The newsletter of
The Acoustical Society of America

ECHOES

Volume 15, Number 1
Winter 2005

50 years of progress in speech waveform coding

Bishnu S. Atal

The research in speech coding (or speech bandwidth compression) originated about 75 years ago. At that time, the demand for telephones was growing rapidly. Telephone service was available coast-to-coast, with close to 10 million telephones in service. The first under-the-ocean transatlantic telephone cable was still years away. Western Electric asked its research engineers at Bell Telephone Laboratories if voice signals could be transmitted over existing telegraph cables.

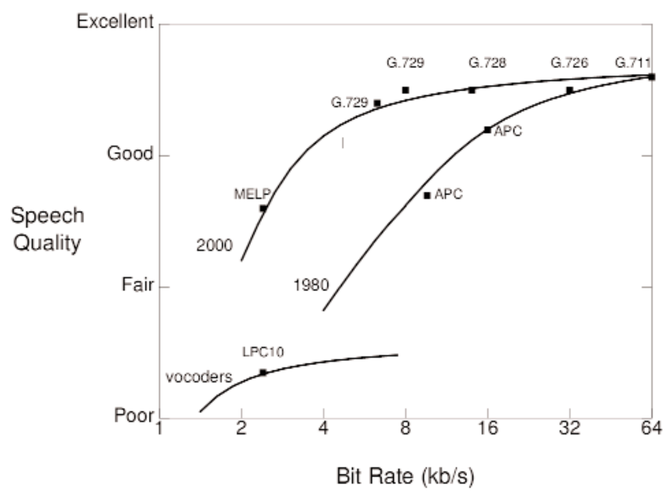
The bandwidth required for voice transmission is approximately 3000 hertz, but the transatlantic telegraph cables had a bandwidth of only a few hundred hertz. Homer Dudley, who had joined Western Electric (parent of Bell Laboratories) in 1921, argued that the real information in speech was carried by telegraph-like low-frequency modulation signals corresponding to slow motion of the vocal organs. Dudley implemented his ideas in a device named Vocoder, but the signal processing technology available then was primitive and it was very difficult to realize the full potential of his ideas. Although vocoders did not produce speech of quality good enough for telephone application, they were used during World War II by President Roosevelt and Prime Minister Churchill for secure voice communication. Vocoders remained the central theme of speech coding research for about 35 years.

During the time speech scientists were occupied with vocoders, several major developments of fundamental importance were taking place outside speech research that would change the course of speech coding. A major contribution to the mathematical theory of communication of signals was made by Claude Shanon, represented in his published work in 1948. Shanon's work established a mathematical framework for coding and transmission of signals. At about the same time, Norbert Wiener found a general method for calculating the best filters and predictors for detecting signals hidden in noise. His work appeared in the famous monograph, "Extrapolation, Interpolation and Smoothing of Time Series." Linear prediction (LPC) is now a major tool in signal processing. Another development was pulse code modulation (PCM), a method for sampling a continuous signal and quantizing each sample into binary digits. It enabled coding of speech with telephone bandwidth at a bit rate of 64 kb/s with negligible loss of quality. PCM marked the beginning of the digital age.

Following the work of Shanon and Wiener, Peter Elias published two papers in 1955 on predictive coding. In predictive coding, both the transmitter and the receiver store the past values of the transmitted signal and from them predict the current value of the signal. The transmitter transmits not the signal but the prediction residual, that is the quantized difference between the signal and its predicted value. At the receiver, this transmitted prediction residual is added to the predicted value to reproduce the signal. In predictive coding, the transmitted

continued on page 4

Speech Quality at Various Bit rates



The figure shows the variation in speech quality as a function of bit rate. The coders labeled G.711, G.726, G.728, and G.729 were standardized by International Telecommunication Union (ITU). MELP and LPC10 are standardized coders for secure voice communication.

We hear that...

• ASA Fellow **Eric Ungar** was presented with a Lifetime Achievement Award at the Shock and Vibration Symposium in Virginia Beach, VA in October, sponsored by the Shock and Vibration Information Center. His citation reads "Through a half-century of research, consulting, and teaching, Dr. Eric E. Ungar has made singular and distinctive contributions to the discipline of Shock and Vibration. His analyses of the excitation and control of structural vibrations will long remain a foundation upon which others can build."

• ASA Fellow **Juergen Meyer** was awarded the Honorary Medal of the Verband Deutscher Tonmeister (VDT) in November for outstanding contributions to sound, particularly for teaching 36 years at the Detmold Music Academy (Tonmeister education) and for attendance at all Tonmeister meetings and reading a paper every time since 1960.

• ASA Fellow **Guillermo Gaunaurd** has been elected Associate Fellow of the American Institute for Aeronautics and Astronautics (AIAA).

• ASA Fellow **Thomas Rossing** has been elected a Fellow in the Institute of Electrical and Electronics Engineers (IEEE) "for contributions to engineering education, acoustics, and magnetic devices."

Student Council Update

Andrew Morrison

The Fall meeting in San Diego was filled with many events sponsored by the Student Council. It was an exciting week and the council members were excited to see the payoff of their efforts.

A major initiative the Student Council has undertaken is hosting a series of workshops for acoustics students and post-docs. The first workshop in the series, on fellowships and grants, was held Wednesday, November 19, at the San Diego meeting. Representatives from several government agencies were on hand including: National Science Foundation (NSF), Naval Research Laboratory (NRL), National Institutes of Health/National Institute of Deafness and Other Communication Disorders (NIH/NIDCD), the Office of Naval Research (ONR) and the Acoustical Society of America Prizes and Special Fellowships committee. The workshop drew over 70 attendees including undergraduates, graduate students, post-docs and faculty. The Council was pleased to see a positive response to the event and is looking forward to hosting similar workshops.

David Blackstock, winner of the Student Council Mentor Award with his wife Marjorie and the McKinney's.

After the workshop, the Council hosted a Student Reception. Turnout for the reception was a new record with over 150 people in attendance. The Student Reception included the presentation of the inaugural Student Council Mentor Award to David Blackstock. The reception is a great place for students to socialize with each other and to network with people in acoustics. Following the reception, approximately 30 students and post-docs went on the student outing to the Billiards Palace in the Gaslamp Quarter of downtown San Diego. At the Billiards Palace, the students and post-docs relaxed with food, drink, darts, pool and a monopoly on the jukebox.

Apart from the meeting, the Council has been active in planning for future events. Also, the Student Council website has been completely redesigned. The website is the best way for acoustics students to get information regarding student activities before attending meetings. The website address is www.acosoc.org/student. On the website is a profile of each Student Council representative. Students interested in acoustics are encouraged to contact Council members with any questions they might have.

Andy Morrison is a graduate student in physics (acoustics) at Northern Illinois University.

Who is the earliest elected living ASA Fellow?

See answer on p. 6

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 . . . . .Thomas Rossing
ASA Editor-in-Chief .Allan Pierce
Advisors . . . . .Elaine Moran, Charles Schmid
Graphic Designer . . . . .Carol Tippit Woolworth

Phone inquiries: 516-576-2360. Contributions, including Letters to the Editor, should be sent to Thomas Rossing, Physics Dept., Northern Illinois University, Dekalb, IL 60115 <Rossing@physics.niu.edu>

Message from the President

William A. Kuperman

In 2004, the Acoustical Society of America celebrated its 75th anniversary. The two 2004 ASA meetings, in New York City and San Diego had a combined total registration exceeding 2700 attendees. All appearances indicate that we are healthy and thriving because of a membership that provides the diversity and vitality to drive the Society. To maintain our vitality we must constantly reexamine our core concerns.

There are two special ASA taskforces now operating that should be of great interest to ASA members. The first deals with future directions of the Society and is called Vision 2010 (chaired by Dick Stern). A recent get together of this group on the Sunday before the San Diego meeting concentrated on 5 topics:1) membership; 2) benefits as a member; 3) specific technical fields; 4) public outreach; 5) challenges for the future. Their initial recommendations are reported on p. 8-9 of this issue. The second task force (chaired by Bill Yost) is more specialized and is concerned with near-term issues related to our publications.

With regard to the latter, and not a concern of the task force, our publications are rapidly adapting to and taking advantage of internet related technology. For example, Peer X-press is speeding the publication process and we are rapidly moving forward to have all JASA issues available online. We are carefully evaluating *ARLO* and considering various options that continue the rapid dissemination of research letters. Finally, on the publication front, I want to mention that the ASA will be inaugurating a new popular acoustics magazine which will be published quarterly. The first issue is expected to appear in the Fall of 2005. *ECHOES* will be a part of the new magazine.

The publication task force is concerned with externally driven events that will have a profound effect on our Society, and JASA in particular. This issue jumps to the forefront because: 1) JASA presently is the most revenue positive cost center of ASA. 2) The change of the publication paradigm to electronic media potentially has problematic financial consequences if not dealt with quickly. 3) A recent National Institutes of Health (NIH) proposal to have a centralized government archive will have, if implemented, a major impact from financial consequences to diminishing the independent, volunteer peer review system which is at the very core of the existence of scholarly societies. With regard to the latter, the proposed action will deny the government the public confidence resulting from the independent evaluation of its research efforts. Further, this proposal is likely to be adopted by other research supporting agencies. In the case of the NIH proposal, the ASA has made a detailed response during the public comment period. We understand that NIH is required to address all the comments and queries it has received from the public. Our ASA group is tasked to come up with recommendations to deal with this important, publication related issue as well as the general problem of adjusting to a financial model that accommodates electronic publishing as a major component of ASA. In the mean time, I urge ASA members to encourage their colleagues to publish only in scholarly society journals and to try to exert influence on their librarians to emphasize these same journals when making relevant decisions. I know, for example, that Stanford University's faculty have adopted this approach.

Let me conclude by reminding everyone that the future always presents both challenges and opportunities. The society has, in the past, adapted with an evolving technical committee structure, modernization of publication procedures, new forms of outreach, to name just a few examples. The new challenges will be met by our innovative membership, meaning you. Let me urge those of you who have ideas addressing some of the issues I have briefly discussed above, (and any others) to contact me or your particular TC chair or the task force leaders. The ASA thrives on your participation.

William A. Kuperman, President of ASA, is a Professor of Oceanography and Director of the Marine Physical Laboratory at the Scripps Institute of Oceanography, University of California, San Diego.

New ASA Fellows

continued from page 1

prediction residual is made as "white" as possible, to achieve coding efficiency. Predictive coding is a remarkably simple concept. For speech coding, the linear predictor is adapted to the slowly varying motion of the vocal organs and the prediction is done over a time interval comparable to a pitch period. This method, known as adaptive predictive coding (APC), brought the bit rate for high-quality speech coding to 16 kb/s, a reduction by a factor of four over PCM.

Linear predictive coding (LPC) models the vocal tract as an acoustic tube and leads to an efficient representation of the vocal tract shape. LPC vocoders, such as LPC10, used the same model for exciting the vocal tract as the old vocoders used and were able to code speech at very low bit rates but the speech from these vocoders was of poor quality. LPC10 vocoder was used mostly for providing secure voice communication in military applications.

The operation of reducing bit rate always introduces physical distortion (noise) in the speech signal. However, the human ear does not hear all the distortions present in the coded speech but only some of them. For the coded speech to sound identical to the original, the coded speech does not have to be physically identical to the original but "perceptually identical." Predictive coding made it possible to reduce the bit rate to 16 kb/s without sacrificing speech quality. To reduce the bit rate even further, the speech coders take advantage of the masking phenomenon in the human auditory system and use a perceptual error criterion for minimizing the distortions introduced in the coded speech signal. Speech coders mask the noise introduced in the coding operation by the speech signal itself!

Predictive coders minimize the perceptual difference between original and coded speech by generating optimum pulse sequences (as in multi-pulse linear predictive coding) or by selecting the best pulse sequence from codebooks (as in code-excited linear prediction). Ideally, the transmitted sequences must be "white" and therefore the codebooks are often populated with "white noise" sequences. Both multi-pulse linear prediction (MPLP) and code-excited linear prediction (CELP) coders are able to produce high-quality speech at 8 kb/s and even lower. The searches for selecting optimum pulse sequences in CELP coders require a large number of computations. The first simulation of CELP in 1983 required over 150 sec on a Cray-1 supercomputer to process 1 sec of speech. The processing capabilities of digital hardware (microprocessors and digital signal processors) increase roughly 100 times every 10 years and by 1993, the CELP coders were implemented for real-time operation on a single DSP chip. CELP coders form the basis of most current international standards for digital speech transmission.

Speech coding research has always been driven by applications. In the 1930s, transmitting voice over undersea telegraph cables was the major motivation. During World War II, secure voice communication for the US Government became a major driver for research on vocoders. By the mid-sixties, voice compression was no longer considered important for commercial telephone services; the research then and until about 1980 was driven by government needs for secure voice communication. It was clear, however, that with the coming digital age, the ability to code speech at low bit rates will be important. By 1980, the developing digital cellular telephone systems in Europe, Japan, and the United States became the major driver for low-bit-rate coding of speech. Cellular telephones rely on wireless for transmitting speech; the available radio-frequency spectrum is limited and therefore their capacity could be increased by employing low-bit-rate speech. The speech coding technology coming out of sustained research over the past several decades now appears in nearly a billion cell phones and hundreds of million PCs used all over the world.

What is the future of speech coding? The telecommunication services are going through a major revolution. The telecommunication networks all over the world are changing, moving away from circuit-switched (where each voice circuit is a dedicated line) to packet-switched (where the voice is broken into small packets of bits and transmitted over a shared network). The demand for telecommunication networks to handle a variety of signals, such as voice, data, and video, in a shared mode is rapidly increasing. The situation was much simpler in the past when voice was the major signal carried by the telephone network and to produce high quality speech at the lowest bit rate was the issue. Not any more. The main issue now is to deliver high quality speech at the lowest possible cost and lower bit rate is only one of the factors. Packet networks transmit voice as packets of bits, using Internet protocols (IP), which must be assembled properly and delivered to our ears as audible speech. And, new issues, such as delay, jitter, and packet loss, become important. The challenge for speech coding is to assist in this major change. The semiconductor revolution offering greater and greater signal processing power and memory is continuing, and together with increased understanding of speech production and perception provide the hope for an exciting future.

Bishnu S. Atal is an Affiliate Professor in Electrical Engineering at the University of Washington, Seattle. He has been involved in speech analysis and coding research for over 40 years. This article is adapted from paper 1pSC2 presented at the 148th meeting of ASA in the special session on "Fifty Years of Progress in Speech Communication: Honoring the Contributions of James L. Flanagan." Email address: bsatal@bishnu.net

Echoes from San Diego

Best Student Paper Awards (San Diego meeting)

Animal Bioacoustics
First: Mandy Hill Cook, University of South Florida and Jennifer L. Miksis-Olds, University of Rhode Island

Acoustical Oceanography
First: Eric Giddens, Scripps Institution of Oceanography
Second: Erica Summers-Morris, California State University at Monterey Bay

Engineering Acoustics
First: Stefan A.L. Stijlen, Delft University of Technology
Second: Micha Shepard, Brigham Young University

Musical Acoustics
First: Rolf Bader, Musikwissenschaftliches Institut, Hamburg
Second: Yumiko Sakamoto, Kyushu University

Noise
Young Presenter Awards: Cesare Hall, University of Cambridge and Beatriz Pinto, AFassociados (Portugal)

Signal Processing in Acoustics
Young Presenter Award: Heinz Teutsch, University of Erlangen-Nuremberg

Speech Communication
First: Jason Tourville, Boston University
Second: Jerry Liu, University of Southern California

Structural Acoustics and Vibration
First: Matt S. Allen, Georgia Institute of Technology
Second: Elizabeth A. Magliula, Boston University

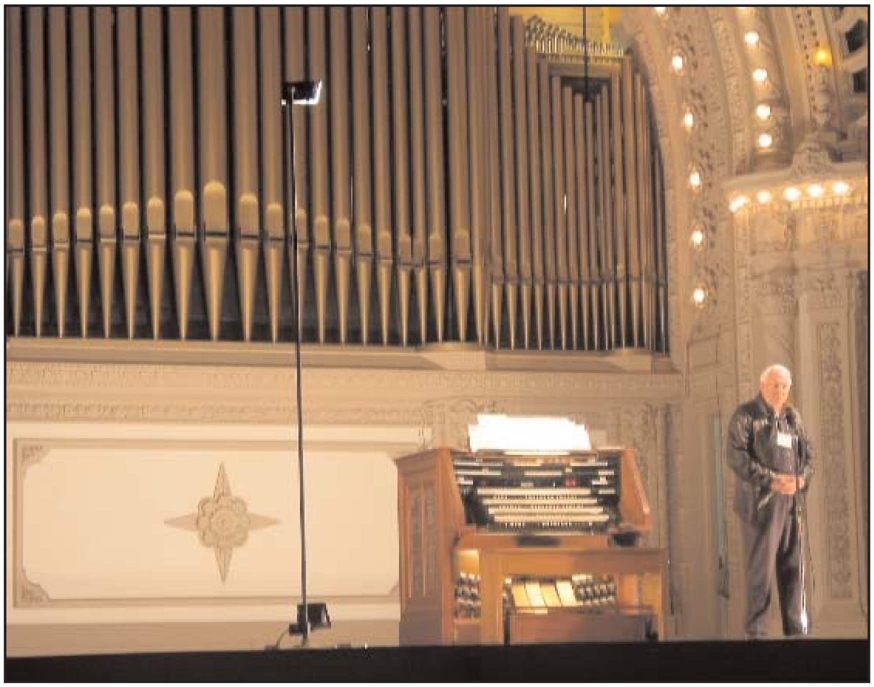
Underwater Acoustics:
First: Elizabeth T. Kusel, Rensselaer Polytechnic Institute
Second: Alexander O. MacGillivray, University of Victoria

Ian Sample, winner of Science Writing Award in Acoustics for Journalists, and Ben Stein, AIP.

Tom Rossing congratulates Allan Pierce, winner of the first Rossing Prize in Acoutics Education.

Echoes from San Diego

Photo by Jens Holger Rindel



Left: *The Spreckels organ with organ builder Lyle Blackinton, our tour guide.*

Paul Wheeler chaired the session on hands-on demonstrations for high school students.

Photo by Stephanie Berger

Answer: *LEO BERANEK, of course. Leo became an ASA Fellow in 1940.*

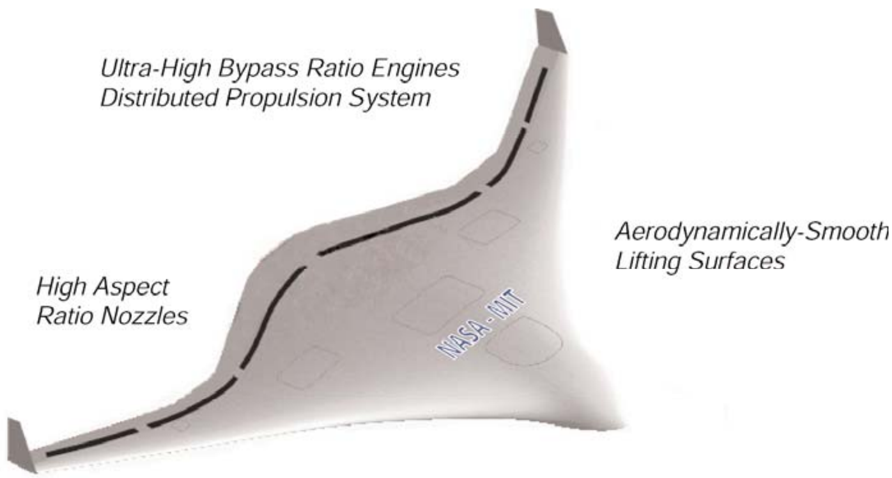
Photo by Jens Holger Rindel

Above: *We got to enter the wind chest of the Spreckels organ*

A quieter aircraft

Quieter Aircraft of the Future Taking Shape in the Research Labs of Today

Russell H. Thomas, Geoffrey A. Hill, and Zoltan Spakovszky



From the beginning of commercial jet-powered aviation, aircraft-generated noise has been a negative issue impacting public acceptance of new airports. While the speed and convenience of jet aviation continues to drive growth of air travel, aircraft noise is increasingly seen as a constraint on the future growth of aviation traffic. Today's best airliners are about a factor of four quieter than the first airliners introduced more than four decades ago. Even with that dramatic decrease in noise from a single aircraft, the number of aircraft at our airports has jumped so much that NASA and other governmental organizations in the US, Europe, and elsewhere see the need for advancements that will bring aircraft noise levels down another factor of four. Looking forward twenty years or so, these noise reductions are thought to be necessary to insure continued growth of our vital air transport system and to contribute to the well being of the traveling public and the communities surrounding airports.

Several organizations have been studying possibilities for viable aircraft technology so different from present day designs that they could enable the large noise reductions that are needed. At the recent 148th Meeting of the ASA in San Diego, two special sessions were devoted to Propulsion Airframe Aeroacoustics. Presenters included researchers from NASA, MIT, Northrop Grumman, and the University of Cambridge talking about concepts for new propulsion and airframe technology and how they might be combined to produce quiet aircraft of the future.

Many aircraft components generate noise. Typically the engine's rotating blades are significant sources of noise, primarily the large fan blades that are seen from the front of the engine. After being pressurized by the rotating blades and heated in the combustor, air expelled from the jet exhaust is generally very noisy. This noise source is particularly difficult to control since it is not localized and actually generates noise after leaving the engine's nozzle. The airframe structure generates noise as it flies through the air: the higher the speed, the more noise. To land and take off, the aircraft deploys devices on the front and back of the wing, slat and flap high lift devices, and noise is generated in the strong local airflow over these surfaces. Some times, the engine exhaust flow interacts with high lift devices, creating even more noise. Generally, to reduce significantly the noise of an aircraft, noise from all noise sources must be reduced, not just one or a few.

Much of the reduction over the last four decades has come from high bypass ratio engines that process larger amounts of air but propel the air at lower velocities. Continuing this same strategy will require new engine types that produce thrust with even larger amounts of air at still slower velocities. These new engines could be distributed on the airframe and include smaller engines that are used in turn to power larger ducted fans. Using the aircraft's solid surfaces to form a barrier to shield the community below will also be an effective way of reducing the engine's noise impact. Such strategies will mean a new look for future aircraft types. They could look more like flying wings with the engines buried in the top surface. Burying engines in the aircraft could add to noise in the passenger compartment, so noise transmission through the aircraft itself will have to be attacked also. Since every aspect of the aircraft has to be considered in order to reduce the total amount of noise magnitude and duration, the new quiet aircraft will have to fly differently as well. If aircraft could climb faster and land at slightly steeper angles, they would be farther from the community and possibly produce lower noise levels.

New quiet aircraft are on the drawing board and are being studied today. Turning them into reality to benefit the public around the world will take the best efforts and investment by governments, academia, and industry over many years.

Russell H. Thomas and Geoffrey A. Hill are at NASA Langley Research Center. Zoltan Spakovszky is at the MIT Gas Turbine Laboratory. This article is based on papers 2pNS4 and 2pNS5 at the 148th ASA meeting in San Diego.

Vision 2010

ASA members meet to discuss Vision 2010

Richard Stern and Charles E. Schmid

President-Elect Bill Yost leads a discussion.

What will the Society look like in 2010 - or more to the point, what would we like the Society to look like in 2010? This was the question poised to a group of 30 ASA members from the Executive Council, the Technical Council and various young professionals at a recent retreat. This all-day meeting was held on November 14th at Scripps Institution of Oceanography in La Jolla, CA. The conclusions below reflect discussions first held as a larger group, and then in five smaller, more focused sessions each with about 6 members.

The general sense of the retreat participants was that they were generally very satisfied with the present activities of the Society, and thus did not foresee radical changes required for it to sustain itself as an excellent organization in 2010. But to be fair, it should be mentioned that most of those in attendance were its elected leaders! Fortunately this sense of satisfaction did not preclude strong opinions on selected problems within our organization, which were followed by constructive proposals on how to improve the Society.

In addition to discussing the more tangible and specific activities of the Society, the group also discussed its overall strengths and weaknesses. The Society was seen as a stable organization with a strong interdisciplinary nature. Meetings, standards, organization and technical publications were given high ratings. Improvements were seen to be needed at the chapter level, in public relations, and in practical applications of acoustics, including exhibits at meetings. The Society shows a strong annual budget backed up with healthy financial reserves. However the Society depends heavily on revenues from selling the *Journal of the Acoustical Society* to libraries. This is now being threatened by a new "open access" model with the intention to make government-sponsored published research freely available to the public after 6 months. Another threat is the overall financial support for basic science and standards activities which has been decreasing. These "outside forces" will no doubt have their effects on all scientific and engineering societies in the coming years, and responses by the Acoustical Society to these threats are, and will primarily be, in coordination with larger organizations. Although these "outside" issues are extremely important to our future, they are not covered in this review of the retreat.

Membership and Member Benefits

The ASA is viewed as serving its student and senior members very well, but the sense was that young professionals can be better served. A number of recommendations were made to improve this situation, including a lower registration fee for the first few years after student members graduate. It was noted that members who attend meetings generally enjoy the experience, but those who are not able to attend, miss out on much of the information that is exchanged. Ideas which arose from the membership session included providing more information from meetings on the web for those members unable to attend. International members were another group that was addressed, and who likewise often are unable to attend meetings. In response, the retreat group felt that it was important to continue international meetings like those held in Berlin, Germany and Cancun, Mexico, and the one planned for Paris, France in 2008.

The ASA holds two meetings a year, and in fact except during WWII, has held two meetings a year since its inception in 1929. The question as to whether the Society should hold one or two meetings per year has been a topic of discussion for many years, and once again became a hot topic at the Vision 2010 retreat. Some members attend other meetings besides ASA's, and find it difficult to spend the time or obtain support funds for so many meetings; hence one way to save time and money is to hold only one ASA meeting a year. This proposal was countered by noting the advantages of two meetings; namely they provide an avenue for the latest work in acoustics and allow members to meet more often for technical and administrative reasons. It was also pointed out that one meeting per year would cause the annual meeting to draw many more attendees and more overlapping sessions, both of which were considered significant disadvantages. In the end, the consensus at the retreat was that one meeting a year would create major obstacles, and two per year should be continued as it is more flexible and creates better communication. One possible compromise was to focus on general topics at one of the meetings each year, and concentrate on specialized technical topics in the field, such as topical meetings, at the other meeting. The Technical Committee on Psychological and Physiological Acoustics has been using a variation on this approach for a number of years by organizing special sessions only at the spring meeting. Another approach which was mentioned is to host joint meetings with other organizations. This will be done with the Canadian Acoustical Association and INCE-USA at the spring and fall meetings in 2005. Not only do joint meetings save meeting time, they also promote cross-fertilization of approaches to solving acoustical problems. Other societies should be contacted to expand upon this concept of joint meetings.

Finally the group encouraged ASA's technical leaders to stress looking "outward" for new and emerging fields in acoustics, in addition to looking "inward" to the present subjects which ASA has traditionally done well in attracting papers and presentations. One idea was to arrange a special emerging technology lecture for each meeting. The intent would be to fulfill a different purpose than the present distinguished lectures and hot topics which many felt were more review in nature. A final need for the membership was to attract more practical applications of acoustics. An oft-heard complaint is that JASA is too theoretical for many readers, and they can't understand or apply its content. The hope was expressed that the new magazine currently being developed by the ASA will provide more information on applied acoustics for its members.

Public Outreach

Among other things, public outreach includes K-12 education, public policy and government relations, career development and building an image of the profession of acoustics to the public-at-large. For a variety of reasons the ASA has traditionally ranked low on surveys to its members in this endeavor. One reason might be due to the fact that this challenge involves many skills and interactions not normally held by our membership or staff. For this reason the session at the retreat which focused on this topic recommended hiring a consultant to develop a coherent approach to ASA's education outreach, along with some specific steps to accomplish this. They also recommended that the ASA take a more active role in promoting and commenting upon public policy related to acoustics. This is currently under the auspices of the recently formed ad hoc Panel on Public Policy (POPP).

ASA now enjoys more publicity on acoustics as a result of publicity coverage at our meetings, the World Wide Press Room, and ASA's technical and financial support of Discoveries and Breakthroughs in Science (DBIS - see Summer 2004 issue of *ECHOES*). However the website <acoustics.org> which was created for non-members and the public needs to be improved. Finally the group expressed the need to increase the number of practicing acousticians in the ASA. Suggestions on how to accomplish this were to include practitioners on the editorial board of the new acoustics magazine, and to add more professional development at meetings such as the recent workshops on forensics acoustics and classroom acoustics.

Summary

As mentioned in the introduction, these thoughts for Vision 2010 emanated from discussions by 30 members of the Society, most of whom have been members for years, and many of whom have served for years on various committees and as officers within the Society. The half-dozen young professionals who also participated in the retreat often had slightly different perspectives. This is exactly what we need. We are therefore asking you to bring your own perspective to Vision 2010 as well, thus insuring that we have the premier organization on acoustics in 2010. Please send your comments on the above discussions from the retreat – or any new ideas we didn't cover – to us, and be assured we will add them to our list for consideration for the final report on Vision 2010.

Richard Stern is chair of the Vision 2010 Committee (rstern@psu.edu); Charles Schmid is Executive Director of ASA (charles@aip.org)

The Pacific Ocean provided a fine backdrop for small group discussions.

Scanning the journals

Thomas D. Rossing

• **Shallow water** is usually a noisy environment because shipping lanes exist along coastlines. Submarines typically radiate in the same frequency band as shipping noise, less than 1 kilohertz. Passive sonar, which only receives a signal, is used mainly for antisubmarine warfare (ASW) and to study ocean biology According to an article in the October issue of *Physics Today*, it is possible to focus an acoustic signal more accurately when that signal travels through a complicated medium than when it doesn't. Various research groups have combined multisensor apertures with a complex medium to enhance signal processing in applications such as communications, medical ultrasonics, seismology, and matched-field acoustics. The proximity and complexity of the boundaries, and the oceanography in shallow water, influence the sonar's performance.

• Bird songs frequently contain trilling sounds that demand extremely **fast vocal control**. According to a paper in the 9 September issue of *Nature*, doves control their syrinx by using superfast muscles similar to those that operate acoustic organs such as the rattle of a rattlesnake. The syrinx of ring doves generates the familiar cooing sound which contains a trill whose elements are generated at repetition rates up to 30 Hz. When doves coo, respiratory airflow excites membranes in the syrinx, causing them to vibrate. The vibrations depend on the tension in the membranes which is modified by activating two pairs of syringeal muscles.

• The August issue of *Acoustics Australia* has reprinted a paper on "**The Sonar of Dolphins**" by Whitlow Au from the Proceedings of the WESPAC8 held in Melbourne, April 2003. The sonar of dolphins, which has undergone evolutionary refinement for millions of years, is the premier sonar system for short-range applications. It far surpasses the capability of technological sonar. A capability to perform time-varying gain is very different from that of a technological sonar.

• The December issue of the *American Journal of Physics* includes a paper on "The physics of **bat echolocation**: Signal processing techniques." Some 813 species of small nocturnal bats echolocate by making use of structured tonal signals rather than simple broadband clicks. They have brains that are adapted for processing acoustic signals and exhibit a wide variety of ear and nose sizes and shapes to improve the focusing of transmitted and received sound waves. It is shown, by calculation and simulation, how the measured echolocation performance of bats can be achieved.

• Ultrasound scans could soon be much more detailed, thanks to a novel material that can bend sound waves the "wrong" way, according to an article in the 4 September edition of *New Scientist*. This property, known as **negative refraction**, means the material should bring sound waves to a focus far sharper than today's medical scanners. (See Fall 2004 issue of *ECHOES*) The material used by scientists at the University of Manitoba is known as a "phononic crystal," a synthetic structure of tungsten carbide beads just 0.8 mm across, painstakingly packed to form a slab 12 layers thick. When the crystal is immersed in water, any sound with a wavelength similar to the bead size is diffracted as it enters the material, leading to the unusual properties. At a frequency of 1.57 MHz, for example, the crystal brings sound to a focus by bending it in a chevron pattern, so that waves that are initially diverging are brought together.

• The National Institutes of Health (NIH) has released a draft policy aimed at increasing public access to the results of NIU-funded research according to a note in the 10 September issue of *Science*. The proposal, which follows the recommendations of a congressional spending panel, would require grantees to deposit copies of their papers in **NIH's free PubMed Central archive** once they have been accepted by a journal. Manuscripts would be posted online 6 months after publication, or immediately if NIH grants were used to pay publication costs. Commercial publishers and many scientific societies lobbied against a mandatory plan, saying it could bankrupt many journals. The executive director of the American Physiological Society, for example, calls the plan "an unnecessary expenditure of federal funds for a redundant repository of peer-reviewed literature." He notes that most journals already provide back articles for around $5 to $30, or for free after a certain period. The proposal was discussed by a number of people at the ASA meeting in San Diego.

• A review of the way the brain processes acoustical features of **musical sound** is the subject of a paper in the August issue of *Acoustics Australia*. Preliminary analysis and organization of the data takes place in the cochlea where incoming acoustic waves are filtered and converted into digital nerve impulses, which are passed on to the brain. Time and frequency analysis occurs simultaneously, allowing continuous assessment both of the starting transient and the steady sound. The tristimulus method of analysis emulates this process by measuring the changes that occur with respect to both time and frequency.

• Nonlinear traveling waves have been observed in **turbulent pipe flow**, according to a report in the 10 September issue of *Science*. Although stability theory suggests that the flow remains laminar for all flow rates, in practice pipe flow becomes turbulent even at moderate speeds. On the basis of the recent discovery of unstable traveling waves in computational studies of the Navier-Stokes equations and ideas from dynamical systems theory, a model for the transition process has been suggested. The experimental observation of these waves confirms the proposed transition scenario and suggests that the dynamics associated with these unstable states may indeed capture the nature of fluid turbulence.

• A machine that **sorts pistachio nuts** according to the sound they make when dropped onto a steel plate has been developed at US Agricultural Research Service in Manhattan, Kansas, according to a note in the 20 November issue of *New*

Scanning the journals

Scientist. The sorter will separate ripe nuts with easy-open shells, which bring top dollar as snacks, from unripe ones with tight shells, which are normally shelled mechanically for use in ice cream or cake mixes. Signal-processing software detects the shorter ping of a closed-shell nut and opens an air valve to blast it off the line.

• The **evolution of music and language** was the subject of a workshop at the recent European Science Foundation Workshop on Music, Language, and Human Evolution at the University of Reading, according to a report in the 12 November issue of *Science*. Music, like language, can be a form of communication and coordination among people. It was pointed out that Darwin himself was hard put to explain how music made humans better adapted to their environment. In the end, Darwin concluded that music was the result of "sexual selection, the elaboration of traits designed to attract a mate and thus ensure reproductive success. Mothers talk and sing to their infants. Maternal speech has a number of features that can be considered musical, including higher pitch than normal speech. But the fact that mothers sing to their babies doesn't explain why children and adults listen to music.

• Brazil nuts in a shaken box of muesli rise to the top, but large grains dispersed among smaller grains can also sink to the bottom (the "reverse Brazil nut effect"), depending on the relative densities of the particles. According to a paper in *Phys. Rev. Letters* 93, 208002 (2004), if the large grains are neutrally buoyant (have about the same density as the small grains), they can **aggregate into a cluster** when shaken. The attraction seems to result from the way the packing of smaller grains dilates during a vibration cycle. The large grains are "ratcheted" together by the vibrations, an effect that could occur during the industrial handling of powders.

• A lone **whale with a voice unlike any other** has been wandering the Pacific for the past 12 years, according to a note in the 11 December issue of *New Scientist*. The whale sings at 52 Hz with a call that doesn't match any known species. Blue whales typically call at frequencies between 15 and 20 Hz, while fin whales make pulsed sounds at around 20 Hz. The tracks of the lone whale do not match the migration patterns of any other species either.

• **Songbirds** must hear a song during a sensitive period early in life in order to later generate a normal song, according to a paper in the 9 December issue of *Nature*. From this early acoustic experience, birds form a memory of the song and later use auditory feedback to compare their vocalizations with the memorized representation of the tutor song. Birds tutored with only pairs of adjacent song phrases are able to assemble full songs with phrases in the correct order, but birds tutored with song phrases presented singly failed to produce a normal song.

Acoustics in the news

• Bulletin No. 149 (November 23) from the American Institute of Physics *Bulletin of Science Policy News* discusses the 1.9% budget cut for the National Science Foundation in the FY2005 budget that the Congress just passed. Education and Human Resources funding declines 10.4%. Republican Congressman Vernon Ehlers (one of two physicists in Congress) is quoted as saying "While I understand the need to make hard choices in the face of fiscal constraint, I do not see the wisdom in putting science funding far behind other priorities…The decision shows dangerous disregard for our nation's future, and I am both concerned and astonished that we would make this decision at a time when other nations continue to surpass our students in math and science and consistently increase their funding of basic research."

• Scientists from St. Andrews University in Scotland and the Woods Hole Oceanographic Institution in Massachusetts have come up with a much fuller picture of how sperm whales use echolcation while foraging, according to a story in the November 23 issue of *The New York Times*. While scientists have long suspected that the whales use both "clicks" (short-duration noises at intervals of up to two seconds) and "creaks" (continuous clicking that sounds like a buzz), it is not easy to find out what an animal is doing 2000 feet or more below the ocean surface. Using recorded information during 103 dives, the scientists have concluded that creaks averaging about 9 seconds are used when the whale is closing in for capture. Almost all of the creaks were from the deepest part of the dives during which the whales swam actively, constantly changing directions. In this respect, the whales are similar to bats, which produce buzzes as they close in on food.

• In its annual survey of dangerous toys, the U.S. Public Interest and Research Group (PIRG) has identified six toys which could damage children's hearing according to a story in the November 24 issue of the *Chicago Tribune*. The toys singled out for being too noisy are Fisher Price's "Learn Through Music," KIDdesigns, Inc.'s "Barbie Princess Musical CD Boombox," EZTEC Scientific Toys' "Radical Rhythms Guitar," SRM International's "Power Gear Star Blaster Set" and "Power Gear Assault Machine," and Geoffrey Inc.'s "Elite Operations M-1 Tank." Last year, the Toy Industry Association agreed to voluntary standards for loudness that said any toy that can be held within 10 inches of a child's ear should not exceed the noise level of a busy city street. The PIRG feels that several toys violate those standards.

continued on page 12

Acoustics in the news

• Overture Hall, part of the Overture Center for the Arts in Madison, Wisconsin, was given a favorable review in the November 23 issue of *The New York Times*. The hall, designed by Cesar Pelli with acoustical design by Kirkegaard Associates, opened in September but was officially inaugurated recently with the dedication of a pipe organ made by Orgelbau Klais of Bonn, Germany. Since Overture Hall is intended as a multi-purpose auditorium, the 30-ton organ, mounted on 16 wheels and two sets of railroad tracks, can recede into an oversize cabinet to expand the stage and provide a more neutral backdrop for musicals, opera, and ballet. Overture Hall, which seats 2150, is the flagship of the Overture Center, a $205 million gift to the city from W. Jerome Frautschi. The $1.1 million organ was a gift from his wife, Pleasant Rowland, creator of the American Girl doll.

• The "Father of MP3," Karlheinz Brandenburg, has been wooing the Hollywood film community with a new spatial sound technology called "Iosono," according to a story in the December issue of *Sound and Vision*. Brandenburg, director of the Fraunhofer Institute of Digital Media Technology, hopes to do for three-dimensional sound what MP3 did for digital music. Designed for use in theme parks, movie theaters and (eventually) in home theaters, Iosono uses computers, complex mathematical formulas based on wave field synthesis, and a 360° array of loudspeakers to create a soundscape in which sound effects can be precisely placed. It promises a richer more immersive experience than traditional surround sound technologies but with the requisite "sweet spot," according to the story.

• The 2005 Honda Odyssey, the Accord Hybrid and the Acura RL will carry active noise reducing systems, according to a story in the 10 December issue of *The New York Times*. Microphones in the front and rear of the vehicle will analyze noise from the engine and exhaust which is canceled by sound from loudspeakers in the car doors. (This is different from the Bose system which works through the car's stereo system). The active noise control system can reduce interior noise by 10 dB, it is claimed.

• Human cells vibrate and might produce very faint sounds which could be used to differentiate cancerous cells from normal cells, according to a story in the December 12 *New York Times Magazine*. So far only sounds from yeast cells have been heard, but cancer specialists are seriously interested in extension of the technique to human cells.

ACOUSTICAL•SOCIETY•OF•AMERICA
SUITE 1NO1
2 HUNTINGTON QUADRANGLE
MELVILLE, NEW YORK 11747-4502

Non-Profit Org.
U.S. Postage
PAID
Hicksville, NY
Permit No. 289