, and hence an infinite number of modes. Among all of these modes, there are only a few that are observed in normal vibration. In pathologic vibration, several of the higher modes can be seen, at least in transient responses. The continuum model, developed by Titze and Talkin, incorporated the three-dimensional complexity of the vocal fold geometry, the layered structure of vocal fold tissue, and the incompressible nature of tissue displacement. Today we have a reasonably complete simulation model of the aerodynamics, the acoustics, and the self-oscillatory behavior of human tissue.

What are the major shortcomings of speech simulation at this point? One of the remaining problems is adequate validation of the physiological parameters used in the model. For example, the viscoelastic constants of mucosal and muscular tissue are only partially known. Some measurements have been made *in vivo* and *in vitro* (see Figure 2), but rarely can one find an accurate, three-dimensional stress-strain equation of any of the tissue in the speech production system. Even the elegant new tongue model of Wilhems-Tricarico is based on many parameters that are only order-of-magnitude estimates. Likewise, simulation of aerodynamics for consonants requires further experimental data. Many researchers are now gathering vocal tract shape data with magnetic resonance and X-ray imaging, but progress is slow because only static shapes can be obtained. Three-dimensional dynamic imaging is still an unfulfilled dream.

If speech is produced from text, there is the added difficulty of producing continuous speech from segmental units that must be either generated by rule (on line) or by joining together previously stored elements. Making smooth transitions from one stored speech segment to another to mimic human speech motor control continues to be a monumental task.

Fortunately, the problem is somewhat simpler for singing. Although on the surface it appears that simulation of the singing voice presents a greater challenge than simulation of speech (because of the added artistry), we sometimes find that what is difficult for humans is easy for machines, and what is easy for machines is difficult for humans. For example, humans have great difficulty producing high-pitched and loud sounds, that is, sustaining muscle contractions for long periods of time. But this is trivial for machines since there is no fatiguing and tiring of muscles. Hence, long, sustained sounds present no difficulty.

Furthermore, in singing, much is prescribed by the musical score. Movement from syllable to syllable is coded by meter and rhythm, so it is relatively easy to incorporate articulatory timing into a strategy for simulating singing. The melody is also prescribed, whereas in speech the "melody" is free-running, dependent upon the individual speaker and dialect.

In our work at the National Center for Voice and Speech, we have been reasonably successful in producing some of the sounds of operatic tenors. We have called our singing robot "Pavarobotti" in honor of our great contemporary tenor, Luciano Pavarotti. Some of the tenor characteristics, such as the vocal ring and the dramatic rich timbre, are surprisingly easy to simulate. Vocal ring is modeled by inserting a small quarterwave resonator above the vocal folds, approximately one-sixth of the length of the vocal tract and one-sixth of the cross-sectional area of the pharyngeal input to the vocal tract. This quarterwave resonator, tuned to approximately 3000 Hz, mimics a narrow acoustic channel in the region of the "false" vocal folds, additional soft tissue above the true folds. Vibrato can be introduced with sinusoidal frequency modulation of the air pulses emitted from the larynx, but this modulation must also include some neurologically-based randomness.

We have found that the glottal airflow pulse in operatic sounds is not substantially different from that found in normal speech production. Hence, we have concluded that sing-

Simulating the Mechanics of the Human Voice

ing is not so different from speech (acoustically), but it takes great amounts of training and building of muscles to maintain this constancy over a two-octave range.

We believe that a future version of Pavarobotti will become a very exciting teaching tool for those who provide voice training and vocal habilitation. Much of what is now done laboriously (off-line) will be able to be accomplished in real time. Perhaps a singing robot will be part of every studio and clinic; buttons can be pushed and knobs can be turned to create a variety of sound qualities that vocalists can listen to and evaluate. Beginning with a model of a beginner's voice, attributes of long-range training can be added, one by one, to project the voice of a pupil or client into the future. This is not to say that Pavarobotti will become the teacher, but rather the teacher's aide. By displaying the robot's vocal tract anatomy, the teacher can provide direct visual confirmation of what the system is and what the system does.

Ingo R. Titze directs the National Center for Voice and Speech, a consortium of institutions that includes the University of Iowa, the Denver Center for the Performing Arts, the University of Wisconsin, and the University of Utah. He is also Professor of Speech and Voice in the University of Iowa's Department of Speech Pathology and Audiology.

At the Plenary Session of ASA's 1993 Fall Meeting in Denver, he demonstrated, with the help of his students and associates, the simulation of the human voice. The demonstration culminated in an unforgettable duet between Titze and Pavarobotti. A video tape of the performance will be available in the future.

Photo: Julie Ostrem, University of Iowa

Figure 2. *"Stretch-release" experiments allow researchers to quantify mechanical properties of laryngeal tissue. Excised tissue is kept physiologically viable in a fluid-filled glass chamber. A servo-controlled arm stretches the tissue according to pre-programmed specifications. Data are collected and saved on a computer file for later analysis.*

ASA will support Eastern Bloc acousticians

ASA's Executive Council has approved plans to help acousticians from the Commonwealth of Independent States (CIS) and Eastern Europe (EU). The Committee for Support for CIS/EU Acoustics, chaired by Peter Mikhalevsky, has announced four major new initiatives:

1. **The CIS/EU Research Grant Program** will provide up to $15,000 for two two-year grants and between five and ten one-year grants of $500 to $1000 each.
2. **The CIS/EU Student Fellowship Program** will provide a small stipend to deserving students of acoustics in universities and institutes.
3. **The CIS/EU Membership Program** will sponsor ASA memberships and pay dues for a limited number of needy acousticians.
4. **The CIS/EU Personal Computer Initiative** will obtain and distribute used PCs donated by ASA members or their organizations.

ASA members who wish to contribute to these programs will be able to add a voluntary contribution to their annual dues. In addition, ASA will assist in publicizing and supporting acoustical meetings organized by sister societies in the CIS/EU and will continue the distribution of our *Journal* through the International Science Foundation (ISF).

ASA has also provided some travel support to meetings, and will help obtain further funds through the ISF and the NSF. Application and selection procedures for grants and fellowships will be distributed shortly. Committee members include Jim Lynch, Peter Mikhalevsky, Joe Blue, Joe Pope, and Malcolm Crocker.

Those interested in donating used PCs should contact:
Jim Lynch at (508) 548-1400 x2230
(jim@vaquero.whoi.edu)

Peter Mikhalevsky can be contacted at
(703) 827-4784 (peter@fiji.osg.saic.com)

Austin meeting highlights

ASA's 128th meeting will take place at the Stouffer Austin Hotel in Austin, Texas, from November 28 through December 2, 1994. Many interesting sessions are planned, just a few of which are shown in the sidebar to the right.

The tutorial will be a lecture by Robert Apfel (ASA's President-Elect), "Acoustic Cavitation: Sonic Effervescence," and short courses will be presented on "Structural Acoustics" by David Feit and on "Matched Field Processing" by Alexandra Tolstoy and Michael Porter.

A new offering will be a special lecture summarizing meeting papers of broad general interest. It will be directed towards an audience of undergraduates, but all registrants and members of the press are welcome. There will be a special technical tour for people interested in architectural and musical acoustics to the University of Texas Performing Arts Center, including its large tracker organ. The Plenary session also promises musical entertainment: Haeyon Kim Lent and her husband Keith Lent will demonstrate techniques by which music and poetry will be processed and synthesized.

Highlights of the upcoming meeting in Austin

- *Effects of sound on marine mammals: Update and discussion of need for standards*
- *Computer music (also Early music and Music performance)*
- *Annoyance of low-level environmental sounds*
- *Sonoluminescence and sonochemistry*
- *Production and perception of speech by children*

"The yellow wall"

The other day someone not acquainted with the Acoustical Society of America wandered into my office and innocently asked what the Society does. With a grand swoop of my arm I proudly directed the inquirer's attention to my ten-foot-long "Yellow Wall," replying, "We publish this!"

My personal collection of *The Journal of the Acoustical Society of America,* with some help from retired member Ted Hueter, goes back to 1949. ASA's bound office collection contains all 65 years, beginning with the first issue in 1929.

Part of the Yellow Wall—specifically some 20,000 pages covering 1600 articles from 1929 to 1958—is about to be replaced by a set of three CD-ROMs (Compact Disc Read Only Memory). Granted that showing a CD-ROM to an inquiring visitor will not have the same impact, its small size will make more than a few spouses happy to regain shelf or cellar space. The CD-ROMs will provide exact images of *The Journal* page, as well as word-search capability for the abstracts. In addition, CD-ROMs will provide younger members access to earlier papers, many of which shed light on current technical problems. One possible disadvantage will be the fact that many of us will have to equip our computers with a CD-ROM reader. (Don't insert the discs in your CD player—the noise will be meaningless.)

You will be receiving the first CD-ROM disc (free) with the November or December issue of *The Journal.* It's the same sort of "free" that you get when you receive the first volume of a three-volume set of an encyclopedia. Actually, only the first two years of *The Journal* will be accessible on the free disc. But we hope that individual members will be so pleased that they will send in their payment for the remainder of the set, which will also enable them to access the rest of Volume No. 1. (If these back issues were purchased separately from the ASA, they would cost over $9,000.)

This effort would not have been possible without the foresight and support of David Bradley from NRL and the volunteer efforts of our Associate Editor for Electronic Publishing, Dick Stern. Please let us know what you think of this service, and, if favorable, we'll continue to place more of *The Journal* on CD-ROM. And the Yellow Wall may diminish in size, much like the number of horses did when the automobile made its entrance in the beginning of the 20th century.

—Charles Schmid, Executive Director

New Noise Coalition

Representatives from 13 national professional organizations concerned with noise-induced hearing loss and its prevention met at the Cambridge ASA meeting to establish a Coalition on Noise and Hearing. The Coalition's objectives are to develop publicity that will increase the public's awareness of the need and ways to prevent noise-induced hearing loss and to establish a national "Save Your Hearing Day." For further information, call Bob Bruce at (713)492-2784.

ICA Extending Deadline for Abstracts

The International Congress on Acoustics (ICA) has extended its deadline for the receipt of abstracts to Sept. 15, 1994. The Congress will meet next year in Trondheim, Norway, from June 26-30. For further information: ICA'95, N-7034, Trondheim, Norway, or Tel: 47-7-359-2639. Fax:47-7-359-1412. E-mail: ica95@tele.unit.no.

Acoustics in the News

The Boston Globe

The Boston Globe carried several articles about ASA's Tokyo String Quartet concert, including the Gabriel Weinreich lecture on violin acoustics and the short presentations by contemporary luthiers. Prior to the event, *The Globe's* music critic, Richard Dyer, authored one on May 27, "Tokyo Quartet tests its acoustics," and the newspaper's calendars mentioned the concert again on June 2 and 3. Then, on June 7, in "Tokyo Quartet plays for expert ears," Mr. Dyer gave the performers and violin makers a warm review.

The June 20 issue of *The Globe* ran an article by Usha Lee McFarling entitled "Super-secret Navy system looks for work." The article reported on the standing-room-only special session at ASA's Cambridge meeting concerning the use of naval facilities for ocean acoustics research. Adjacent to the "Navy" article was a short piece on the Acoustic Thermometry of Ocean Climate (ATOC) experiment, "Undersea sound test is on hold."

The New York Times

Five pieces on acoustics were published recently in *The New York Times,* three of which were authored by Malcolm W. Browne. "Perfect Violin: Does Artistry Or Physics Hold Secret?" appeared in the June 14 "Science Times" section of *The Times.* It was a comprehensive piece, covering the ASA's Tokyo String Quartet concert and the contributions of Carleen Hutchins and the other modern luthiers, and summarizing the vibrational modes of violins. Two other articles by Mr. Browne were published concurrently with ASA's meeting: "Using Sound to Disarm Still-Deadly Mine Fields"

The June 8 issue discussed the paper by Charles Don on the use of acoustics to detect non-metallic objects in the ground, and the proposed research by Lawrence Crum using ultrasound to detect plastic shards invisible to X-rays.

In "Scientists Hope to See Effects of Comet Bombardment of Jupiter" (June 9), Mr. Browne reported on the paper by Michael Collins *et al.* using methods developed in ocean acoustic tomography to study the impact of comet fragments colliding with the planet Jupiter.

Two other *New York Times* articles are of interest. One is "2 Environmental Camps Are Feuding Over a Noisy Ocean Experiment" by William J. Broad (April 5), which discusses the controversy over the ATOC program and its possible effects on marine mammals. The other is Sandra Blakeslee's article, "Brain Locates Source of a Sound With Temporal, Not Spatial, Clues" in the "Science" section (May 10), in which the author discusses recent findings in the brain's ability to localize auditory cues by researchers John Middlebrooks, Eric Knudsen, and John Brugge.

Science

Ms. Blakeslee referred to an earlier article on this subject in *Science* (May 6) that includes the work of David Green, Li Xu, and Ann Clock as well. A summary, "Neurons Tap Out a Code That May Help Locate Sounds," may be found on p. 775 and the main article by Middlebrooks, Clock, Xu, and Green, "A Panoramic Code for Sound Location by Cortical Neurons," is found on p. 842.

Other articles of interest in *Science* include more on neural responses to sound: "Neural Tuning for Sound Duration: Role of Inhibitory Mechanisms in the Inferior Colliculus" (also May 6) by J.H. Casseday, D. Ehrlich, and E. Covey, as well as several articles on acoustics in the ocean.

In "Dialing Up Undersea Data—Long Distance," author John Travis describes the transmittal of data via an "acoustic modem" from underwater instruments to land, the work of scientists at Woods Hole Oceanographic Institution. "Giant Hawaiian Underwater Landslides" are tracked with side-scan sonar imagery in the April 1 article by J.G. Moore, W.R. Normark, and R.T. Holcomb. Similarly, the fact that "Volcanoes With Bad Hearts Are Tumbling Down All Over" can be elucidated with sonar imaging of the sea floor is the subject of a short piece by Richard A. Kerr, April 29. An article by Karen Schmidt in the April 15 issue of *Science* presents another (earlier) discussion of the ATOC project's woes: "ATOC Delayed as Report Laments Research Gaps." (See also "A Drop of Noise in the Ocean to Measure Global Warming?" by Boyce Rensberger in *The Washington Post,* April 11.) Finally, on dry land (very dry in this case) "The Sandman Speaks" by Robert Service discusses the "booming" of sand dunes, presumably due to unusually high friction between sand grains *Science,* April 8).

Other publications

Elsewhere in the media, the May issue of *Discover* carried a short piece on the research of Dennis McFadden showing that women with twin brothers had only half the spontaneous otoacoustic emissions of other women (!) "Quiet-Eared Women and the Men Born With Them," and, in the same issue, another article reported on a device that "hears" an electrical fire in a wall before there is smoke or flame "Sounds Like Fire."

Finally, the June 11 issue of *New Scientist* ran an article by Susan Katz Miller, "Bugging the bugs as they gobble the crops." Reporting on the paper by Robert Hickling and his colleagues presented at the Cambridge meeting, the author describes a listening device that catches pink bollworm larvae squirming and chomping on their favorite fare, the cotton boll.

Miscellanous Soundings

ADA may require quieter restaurants

One of the most difficult listening environments for a hearing-impaired person is a noisy restaurant. Soon, however, restaurant owners may have to create quiet areas to fulfill the mandate of the Americans with Disabilities Act.

The U.S. Architectural and Transportation Barriers Compliance Board, also called the "Access Board," has contracted with Battelle, a research organization, to investigate the problems of hearing-impaired individuals when dining out. A report entitled "Proposed Guidelines for Quiet Areas in Restaurants for Hearing-Impaired Individuals" is now available from the Access Board in Washington, DC.

Principal investigator Ron Moulder and his colleagues studied 14 typical restaurants. They measured average A-weighted background noise levels during busy times ranging from 55 to 68 dB and reverberation times that ranged from 0.36 to 0.95 sec. On the basis of their research, the investigators' report recommends maximum average background levels of 50 dB(A) and a maximum reverberation time of 0.5 sec. To achieve these levels, the report recommends that restaurant owners use more sound absorption in the proposed quiet areas and limit the seating density to reduce sound levels further. Copies of the report may be obtained by calling (202)272-5434.

ASA conducts workshop on aircraft noise

On April 9, ASA conducted an all-day workshop to educate citizens on the acoustics and effects of aircraft noise. The workshop attracted 85 participants from the U.S. and Canada, consisting of interested citizens, city planners, Port of Seattle staff, and mayors and council members from communities located near civilian and government airfields.

The faculty consisted of five acousticians from around the U.S.: Andy Harris and Alice Suter spoke on the effects of noise, Ken Eldred discussed noise measurement, Sandy Fidell reviewed community surveys of airport noise, and Andy Powell gave an overview of the noise reduction program at NASA. In addition to lectures, the workshop's format included small group and panel discussions.

Attendees expressed appreciation for the technical information and explanations, which would improve their ability to conduct meaningful dialogue with airport and municipal authorities.

The workshop was jointly sponsored by ASA, the Northwest Chapter of the ASA, the Port of Seattle, citizens groups, such as N.O.I.S.E., and a number of firms with activities in the aircraft noise area.

AWARDS—Continued from pg. 2

Science writing awards

The Judging Panel of the Committee on Public Relations has selected the winners of ASA's 1993 science writing competition. The winner of the award for journalists is **Jane E. Brody** of *The New York Times* for her article "Picking Up Mammals' Deep Notes," appearing on Nov. 9. The article described the life and work of bioacoustician Katy Payne and her investigation of the songs of whales and the infrasonic calls of elephants. Winning the science writing award for acousticians is **Masakazu Konishi** of the California Institute of Technology for his article "Listening with Two Ears," which appeared in the April issue of *Scientific American.* The article describes the author's many years of research in binaural hearing, using the barn owl as a model. Dr. Konishi also recognizes two editors from *Scientific American,* Michelle Press and Ricki Rusting. The prizes will be presented during the Plenary Session at the November meeting in Austin.

ACOUSTICAL • SOCIETY • OF • AMERICA
500 SUNNYSIDE BLVD.
WOODBURY, NEW YORK 11797

Non-Profit Org.
U.S. POSTAGE
PAID
Seattle, WA
Permit No. 5675