The newsletter of
The Acoustical Society of America

ECHOES

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The crack of the bat

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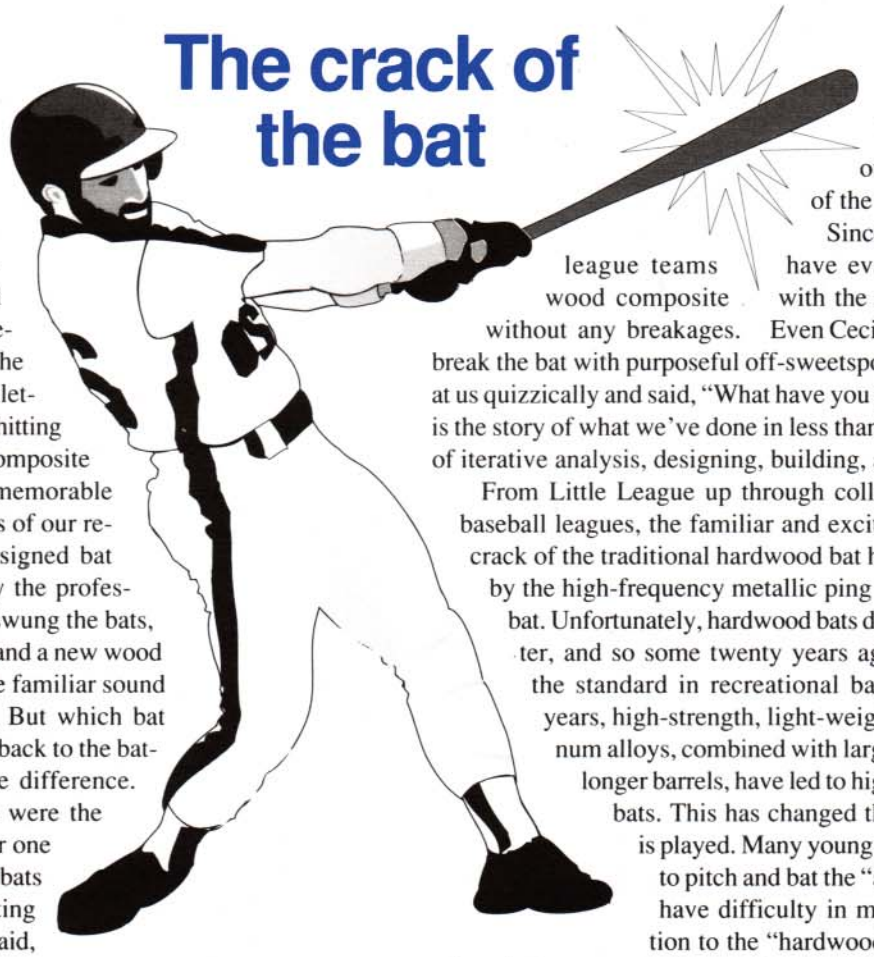

On July 13, at Tiger Stadium, Cecil Fielder and other members of the Detroit Tigers, along with the visiting Kansas City Athletics, conducted pre-game hitting tests with a new wood composite baseball bat. It was a memorable evening when the results of our research on the Baum-designed bat were to be evaluated by the professionals. As each player swung the bats, both his own hardwood and a new wood composite, one heard the familiar sound of the crack-of-the-bat. But which bat was it? No one, with his back to the batting cage, could tell the difference. The acoustic signatures were the same for both bats. After one hour of hitting with both bats and getting the same hitting distances, George Brett said, "OK, it's a wood bat." We had achieved our goal, a replica of the hardwood bat.

Since then, 14 major league teams have evaluated this new wood composite with the same results and without any breakages. Even Cecil Fielder couldn't break the bat with purposeful off-sweetspot hits. He looked at us quizzically and said, "What have you guys done?" This is the story of what we've done in less than a year and a half of iterative analysis, designing, building, and testing.

From Little League up through college and amateur baseball leagues, the familiar and exciting sound of the crack of the traditional hardwood bat has been replaced by the high-frequency metallic ping of the aluminum bat. Unfortunately, hardwood bats do crack and splinter, and so some twenty years ago metal became the standard in recreational baseball. Over the years, high-strength, light-weight tubular aluminum alloys, combined with larger diameters and longer barrels, have led to higher performance bats. This has changed the way the game is played. Many young people who learn to pitch and bat the "aluminum" game have difficulty in making the transition to the "hardwood" game and, for talented players, move into professional baseball.

Just as "high-tech" materials and designs have changed the game of tennis and other sports, so too has recreational baseball been changed by the aluminum bat with increased power hitting and a larger sweetspot. Now, let's turn this around. How can material science and an understanding of structural dynamics help us to design an unbreakable bat that sounds and performs like a hardwood bat? That was the question addressed by Steve Baum, a Michigan inventor, and the result is the Baum Wood Composite Bat. It is a solid unibody (as opposed to the tubular design of aluminum and

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We hear that . . .

Two ASA medals will be presented at the upcoming meeting in Salt Lake City. The Society's Gold Medal will be presented to **Ira Hirsh**, and **Anthony Atchley** will receive the R. Bruce Lindsay Award.

The **Coordinating Panel on Ocean Acoustics Sciences** is the new name for the group that collates information and coordinates the scheduling of sessions and papers from the five related technical areas: (1) Acoustical Oceanography, (2) Animal Bioacoustics, (3) Engineering Acoustics, (4) Physical Acoustics, and (5) Underwater Acoustics.

In recognition of his contribution to the scientific understanding of hearing processes, **Jozef Zwislocki** received an honorary doctorate from the Adam Mickiewicz University in Poznan, Poland. The degree was awarded last October and was the first honorary doctorate in acoustics awarded by this university.

Quan Qi is the winner of ASA's Hunt Fellowship for post-doctoral studies. Dr. Qi's research topic will be the Mechanical Mechanisms of Ultrasonic Cleaning, and he will conduct it during the academic year 1992-1993 at the University of Illinois.

Two ASA members have been honored by the American Institute of Ultrasound in Medicine (AIUM). ASA Fellow **Frederick Kremkau** has been elected Vice-President of the AIUM. Dr. Kremkau is Director of the Center for Medical Ultrasound at the Bowman Gray School of Medicine, Wake Forest University. The AIUM gave **Robert Waag**, of the University of Rochester's College of Engineering and School of Medicine, the Joseph H. Holmes Basic Science Pioneer Award. Dr. Waag became an ASA Fellow last November, and is also a Fellow of the AIUM and the IEEE.

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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The new ASA Directory

ASA mailed out the new "green" directory in mid-January. In addition to some of the handy features of its predecessor, the new directory has some additional items. There is a subject index in the last three pages to help you locate all the features of the directory. The 1992 version of the Physics and Astronomy Classification Scheme, better known as the PACS, is outlined on pages A49-A52. Also, there is an updated profile of Society members (page A60), which gives current information on the geographical, age, and sex distributions of ASA members, along with professional identifications and type of employer. In addition, the new directory is the only publication of the Society that lists past as well as present chairs and members of ASA administrative committees (pages A15-A20). This information is available for the technical committees as well.

Most members don't appreciate the fact that the directory contains information other than people's addresses and phone numbers. But if you want to know who won the Gold Medal in 1979, who was President in 1950, and who chaired the Coordinating Committee on Environmental Acoustics in 1976, the answers are on pages A5, A13, and A15 respectively. If you want to know how to sponsor somebody for Fellowship, who are ASA's sustaining members, and what rules govern the operation of technical committees, see pages A47, A65-66, and A37-A39, respectively.

Any member who did not receive a copy of the directory should call Elaine Moran at ASA's Woodbury Office (516) 576-2360.

CRACK OF THE BAT—from page 1

other types of composite bats), made up of a high-strength inner core, resin impregnated synthetic fibers and composites, with an integrated wood outer surface.

Actually, there are two families of wood composite bats. The first, designated the AAA Pro model, has a $2^1/_2$" diameter and is designed to emulate the professional hardwood bat but with superior durability. The second, designated the Equalizer, has a $2^3/_4$" diameter and is designed to match or even exceed the performance of the aluminum bat.

The design, evolution, and testing of these two families of prototype bats was supported by an independent research program at Tufts University. The challenge was to integrate the properties of the different materials of the wood composite to achieve the specified structural dynamic characteristics and the corresponding performance. The technical approach has been to integrate controlled, side-by-side hitting performance measurements with a series of laboratory measurements.

Bob Collier and his research assistant, Paul Dresens, in their lab at Tufts.

This research has been conducted with full recognition of the statement by Robert Adair, Sterling Professor of Physics at Yale, that: *"It may be curious that the physics of baseball is not at all under control. We cannot calculate from first principles the character of the collision of an ash bat with a sphere made up of layers of tightly wound yarns..."* (*The Physics of Baseball, Harper and Row, 1990*). And there is very little published data either on the characteristics and performance of wood, composite, and aluminum bats, or on experimental techniques.

We started out with two basic objectives: (1) to develop an understanding of the bat-ball collision process, and (2) to relate the results of laboratory measurements on materials and structures to field performance. The fact that two of my engineering graduate students were active in Tufts athletics was the key "bridge"; one is a former varsity baseball captain and currently is the assistant baseball coach. The field performance was determined by hitting tests carried out by members of the Tufts baseball team with machine pitching at 75 mph. Hitting statistics and distances were established through a series of tests showing equivalent results for both bats.

Through the prototype development and design iterations, we established the static and dynamic similarity of the wood and wood-composite professional model bats. The laboratory measurement procedures were developed to obtain both quantitative and relative engineering data on bats including structural stiffness, modal response (natural frequencies and damping), breaking strength, and material elasticity under repeated loading through a baseball.

First, we established that the bats have the same overall stiffness. This is important for its "feel" or flexibility. And, by the way, we disproved the notion that more stiffness

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About Bob Collier...

At ASA's Fall 1990 Meeting in San Diego, Bob Collier presented an informative and entertaining talk, complete with video and tape recordings, on the acoustics of the bat-baseball collision. Prior to baseball acoustics, Bob spent a large part of his career in underwater acoustics, sonar, and noise and vibration control, as a senior staff member of Bolt Beranek and Newman, Inc.

Currently, as Professor of Mechanical Engineering at Tufts University, his research is focussed on the mechanical characterization of composite materials. This is evidenced not only in his research on the wood-composite baseball bat, but also in a recently awarded NIH grant for research in dental composite materials. In addition, he is conducting research in thermal acoustic tomography for characterizing temperature fields in combustion chambers as part of an environmental engineering pollution prevention program.

Acoustics in the news

"Babies Learn Sounds of Language by 6 Months" (NY Times Science Section, 2/4/92). Findings by Patricia Kuhl, a Fellow of the Society and an Executive Council member, indicate that babies learn to identify basic speech sounds by the age of six months. Dr. Kuhl tested Swedish and American babies with vowel sounds from both languages and found that they recognized the phonetic sounds of their native language at a very young age. This research should encourage parents to talk to their babies before they develop speech, since the babies are listening and learning! Dr. Kuhl also stressed the importance of avoiding ear infections that might impair early language development.

"Cooling with Sound: An Effort to Save the Ozone Shield" (NY Times Science Section, 2/25/92). Under the leadership of the late J.C. Wheatley, ASA members Steven Garret, Thomas Hofler, Gregory Swift, and Albert Migliori pioneered the principle of thermoacoustic refrigeration in the 1980s at the Los Alamos Lab. This principle has been used to make the thermoacoustic refrigerator, in which a loudspeaker generates a high-intensity standing wave in an organ-like pipe. The cooling occurs through the interaction between the temperature oscillations in the standing wave and the thermoacoustic stack, a series of thin plates parallel to the acoustic displacement. A team of ASA members, headed by Garrett and Hoffler, and including David Gardner, Jay Adeff and students at the Naval Postgraduate School, built a thermoacoustic refrigerator and tested it aboard a space shuttle flight in January. Although a commercial thermoacoustic generator is probably years away, it holds the promise of eliminating the use of chlorinated fluorocarbons (CFCs), which are used in today's refrigerators. The release of CFCs is believed to be the principal cause of the depletion of the ozone layer.

"Is Elvis Alive?" was the title of a January 22 TV show featuring ASA Fellow Peter Ladefoged of UCLA's Linguistics Department. The producers brought two audio tapes into Dr. Ladefoged's lab: one of an interview with the actual Elvis when he was alive, and the other of an interview of a person who alleges to be Elvis, still alive. After examining the speech spectra as he would in a court case, Dr. Ladefoged determined that the two voices belonged to two different people. Anyone interested in the details can call the Linguistics Department at (310) 825-4321.

CRACK OF THE BAT—from page 3

is needed for higher performance in solid bats.

Second, through laboratory modal analysis of elastically supported bats, we measured directly the natural frequencies and damping of the wood and the wood composite bats. They are essentially equal. Since the Frequency Response Functions of the two structures are the same, their dynamic response to impact forces are the same: the sweetspot is the same and off-node hitting has the same sting. Ask the professionals! And the fact that the bat behaves as a free-free beam in hitting was confirmed by field vibration measurements.

Third, the relative strengths and fracture mechanisms of the bats were determined. (Wood splinters and snaps in the small diameter handle and a broken bat flies.) There is, of course, a wide variation in the properties of natural woods. The wood composite fractures in a progressive sequence, and, though not as strong as aluminum, it is significantly stronger than wood. After early fractures and redesign, none of the composite AAA Pro bats has been broken so far either in hitting by professionals or in extended durability hitting tests at Tufts.

Fourth, we focussed on the elastic properties of the materials and structures, a particularly fascinating area of research. We conducted repetitive loading tests and investigated the hitting durability of the bats. For example, when the ball strikes an aluminum bat, the cylinder deforms and, in the spring back, contributes to the so-called trampoline effect. But more than that, one may ask how the metal properties themselves may be changed as a result of continued impact forces. Our laboratory measurements show that the materials and structure of the wood composite remain in the elastic range after two thousand or more hits and that hitting performance is unchanged.

The dynamic characteristics of the bat and the impact wave-form determine its sound radiation. Field measurements confirm what the measurements and our ears tell us, that the broadband sound radiation in levels and spectra are indistinguishable for wood and wood composite bats. In other experiments with aluminum bats, we have shown that the high sound pressure levels and narrow-band, ping-like noise are associated with resonant frequencies of the shell's (barrel's) breathing modes.

Currently, our research is focused on developing a better understanding of the energy exchange in the hitting process. The aim of this work, which incorporates high speed photography, is to help baseball players improve their game and to develop more realistic models for the analysis and design of all types of bats. In the future, a newly designed "Equalizer" wood composite bat is to be compared with other high performance aluminum and composite models. Also, we plan to develop design guidelines for wood composite bats for a wide range of weight and performance characteristics to suit players of all ages and different levels of play. ■

Noise recommendations from the TRB

The Transportation Research Board (TRB) of the National Research Council held a conference entitled "Transportation Environmental Research Needs" in Denver last November. One of the working groups was concerned with noise and vibration issues, and it separated into three subgroups: highway noise, aircraft noise, and rail/mass transit noise. The three subgroups developed 22 research recommendations. Just to name a few: those for highway noise include the development of new traffic noise prediction procedures, and the field evaluation of traffic noise generation, propagation, and attenuation. Aircraft noise recommendations include advanced technology for aircraft noise control and supplementary metrics for the evaluation of aircraft noise impact. Rail and mass transit research recommendations include a study of high speed transportation noise and vibration design criteria, and an evaluation of ground vibration control technology.

The report contains recommendations in all environmental areas, along with background statements, research proposals, and estimates for funding requirements and project durations. The recommendations are intended for the U.S. Department of Transportation and State transportation agencies. The report, *Transportation Environmental Research Needs,* is in the form of a TRB Circular and may be obtained from the TRB Publications Sales Office, (202) 334-3214.

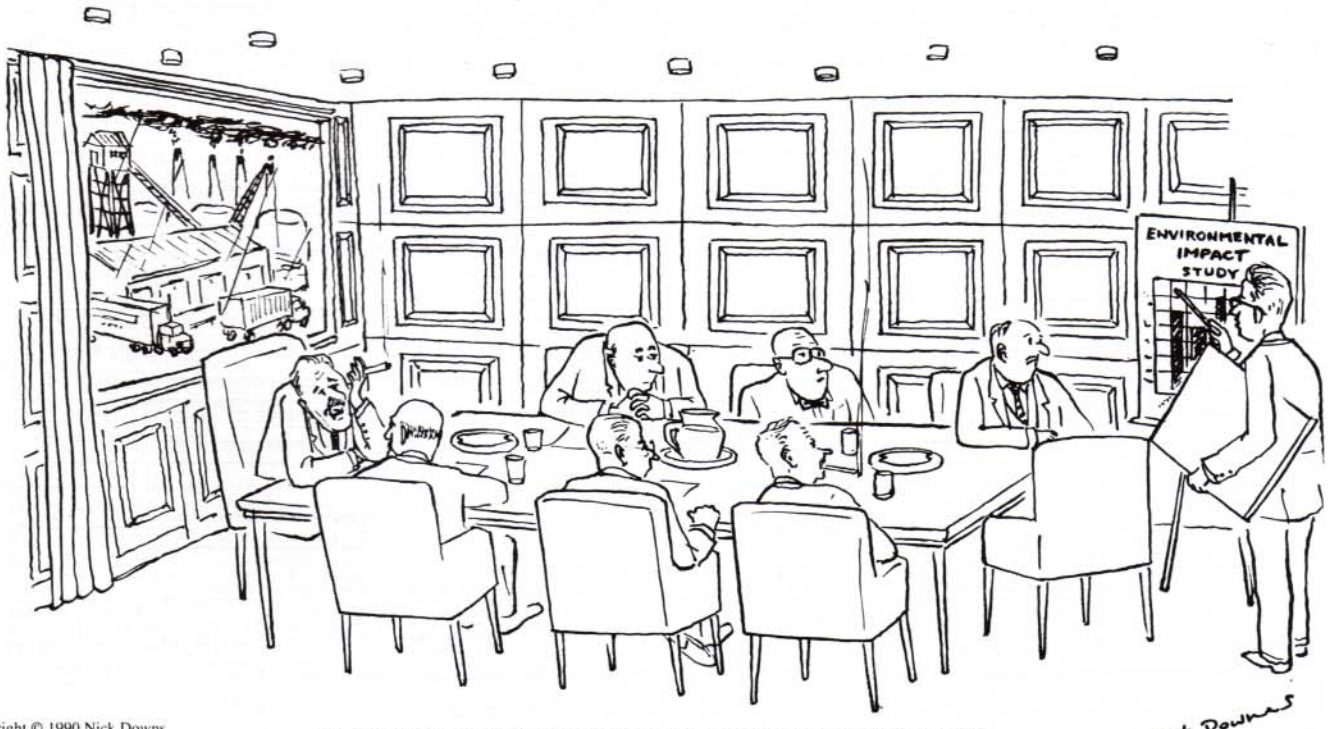
Physical Acoustics summer school

Twelve students will receive full or partial funding from the Acoustical Society to attend the summer school to be held in June at Asilomar, California. They are: Sanjay Chowbey, James Finneran, Peng Jiang, Debra Kenney, Hyun-Gwon Kil, Douglas Mast, Ralph Muehleisen, Quan Qi (the newly selected Hunt Fellow), Glenn Stout, Daniel Warren, William Wright, and Xiaoyu Zheng. The attendance of 12 additional students will be supported by the Office of Naval Research.

Lecturers at the Asilomar Summer School will include Anthony Atchley, Henry Bass, Yves Berthelot, Larry Crum, Bruce Denardo, Mark Hamilton, Robert Keolian, Moises Levy, Julian Maynard, Wolfgang Sachse, and James Wagner. In addition, a number of discussion group leaders will also attend.

New standards catalogue

A new catalogue of standards on acoustics, No. 11-1992, is now available from ASA's standards program. The catalogue contains an up-to-date listing of the approximately 100 standards for which ASA has responsibility, along with information on pricing and ordering. It can be obtained without charge by writing to the ASA Standards Secretariat, 335 E. 45th Street, New York, NY 10017 or by calling (212) 661-9404.



"Did he say *someday* we'd be sorry or *Sunday* we'd be sorry?"

Acoustics in the former Soviet Union

Ira Dyer
Massachusetts Institute of Technology

In early January of this year I visited four institutes of the former Soviet Academy of Sciences: Andreev Acoustics Institute in Moscow, Shirshov Institute of Oceanology in Moscow, the Institute of Applied Physics in Nizhny Novgorod (Gorky), and the Hydromechanics Institute in Kiev. The host for my visit at each were, respectively, Professor Nikolai Dubrovskiy, Academician Leonid Brekhovskikh, Professor Lev Ostrovsky, and Professor Victor Grinchenko. My purpose was to explore research areas in acoustics, mainly in ocean acoustics and hydrodynamic noise, that might serve as foci for future joint research between Russians and Ukrainians and U.S. scientists. With 18 days available for explorations, I was able to gain a broad understanding of their programs and, by giving seminars in each of the cities, I think acoustics scientists there learned something about my interests and those of my immediate colleagues at M.I.T.

I was also able to visit the principal acoustics university centers in Nizhny Novgorod and Kiev. Each evening was also informative since we (my wife Betty accompanied me) were graciously entertained at the flats of various scientists, at which time we informally discussed not only acoustics and the practicalities of possible collaboration, but also the social, political, and economic gradients the former Soviet scientists and their families are now confronting.

While obvious, it is worth stating: Virtually all scientists we talked with are uncertain about their future in acoustics research. Large funding reductions seem inevitable as the former Soviet Union redirects and divides its economy and social structure. Thus my offer to explore joint avenues of research was met with enthusiasm; certainly too many proposals were eagerly suggested by them for any one individual properly to relate to. But from a very long list of such possibilities, we came down to a list of early initiatives:

- Joint use of the research ships Akademik Nikolay Andreev and Akademik Boris Konstantinov for ocean acoustics experiments.
- Purchase or use of underwater electrodynamic sound sources with source levels up to 215 dB re 1 μPa and lm.
- Cooperation in planning and execution of a global warming experiment in an Arctic basin.
- Joint theoretical and laboratory research in scattering from very rough surfaces, such as those that model roughness on the flanks of oceanic spreading ridges.
- Joint theoretical and laboratory research on wave propagation in ice, with special attention to its granular composition and its brine drainage channels.
- Sharing research ideas and results in forcing functions of, and radiation from, turbulent boundary layers.
- Advice in, and provision of contacts for, publication in English of books and monographs recently completed there, on topics such as structural acoustics, electroelasticity, intense underwater sound sources, sonar signal processing, and nonlinear random waves.

U.S. scientists had already initiated discussion with those I visited on a few of these topics, and my role will be to lend support to their efforts. In other topics, the initiatives might well be new. I invite all readers of this note who have an interest in what is listed here to become involved as might be appropriate. Also the list could readily be expanded, perhaps by an order-of-magnitude, since all of acoustics science in the former USSR seems destined to move to much closer collaboration with the West. Indeed, if such movement does not take place, the best of such science there may well disappear.

Contact:

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Program for Salt Lake City meeting available on PINET

Since early in March, the whole program for ASA's Salt Lake City meeting has been available on PINET, the electronic mail system operated by the American Institute of Physics (AIP). Because the Acoustical Society is a member society of AIP, all of our members have access to PINET for a small charge.

This is the first time that the entire program is available electronically, including abstracts, practical information about the meeting, and names of authors, etc.

We hope that ASA members will benefit from having the program available so far in advance of the meeting. Anyone who would like more information on Pinet should call AIP's Pinet Administrator, Suzanne Pischel, at (516) 576-2261.

International conferences featuring acoustics

Toronto

Inter-Noise

The 1992 International Congress on Noise Control Engineering will take place in Toronto, July 20-22, with the theme, "Noise Control and the Public." The general chairman is Tony Embleton and the joint program chairs are Gilles Daigle and Michael Stinson. This is the first Inter-Noise Congress to be held in Canada. Information may be obtained from Tony Embleton at (416)859-1136.

Finnish Lapland

Combined Effects of Environmental Factors

The Fifth International Conference on the Combined Effects of Environmental Factors will be held September 6-10, 1992 in Sarriselka in the Finnish Lapland. Tentative themes of the conference include various interactions of noise with other agents, such as chemicals, heavy metals, and vibration, as well as annoyance from noise and the health effects of other environmental factors. For information, write to the ECCEF 92 Secretariat, c/o Archives of Complex Environmental Studies, ACES Publishing, P.O. Box 114, SF-33101 Tampere, Finland.

Beijing

ICA

The 14th International Congress on Acoustics will take place in Beijing, September 3-10, 1992. In addition to the usual menu of acoustical topics there will be twelve plenary sessions on special topics, and technical tours in the Beijing environs. For the tourist, destinations for day-trips will be the Great Wall, Ming Tombs, Fragrant Hill park, Tan-zhe Temple, and the Sleeping Buddha Temple. One can also choose from four post-congress tours, which include such exotic places

(Beijing cont.)

as Xi'an, Guilin, Chengdu, Suzhou, Shanghai, and Lhasa in Tibet. Special rates are available to early registrants (until June 30), as well as to students and accompanying persons. For further information, contact: 14th ICA Secretariat, Institute of Acoustics, P.O. Box 2712, Beijing 100080, China. Or call Dr. David Blackstock at (512) 835-3372.

Tokyo

Musical acoustics

An International Symposium on Musical Acoustics will precede the Beijing meeting of the ICA. The symposium will take place in Tokyo, August 28 through September 1, 1992. Sponsored by the Musical Acoustics Research Group of the Acoustical Society of Japan and the Catgut Acoustical Society, it will feature three days of scientific papers plus a concert of Japanese music and a full-day tour on Sunday, August 30. Interested persons should write to Dr. Hideo Suzuki, Ono Sokki Co., Ltd., 1-16-1 Hakusan, Midoriku, Yokohama 226, Japan.

ASA's ship of state

I've always enjoyed standing on the shore and watching the big ocean liners pass by majestically, smoothly, seemingly without effort. The fact that all sorts of things were going on aboard the ships as I watched rarely crossed my mind. In my early membership days, I had a very similar attitude about the Acoustical Society. I saw ASA as floating effortlessly along its time-honored path of meetings and publications, followed by more of the same. Only later, as I became more involved, did I learn that not only was there a great deal of activity on board, but also that the ship's propulsion resulted from the rowing efforts of a whole lot of people. I also found out that it takes a dedicated and active crew to maintain, guide and improve the ship.

Like changes in the technology of ships or of other complex systems, changes in the Acoustical Society tend to occur more by evolution than by revolution. And indeed, our crew has accomplished some efficiency increases while fixing some minor leaks, without making severe course corrections that might have caused significant passenger discomfort. Thanks to the Long-Range Planning Committee's radar foresight a few years ago, our crew is now headed by a full-time Executive Director, Charles Schmid. Charles has done an admirable job supervising our day-to-day operations, interacting with other organizations, and keeping an eye open for new opportunities and for potential problems.

As most of you know, the Technical Specialty Group on Acoustical Oceanography was upgraded to a full-fledged Technical Committee at our Houston meeting, with at least part of the intent being to attract more oceanographers and related specialists to our Society. In regard to improving our general procedures, we are studying rule changes that would encourage the formation of new technical committees without detracting from the established ones. We are also exploring means for improving the planning of our meeting sessions, including the establishment on a trial basis of an Ocean Acoustics Panel to coordinate for the Salt Lake City meeting all session assignments and scheduling of papers in its general area of interest. Perhaps a similar coordinating panel in another one of our broad technical areas should be considered for future meetings.

Of course, it costs money to run our ship of state. In the hope of compensating our staff adequately while limiting the financial burden on our members, we are working on the development of a comprehensive personnel policy and we've revitalized our Development Committee.

We are constantly considering how we might tidy up our ship. How can we attract more students and new members? Are we doing enough to assist disadvantaged students? Should we consider electronic publishing of all or part of our Journal? How can we help in emerging or soft currency nations? What can we do to assist immigrant scientists? Charles Schmid, all of our committee chairmen, and I would welcome your comments and suggestions.

–Eric E. Ungar

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