

INTER-NOISE 2003: Report

The thundering sound of a Korean drum provided a dramatic opening to the 2003 INTER-NOISE Congress—held on 2003 August 25-28 at the International Convention Center Jeju on Jeju Island, Korea. Jeju is the largest island in Korea, and is located in the Pacific Ocean just off the southwestern tip of the Korean peninsula. It is a mountainous volcanic island with spectacular views of the coastline and inland terrain.

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Secretary General Jeong-Guon Ih offers practical advice on the INTER-NOISE Congress.

General Secretary Jeong-Guon Ih, made a few remarks at the opening session and then introduced the Congress President, Hee Joon Eun who welcomed delegates on behalf of the INTER-NOISE 03 organizing committee. Then followed the official opening of the congress by International INCE president Tor Kihlman. There were two co-presidents of the congress, Young-Pil Park, president of the Korean Society for Noise and Vibration Engineering, and Chun-Duck Kim, president of the Acoustical Society of Korea who also



Jang Moo Lee presents the opening keynote address.

A performance on a Korean drum opens INTER-NOISE 03.

welcomed the delegates on behalf of their professional societies. Local greetings were also brought by a representative of the provincial government.

In addition to the congress opening with a Korean drum, delegates were well entertained by a musical performance on a traditional Korean stringed instrument. The session was very well balanced with practical information on the activities to take place during the congress, introductory remarks, and Korean cultural elements.

Jang Moo Lee, a professor at Seoul National University presented the keynote lecture, which was titled "Analysis of structure-borne sound of various systems." The purpose of his lecture was to give some examples of structure-borne sound radiation, and to compare some very old structures to modern structures. Using the principles of cavity resonance, he showed that the generation of sound in a 1300-year



From left to right: Congress President Hee Joon Eun welcomes the delegates; International INCE President Tor Kihlman describes I-INCE activities and opens the congress; Young-Pil Park, President of the Korean Society for Noise and Vibration Engineering, brings greetings from KSNVE; Chun-Duck Kim, President of the Korean Acoustical Society brings greetings from ASK; A local government representative welcomes delegates to Jeju Island.

old Korean bell is similar to the generation of sound in a passenger vehicle with a trunk. He went on to discuss the acoustical characteristics of bells—comparing the sound of a Korean bell with the Liberty Bell—and discussed the shapes of bells from Korea, China, and Japan. He presented some principles of bell design and modeling—for example modeling a bell as a variable-thickness cylinder. He returned to more modern problems such as the radiation of structure-borne sound into a vehicle interior. He emphasized structural and acoustical coupling, and presented a study of the effect of an air gap between the roof and headliner of a vehicle, which can be used to reduce sound levels. He also discussed the treatment of a passenger car compartment and trunk as a coupled system—treating the car and trunk as separate cavities. He completed his lecture with a discussion of active control of a car floor to reduce sound levels and an analysis of the squeal of disk brakes.

Following the opening session, a welcome reception for all delegates was held in the Sunken Garden of the ICC Jeju Convention Center. Unfortunately, the weather did not cooperate for the planned outdoor reception.



Michael Vorländer presents the second keynote address.

The following morning, Michael Vorländer, a professor at Aachen University in Germany presented the second plenary lecture titled “Auralization in noise control.” One key question in noise control, he said, is how to interpret the results of an acoustical analysis. For example, single-number ratings can be misleading and two sounds may have the same one-third octave band spectrum, but may sound quite different. Auralization, he said, is a tool for making judgments by listening to sounds created by a source and a filtering system, which may be quite complex. Although the basic analysis tool is convolution, signals have many dimensions (loudness, etc.), and decisions must be made as what is important. He turned to the problem of

source/transmission path interactions, and then to various analysis methods—finite element modeling, boundary element modeling and statistical energy analysis—and how they affect the choice of a filter to model system performance. He gave examples of auralization in room acoustics and factory noise.

He discussed the tapping machine as a source of impact sound and the need to determine both the impedance of the source and the impedance of the floor in order to make a realistic model for auralization studies, and presented preliminary results. He then turned to binaural transfer path synthesis where both an airborne path and a vibration path may exist, and gave studies of washing machines and vehicle noise as examples. In closing, he suggested that auralization could be added to visualization for marketing and other purposes.

INTER-NOISE 2003 Exposition

The exposition was managed by Duck-Joo Lee from the Korea Advanced Institute of Science and Technology. The booths were well-placed in a central area of the conference center. Thirty-six exhibitors from 10 countries participated in the exposition, and occupied 48 exhibit booths. Companies participating were:

- 01dB Acoustics and Vibration-Metravib Technologies, France
- ABC Trading, Korea
- Acoustics Group, Korea Institute of Machinery and Materials, Korea
- ATES, Korea
- AVT Co., Ltd., Korea
- Beijing ShengWang Acoustic-Electric (BSWA)Technology Co., Ltd., China
- Brüel & Kjær, Denmark
- Center for Information Storage Device (CISD), Korea
- DataKustik GmbH, Germany
- Degussa Röhm Plexiglas, Germany
- DICESVA S.L., Spain
- ESI Group & Vibro-Acoustic Sciences, Inc., France
- Face Trading Company, Ltd., Korea
- G.R.A.S. Sound & Vibration, Denmark
- Hanglas, Korea
- HanKook AAC, Korea
- imc Messysteme GmbH, Germany
- Larson Davis Inc., A PCB Group Company, USA
- LMS Korea, Korea
- MSC Software, Korea
- MTS Systems Corporation, Korea
- Müller-BBM Vibroakustik Systeme, Germany
- Namyang Novitech Co., Ltd., Korea
- National Instruments, Korea
- Norsonic AS, Norway
- Center for Noise and Vibration Control (NOVIC), KAIST, Korea
- OROS, France
- Rion Co., Ltd., Japan
- Sekisui Korea Co., Ltd., Korea
- SEVIT TECH, Korea
- Sony Precision Technology, Inc., KTM Engineering, Inc., Japan
- SoundPlan, USA
- Sunil Measuring System Co., Ltd., Korea
- SVANTEK, Poland
- TaeJong Development CO, Ltd & Nittobo, Japan
- WooJoo Hi-Tech Corp, Korea

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Stuart Bolton (top) presents the third keynote address; Young-Pil Park (center) presents the fourth keynote address; Paul R. White (bottom) presents the fifth keynote address

Professor Stuart Bolton of Purdue University, USA gave the third plenary speech titled "The reduction of tire/road interaction noise."

Professor Yong-Pil Pak of Yonsei University, Korea gave the fourth plenary presentation titled "Noise and Vibration in Information Processing Devices." He gave examples of various noise sources in information processing—such as paper feed mechanisms, printers, scanners, hard drives and optical drives, and reviewed some of the things people say about computer noise. Manufacturers, he said, are forced to reduce noise and vibration from their equipment not only because of its effect on users, but because the noise and vibration may affect the operation of the mechanism itself. He identified fan noise as the main source of noise from computers, but then turned to hard disks and optical disks as important sources of noise—not only in computers, but in many other pieces of equipment such as home electronics and communications equipment. The tendency to make this equipment smaller and smaller, he said, causes problems with key dimensions well below that of the diameter of a human hair. There are also benefits, he said, such as recording densities up by a factor of 10^4 while prices drop by a factor of 10^3 .

He then discussed analysis techniques such as sound power determination, scanning systems using sound intensity, vibration measurements using accelerometers and laser doppler vibrometers, and methods for measuring sound absorption (2-microphone method). He illustrated how sound intensity maps can be used to identify ball bearing defects in hard drives—with 5-8 dB noise reductions after control measures are introduced. He said that air flow turbulence can affect the performance of hard drives and optical drives. He discussed spindle system design and



INTER-NOISE 03 delegates are entertained by a performance on a traditional Korean stringed instrument.

touched briefly on smart spindle systems, smart isolation mounts, and piezoelectric shunts. He concluded by saying that it is very important to pay attention to noise and vibration in information processing systems not only because of annoyance to users, but because of important performance issues.

Paul White of Southampton University, UK gave the fifth keynote speech titled “Non-stationary and non-linear signal processing.” Traditional signal processing techniques, he said, depend on classical assumptions such as linearity, and stationary gaussian signals, but that modern digital signal processing techniques can remove the need for such assumptions. All real systems are non-linear, non-stationary, and non-gaussian, although the classical assumptions may be a good approximation to the real situation. He discussed complicated signals such as speech in connection with time-frequency analysis, and various models which are non-linear where filter coefficients may vary with time. He also discussed some parametric models, and their application with respect to helicopter gearbox monitoring, and finally Volterra models for weakly non-linear systems.

Professor Toshio Sone from Akita Prefectural University, Japan gave the sixth keynote speech titled “Environmental noise and personal noise exposure.” He discussed the results of several surveys taken in Japan—objective surveys to determine noise exposure in terms of 24-hour A-weighted equivalent levels and subjective



Toshio Sone presents the sixth keynote address.

surveys to determine the reaction of individuals to various sound levels and types of sound. The results include the noise exposure of workers in various occupations as well as the noise exposure as a function of the tasks performed and noise exposure as a function of means of commuting to work. The noise exposure of housewives was also studied. Then, the response of workers and residents to their acoustical environment was studied. A large fraction of the respondents were annoyed by traffic noise, and about the same fraction (60%) were just generally annoyed by environmental noise of no particular origin.

Professor Wen Bangchun from Northeast University, China gave the seventh keynote speech titled “The progress of noise control in China.” He predicted that 200 billion Yuan (about 8.2 Yuan to the U.S. dollar) is needed for control of noise in China. He said that legislation for noise control is now progressing rapidly, and that two of the “hot points” are the development of monitoring equipment and instrumentation as well as the application of new materials and structures for noise control. There are now standards in place for vehicle noise, noise around airports, and factory noise, so, he said, the basis for noise control in cities has been established. Because China is now a member of the World Trade Organization, he said, the country must get into the international track and be concerned with both product quality and environmental protection in factories.

Transportation noise, he said, is a very serious problem in China, and a “hot point” for control of vehicle noise is the design of lightweight barriers—for road vehicles as well as rail vehicles. He gave some examples of noise barriers in Chinese cities, and said that a standard for noise barrier design would soon be published.

He discussed other serious noise problems, including subway stations and ventilating



Wen Bangchun presents the seventh keynote address.

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towers, and noise from elevated trains. The latter, he said, would benefit from such technologies as floating structures, acoustical materials, barriers, and damping materials. Aircraft noise is also a serious problem in China, he said, and consideration is being given to a “polluter pays” system, which will force airlines to discontinue the use of noisy airplanes.

He recognized that noise control is required in the early stages of a design because application of techniques late in the cycle is difficult and expensive. There is, he said, a Chinese instrumentation industry, but that the equipment is not as sophisticated as that available on the international market. He said that there are noise control programs in 400 factories, and that there are 10 standards in place for measurement and assessment of facilities, but that there are still disparities relative to progress on the international level, and that facilities must be improved.

He said that there is work in China on sound absorptive materials such as micro-hole perforated plates, aluminum fiber materials, perforated plates and bonded fabrics—and work on vibration isolating materials.

The trend, he said, is for noise pollution to become the biggest environmental problem in Chinese cities, and that although there has been much hard work, many techniques applied, training available, and some progress made, much more effort to control noise is required.

The congress banquet was held in the Lotte hotel. The speeches were short and entertaining, and the quality of the Korean food was outstanding and served buffet style. The show, with traditional dances by the Kun Hee-suk Dance Team, was very much appreciated.

Professor Philip J. Morris of the Pennsylvania State University, USA gave the eighth keynote speech titled “Aeroacoustics: Classical and Modern Approaches.” He began with the notion of acoustical analogies, the idea that the equations of fluid motion can be put into the form of a linear operator (such as the wave equation) and a source term. He showed how the source term could be derived following the work of Lighthill, and how the well-known 8th power law followed from that analysis. He discussed convection effects, the contributions of other workers in the field, and gave an explanation of why, in the case of sound generation by turbulence, only a small portion of turbulent energy is actually radiated as sound.

He then discussed an alternative acoustical analogy that he and a co-author developed, which is based on the equations of motion written in terms of the velocity and the logarithm of pressure. One of the two source terms in the formulation can be thought of as a “vortex force.” He showed how this model works better than the original analogy in the prediction of far field spectral density.

He then discussed some problems in computational fluid dynamics (CFD)—a field that has grown rapidly with the availability of very fast computers. One example he gave related to predictions of landing gear noise. He then touched briefly on thermoacoustics problems before concluding with the statement that there is great potential for CFD (for both steady and unsteady flow) and acoustical methods such as acoustical analogies for noise prediction. Unfortunately, he said, this doesn’t necessarily tell one how to reduce noise.

Professor Jens Blauert of Ruhr Universität, Germany presented the final keynote speech titled “Concepts behind sound quality: some basic considerations.” He said that in 1986 he was surprised to receive an invitation to give a paper at INTER-NOISE 86 on sound quality because the subject was not thought of



Philip J. Morris (top) presents the eighth keynote address; Jens Blauert (bottom) presents the ninth keynote address.

as related to noise control engineering. However, even at that time, it was becoming clear that A-weighted sound levels were not sufficient to describe the perception of sounds. Noise is not just unwanted sound, he said, and emphasized that much of what we “hear” does not come through the ears. Psychoacoustics and an understanding of psychophysical measurements allow physical instruments to be designed to determine the “character” of sounds. This is not necessarily quality, he said because quality is related to function, and the quality of the sound of a product enables us to put a value on the character of the sound. The area of product sound quality (PSQ) shows how cognition, action, and emotion play a role in making a judgment by the user, resulting in a quality “event” as the output.

He then turned to binaural models, and how binaural activity can be used to study sound in concert halls, classrooms, and in cars—and also for speech recognition. He concluded with a simplified model of PSQ where the inputs are the character of the sound and some reference, and processing

in terms of comparison and appraisal lead to a judgment of sound quality.

The closing ceremony followed the last keynote. One of the outstanding features of the congress was the poster sessions. There were 103 papers presented in three poster sessions, and prizes for the best posters were given by Honorary Congress President Il-Whan Cha at the closing session.

A statistical overview (updated below) of the congress was given by General Secretary J.-G. Ih, and the farewell speech by Congress President Hee Joon Eun left all of the delegates with very warm feelings about the experience of attending a congress in Korea. Finally, Ondřej Jiříček Program Committee Chair for INTER-NOISE 04, representing INTER-NOISE 04 General Chair Josef Novák, invited all of the delegates to attend the 2004 congress in Prague, Czech Republic, and showed a video of the attractions in the city. The 2004 congress will be held on 2004 August 22-25.

The total attendance at the INTER-NOISE 03 Congress was 953. This included 180 exhibition-only attendees and 39 accompanying persons. There was a total of 105 sessions—including the nine keynote lecture sessions. The technical program was very well arranged by Soogab Lee.

The proceedings of the congress were published on a CD-ROM, which contains 658 technical papers. 



Honorary Congress President Il-Whan Cha, right, awards a poster prize at the INTER-NOISE 03 closing ceremony. A donation for the prizes was given by Finegold & So, consultants.

The 2004 Martin Hirschorn IAC Prize

The \$5000 Martin Hirschorn IAC Prize is made possible by a grant from the Martin Hirschorn IAC Fund established with the New York Community Trust. The grant is for a permanent endowment managed by the INCE Foundation, the income from which is used to award the prize. In 2004, the prize will be awarded for the sixth time. It will be awarded for:

The best paper on new and/or improved cost effective noise control and/or acoustical conditioning products as published in the two years preceding the award.

All papers published in *Noise Control Engineering Journal* in the years 2002 and 2003 will be considered for the prize. However, submissions from other journals are welcome, and will also be considered by the Awards Committee.

Authors who wish to submit one or more of their publications for consideration must send five copies of each paper to the address at the bottom of this announcement. The deadline for receipt of entries is 2004 April 12.

2004 Student Paper Prize Competition

Institute of Noise Control Engineering of the USA will give up to five prizes of \$1000 each at NOISE-CON 04, The 2004 National Conference on Noise Control Engineering. The conference will be held in Baltimore, Maryland on July 12-14. These awards are funded by the INCE Foundation.

INCE/USA will award up to five prizes of \$1000 each to students who are judged to have produced the best papers for the NOISE-CON 2004 Proceedings. The winning students also receive a complimentary registration for the conference. To be eligible for one of these awards, a student must:

- Obtain an entry form from the address below.
- Submit an abstract of the paper—clearly marked as an entry into the student competition. The abstract must be received no later than 2004 March 05
- Submit a paper six pages in length—clearly marked as an entry into the student competition. The paper must be received no later than 2004 March 31. Note that this is earlier than the NOISE-CON 2004 deadline for receipt of papers, 2004 April 15.

The NOISE-CON 04 Announcement and Call for Papers is on the Internet. Go to <http://www.inceusa.org>. All materials required for participation in these competitions should be submitted to:

Institute of Noise Control Engineering
Business Office
210 Marston Hall
Iowa State University
Ames, IA 50011-2153