Noise Control and Acoustics Division

NCAD NEWSLETTER

JANUARY 2007

- Stephen Hambric and Michael Jonson, Editors

IN THIS ISSUE

Report from the Chair ~ Lonny Thompson

With change comes opportunity. Your Noise Control and Acoustics Division (NCAD) is poised to take advantage of the new changes occurring within ASME. This year's 2007 International Mechanical Engineering Congress & Exposition (IMECE) will be held Nov 11 - Nov 16, 2007, in Seattle, Washington. For the first time, symposia for the 2007 IMECE program will be organized under multi-disciplinary tracks.

Our program chair, Michael L. Jonson, working with our Technical Committee members has constructed an outstanding NCAD sponsored program for 2007 IMECE which capitalizes on this new opportunity by sponsoring NCAD sessions in collaboration with three different divisions including Design, Fluid Engineering, and Non-Destructive Evaluation Divisions. This new format of co-sponsoring and collaborating with other divisions with common interests promises to enhance collaborations and increase exposure of NCAD activities across a wide group of ASME members.

To further enable our vision to encourage, focus, and further the development and application of noise control and acoustics principles to multidisciplinary engineering, ASME NCAD is collaborating with the Institute of Noise Control Engineers (INCE) to hold a joint Noise-Con 2008/ASME NCAD meeting in Dearborn, MI, in July 2008. We are fortunate to have our new Executive Committee member Stephen Hambric who will serve as a General Chair for this event. His energy and leadership is helping provide a new and important initiative for NCAD to expand our collaborations and attract new members to ASME NCAD. As a member of ASME NCAD, you can read about all upcoming activities at our website: http://divisions.asme.org/ncad. There you can also view past years' tutorials, invited lectures, and panel discussions. Passwords for the presentation slides will be resent to NCAD members in a follow-up communication to this newsletter. Other changes within NCAD are the appointment of our new Aero / Hydro Acoustics Technical Committee Chair, Brent Paul, from Alion Science and Technology, Structural Acoustics Technical Committee Chair Liang-Wu Cai, PhD, from Kansas State University, and incoming Executive Committee member Jeffrey Vipperman, Ph.D ,from University of Pittsburgh.

We are off to another great year for NCAD. I look forward to hearing from our NCAD members in the months ahead. I would like to encourage all of you to get involved and participate in your Division. Please let me or our other committee members know how we can make NCAD more responsive to your needs. If you would like to get involved, volunteer and participate in technical committees, newsletters, or any of the other many activities in our division, please contact me (lonny.thompson@ces.clemson.edu) or any one of us. You may want to participate in ASME for many reasons: knowledge gathering, evaluation of both competitors and potential partners, professional development, and networking with colleagues of similar interests. We are thankful you have chosen NCAD as a division of interest. If you haven't already, join us as your primary division during the next membership renewal. You can have a real impact on what NCAD will become in the many years ahead.

Report from IMECE 2006 ~ Michael Jonson and Joe Gavin

Dr Brigitte Schulte-Fortkamp gives a lecture on Sound Quality at the 2006 ASME IMECE

The ASME International Mechanical Engineering Congress and Exposition (ASME IMECE) was held in Chicago, 8-10 November 2006. The overall conference was well attended, but the NCAD sessions were sparsely attended at best. More readers of the newsletter are encouraged to attend future NCAD symposia such as IMECE-2007 and NoiseCon 2008.

With a broad emphasis to support the Transportation Track, we had several excellent technical papers in our conventional noise disciplines: three papers in computation (structural) acoustics, two papers in transportation noise, seven papers in flow induced noise, and three papers in advanced noise control. For our newer applications, there were seven papers on phononic crystals and five papers for sound quality. Dr. Jeff Vipperman of the University of Pittsburgh presented a very nice tutorial on adaptive filtering.

In addition to standard technical sessions, Dr. Donald Thompson of Alion Science corporation presented the Rayleigh Lecture on “The Cost of Silence.” The wine and cheese social after the presentation was well received.

Technical, executive, and general NCAD meetings were also held. To increase interest in NCAD with other divisions, NCAD members also attended the meetings of other divisions. For example, Steve Hambric, Jeff Vipperman, and Liang-Wu Cai attend the Technical Committee on Vibration and Sound (TCVS) technical meeting. As a result, several of the symposia planned for IMECE 2007 are co-sponsored by NCAD and the TCVS.

Dr. Donald Thompson gives Rayleigh Lecture

Dr. Donald Thompson has more than 40 years of research experience in hydro-acoustics. He has worked at the Penn State Applied Research Laboratory, General Dynamics/Electric Boat, and Alion Science Corp. where he has been involved with noise control for large marine systems. He has a BA in Physics from Gettysburg College, and a BS, MS, and PhD in Aerospace Engineering from Penn State University.

Dr. Michael Jonson, NCAD Executive Committee member(right), presents Dr. Donald Thompson with a plaque commemorating Thompson’s Rayleigh Lecture at ASME IMECE 2006

During his Rayleigh lecture, Dr. Thompson discussed the changing role of acoustics for large systems such as marine ships. He discussed how acoustic requirements have a large effect on system cost. The abstract for his talk is below. Dr. Thompson’s presentation materials will soon be available on the ASME NCAD website: divisions.asme.org/ncad

Cost has always been a major driver in commercial products and has become a major driver in military applications. Meeting acoustic requirements can add substantially to the cost of either commercial or military applications. Efforts must be made to contain cost while still achieving performance. Several approaches are considered herein to help achieve that objective. Quieting a particular system component usually affects other components of the system and, therefore, the overall cost. A systems approach, with a cost component, should therefore be used in the design process, especially at the concept and preliminary design stages. In addition, innovative concepts and noise mitigation strategies should be explored as ways to meet program objectives within constrained budgets. Each of these is explored herein by reviewing state-of-the-art examples of system approaches to design and by considering typical innovative approaches to concepts and noise mitigation strategies.

Dr. Jeff Vipperman gives tutorial on Adaptive Filtering and Active Noise Control

The tutorial lecture covered the basics of adaptive filtering for active noise control, including the physics feedback and feed forward control approaches, signal representations, and finite versus infinite impulse response digital filters. Several adaptive algorithms were presented and contrasted, including their stability limits and applications. Consideration was also given regarding control of harmonic, multiple-harmonic, and broadband disturbances.

Dr. Vipperman's tutorial is available on the ASME NCAD website: divisions.asme.org/ncad

---

Cyril Harris receives NCAD Per Bruel Award

*THE **PER BRUEL GOLD MEDAL** FOR NOISE CONTROL AND ACOUSTICS was established in honor of Dr. Per Bruel, who pioneered the development of sophisticated noise and vibration measuring and processing equipment. The medal recognizes eminent achievement and extraordinary merit in the field of noise control and acoustics, including useful applications of the principles of noise control and acoustics to the art and science of mechanical engineering.*

CYRIL M. HARRIS, Ph.D., Charles Batchelor professor emeritus of electrical engineering and professor emeritus of architecture, Columbia University, New York, for outstanding contributions to the acoustical design of concert halls, opera houses and theatres; and for authoring a series of seminal handbooks that provide educators and practitioners with design methods for noise and vibration control. Dr. Harris has had a distinctive career in acoustics and noise control engineering. In addition to making significant contributions to the theoretical foundation of acoustics, he demonstrated that the science of sound could be applied to cultural endeavors.

Harris joined the faculty at Columbia University, New York, in 1952 and taught courses in architectural acoustics, noise control, theoretical and experimental acoustics and the legal aspects of noise control. He is currently Charles Batchelor professor emeritus of electrical engineering and professor emeritus of architecture. Prior to his career at Columbia University, Harris was a member of the technical staff at Bell Telephone Laboratories (1945-1951), where he published numerous technical papers on room acoustics, sound absorption and acoustical impedance and co-authored his first book, Acoustical Designing in Architecture.

Over the years, Harris has been an acoustical consultant for numerous concert halls, lecture halls, opera houses and theatres including the Metropolitan Opera House in New York; the Kennedy Center for the Performing Arts and the National Academy of Sciences Auditorium in Washington, D.C.; Benaroya Hall in Seattle; Powell Symphony Hall in St. Louis; Orchestra Hall in Minneapolis; Abravanel Hall in Salt Lake City; the National Centre for the Performing Arts in Bombay, India; and the Krannert Center for the Performing Arts at the University of Illinois at Urbana- Champaign. Columbia University honored him with the Pupin Medal for Distinguished Service to the Nation (1998).

He has published many research papers in the Journal of the Acoustical Society of America and other technical journals on subjects ranging from the absorption of sound in air to the acoustical characteristics of highland bagpipes. He wrote/edited several other books including the Handbook of Acoustical Measurements and Noise Control (5th edition), the Shock and Vibration Handbook (4th edition), Noise Control in Buildings, the Illustrated Dictionary of Historic Architecture, the Dictionary of Architecture and Construction (4th edition) and American Architecture: An Illustrated Encyclopedia.

Harris is a member of the National Academy of Sciences and the National Academy of Engineering, an Honorary Member of the Seattle Symphony Orchestra and Honorary Trustee of the Saint Louis Symphony Orchestra. Harris is past president of the Acoustical Society of America, which honored him with the Sabine Medal (1979) and the Gold Medal (1987); past president of the New York Academy of Sciences, and an Honorary Member of the Audio Engineering Society. He received the city of New York Mayor's Award of Honor for Science and Technology (1985) and the American Institute of Architects AIA Medal (1980).

Anyone wishing to nominate deserving engineers for the Per Bruel award is welcome to do so by submitting the form at: http://www.asme.org/Governance/Honors/SocietyAwards/Per_Bruel_Gold_Medal_Noise.cfm

FUTURE NCAD MEETINGS ~ Michael L. Jonson, Program chair

29th Meeting of NCAD at IMECE 2007, 10-16 November 2007, Seattle, Washington

Calls for papers are listed at:
http://www.asmeconferences.org/Congress07/CallForPapers.cfm

Abstract deadline: March 5, 2007
Draft paper submission deadline: May 29, 2007
Final paper submission deadline: August 20, 2007.

The organization of the conference will be different this year. In the past, the sessions were organized by technical division however a track system will be used this time. The table below shows a link between the session title and track. The sessions will support NCAD's technical committees which include aero-hydroacoustics, structural acoustics, and active control. The integration of NCAD sessions within the varied disciplines provides greater opportunity for interaction with the other technical divisions.

We will also hold a student paper competition. Please be sure to let me know (email me at mxj6@only.arl.psu.edu) if you're a student and have submitted a paper so we can consider it in the competition.

Track	Session number and title	Collaborating Divisions / Committees	Organizer(s)
New developments in simulation methods and software for engineering applications	20-2: Computational Vibrations and Acoustics	Technical Committee on Vibration and Sound, Design Engineering Division	Frank Aldrich and Lonny Thompson
Design and Manufacturing	6-4: Design for Sound Quality	Technical Committee on Vibration and Sound, Design Engineering Division	Jie Xiao and Mae Seto
Emerging Technologies	10-3: Phononic materials and bandgap filters	Technical Committee on Vibration and Sound, Design Engineering Division	Liang-Wu Cai, Mahmoud Hussein, Jerome Vasseur
Emerging Technologies	10-6: Ultrasonic Communication	Non Destructive Evaluation Division	Henry Scarton
Advances in Aerospace Technology	2-5: Symposium on External Flow Acoustics	Fluid Engineering Division	Robert Tomko
Heat Transfer, Fluid flows, and Thermal Systems	16-36: Symposium on Turbomachinery Noise	Fluid Engineering Division	Brent Paul
Mechanical Systems and Controls	17-2: Active/passive Noise Control	Technical Committee on Vibration and Sound, Design Engineering Division	Jeff Vipperman

30th meeting of NCAD at NoiseCon 2008, 28-31 July 2008, Dearborn, Michigan
~ Stephen Hambric, program chair NCAD 2008

ASME NCAD is excited to announce our first joint meeting with the Institute of Noise Control Engineering (INCE), to be held at NoiseCon 2008. INCE is an organization of over 1000 noise control engineers, most of who work in acoustics and noise control companies throughout the United States. This joint meeting will blend the research and development work performed by ASME NCAD members with the practical noise control applications (along with other R&D) presented by INCE. We expect 150-200 papers, and 250-300 participants at the joint meeting, and welcome contributions from all NCAD members. NoiseCon will be followed immediately by a one day conference on sound quality (SQS 2008), which ASME NCAD members are also welcome to attend.

Our next newsletter will include information on scheduled symposia, a link to the conference website, and more information. If you'd like to find out now how you can help organize sessions for the joint conference, please contact Steve Hambric at sah19@only.arl.psu.edu

Emerging NCAD Areas of Interest

The field of noise control and acoustics is evolving constantly, and we've been pleased to welcome recently two new symposia topics to our NCAD meetings. Dr. Liang Wu Cai has organized sessions in the area of Phononics at the last three IMECE's, and Dr. Jie Xiao organized NCAD's first Symposium on Design for Sound Quality at IMECE 2006. Dr. Cai and Dr. Xiao have written summaries of these excited topics for this newsletter.

Are you working in an emerging noise control and acoustic area? Would you like to develop symposia in that area at future ASME NCAD meetings? If so, please contact any of the Executive Committee or Technical Committee chairs listed in this newsletter.

Symposium on Phononic Crystals Held for Third Straight Year in IMECE-2006

~ Liang-Wu Cai

The symposium on phononic crystals in last year's ASME International Mechanical Engineering Congress and Exposition, held in Chicago in November 5-10, 2006, was the third annual gathering of researchers on this emerging topic. An overview of the research topic by Dr. Manvir S. Kushwaha of University of Puebla, Mexico, one of early pioneers in the phononic crystals research, marked the opening of the symposium. Researchers from France, England, Egypt and US, including Georgia Institute of Technology, University of Colorado at Boulder, Kansas State University and University of Arizona, presented their latest research findings. In the past symposia, researches from Japan and China and other US institutions and government laboratory also presented their findings.

Phononic band gap materials, also called sonic crystals, are the mechanical equivalent of the photonic band gap materials. The mechanical waves can be elastic, acoustic or water waves. The key ingredient for these materials is an internal periodic structure typically composed of two or more distinctive materials. When a wave encounters such a structure, scattering occurs and the resulting waves scattered by different parts of the periodic structure interfere with each other. At a certain band of frequency, the interference results in a cancellation of the scattered waves, effectively making the material impassable for the wave. Such a frequency band is a "gap" in the wave transmission spectrum, hence the name of band gap material.

The band gap phenomenon was not entirely new for mechanical waves. Researchers have noticed such behavior in periodically layered structures (such as transducers) and periodically rib-stiffened shell structures in the 1970s. In 1995, a report published in the Nature magazine by researchers at the Valencia Polytechnic University, Spain, stoked the curiosity of many researchers around the world. In that report, high attenuation of sound was measured for air-borne sound propagating through a minimalist sculpture in front of the Juan March Foundation in Madrid, Spain. The sculpture contains a periodic arrangement of hollow stainless-steel cylinders fixed on a circular platform. The high attenuation was attributed to the band gap phenomenon, as the mechanical analogy to its electromagnetic counterpart. This report inspired many researchers around the world to join the exploration in the area now known as the phononic crystals.

The research community soon realized that, as solid materials have a much wider range of material properties to choose from, such band gap materials would offer a larger design space for observing the band gap phenomenon as well as to discover other possible new physics. In 2000, a research group from Hong Kong, China, reported their discovery of a new mechanism for band gap formation in the Science magazine. They fabricated a phononic crystal by casting a periodic arrangement of lead balls, coated with silicone, in an epoxy host. The new band gap formation mechanism was attributed to the local mechanical resonance of the massive lead balls inside their springy coating. The new band gap was observed in a frequency range that is one or two orders of magnitude lower than the one due to the periodic structure.

Over the past few years, other new discoveries have been made. For example, in 2002, researchers from Span

demonstrated an acoustic equivalent of an optical lens that can focus sound. In 2004, two research groups from Spain and China, respectively, demonstrated the so-called superlens effect, in which an ensemble of solid cylinders arranged in a configuration with flat surfaces has the capability to focus the wave or form an image of the source. It was believed that, under certain conditions, the effective medium possesses a negative refraction index.

During the symposium in Chicago Congress, researches presented include: efforts to design tunable phononic crystals in which the band gap can be adjusted by the user; to apply the band gap filtering for surface acoustic wave devices; and using genetic algorithms to design a device that can guide the wave through a desired passage or to split the wave based on its frequency components. Researchers envisioned that the new-found ways of controlling the propagation of mechanical waves can lead to many innovative applications, such as filter and transducer designs, sound shielding, noise control, and vibration isolation. They can also lead to developing mechanisms for protecting delicate instruments, buildings and structures from earthquake and other shocks, and battle-field soldiers from explosive blasts.

This year, the Technical Committee on Structural Acoustics of the Noise Control and Acoustics Division (NCAD) is teaming up with three other technical committees to co-sponsor the symposium on the phononic crystals. The co-sponsoring technical committees include: the Technical Committee on Vibration and Sound in the Design Engineering Division (DED), the K-8 Committee on Theory and Fundamental Research in the Heat Transfer Division (HTD), and the Technical Committee on Dynamic Responses of Materials in the Applied Mechanics Division (AMD). In addition to regular technical sessions in the symposium, the organizers have invited Dr. Jose Sanchez-Dehesa, the head of the Wave Phenomenon Group of the Nanophtonics Technology Center at Valencia Polytechnic University, Spain, and a world leading expert on phononic crystals, to give a special tutorial session to a broader audience on the latest research developments in phononic crystals. Papers dealing with band gap or other wave phenomena related to periodic structures and their applications are all invited.

For paper submission, please refer to the following web site: **www.asmeconferences.org/congress07**

First Product Sound Quality Symposium held at IMECE 2006

~ Jie Xiao

The first symposium on advances in design for product sound quality in the ASME International Mechanical Engineering Congress and Exposition was held successfully in Chicago on Nov. 10th, 2006. Engineers and researchers from industry, government research laboratories, and universities around the world shared their ideas and views on recent advances in aspects of measurement, analysis and design for product sound quality.

In recent years, industry has been raising the bar to design and manufacture products with better sound quality. The effort consists of both generating less noise levels and enhancing desirable sound quality characteristic that conveys information and/or establishes brand identity. In response to this demand, researchers have been investigating different aspects of sound quality.

The very first question researchers encountered is: What is product sound quality? There are several definitions, however, fundamental building blocks are common: sound characteristics of a product and customer's perceptual reaction to the sound. The temporal and spectral characteristics of sound are the objective side of sound quality. Investigation on quantitative measure of those properties has been carried out for decades. Matured sound quality metrics, such as sharpness, fluctuation strength, roughness, tonality and so forth, are widely adopted. On the other hand, how to measure a customer's preference is not obvious because a customer's perceptual reaction is influenced by their sociological and psychological status as well as situational factors. This complication enriches studies in this interdisciplinary research field.

Pioneering work on psychological reaction to sound can be found in the books by S. S. Stevens and E. Zwicker . In the early 1940s, Stevens founded the Psycho-Acoustic Laboratory at Harvard University. During the next 30 years, he classified the scales of measurement into the hierarchical scales, which extended

psychophysics into a sound scientific basis for the measurement of sensory and perceptual magnitude. He also proposed the power-function law to describe the relationship between perceived and physical magnitudes. The law is suitable to all 5 sensory channels, including audition. From early 1950s to late 1960s, two research groups in Germany conducted thorough investigation on psychoacoustics. Later on, it became the book, Psychoacoustics – Facts and Models by Zwicker and Fastle. The focus was on both spectral and temporal characteristics of sound as well as the property of our receiver, hearing system, for acoustical signals. Both efforts by Stevens as well as by Zwicker and Fastle set a solid foundation for today's study of product sound quality.

Understanding or characterizing product sound using objective metrics is only half of the work. Finding a good correlation between sound characteristic and customer's sensory profile is the other half. R. H. Lyon discussed generation of customer sensory profile . Wei and others shared their views on psychological methods for evaluating sound quality , . Among common methods such as unidimensional method, multidimensional analysis and etc., semantic differential method is most extensively used. Other innovative methods, like Taguchi orthogonal array and Design of Experiments (DOE), are also introduced into the field . The DOE based methods are excellent for identifying the root cause of certain features of sound, which directly benefits product design.

Overall, industry sees the importance of product sound quality in the future market. Computer simulation tools are implemented in early stage of product design cycle for better sound quality. BMW and Harley Davison are good examples of companies who use sound quality to establish their brand image , . In Japan, the noise and vibration committee of the society of automotive engineers (JSAE) has integrated sound quality into their long term road map . Their top priority is integrated design and analysis tools that can link sound quality evaluation with concrete design change. There, computer simulation plays an important role. Ford as a leader in automotive industry has paid attention in sound quality since 1990s . Virtual sound quality is the tool being developed for their computer aided design process.

In 2007, the Structural Acoustics Committee of the Noise Control and Acoustics Division (NCAD) and the Technical Committee on Vibration and Sound of the Design Engineering Division (DE) are co-sponsoring the second Symposium on Advances in Design for Product Sound Quality. Papers dealing with all aspects of sound quality are invited.

---

1. S. S. Stevens, "Psychophysics", John Wiley & Sons, 1975.
2. E. Zwicker, H. Fastl, "Psychoacoustics: fact and models", Springer-Verlag, 1990.
3. R.H. Lyon, "Product Sound Quality – from Perception to Design," Sound and Vibration, 2003, march.
4. K.C. Wei, N. C. Otto, " Engine sound quality evaluation using semantic differential method," Proceedings of the human factors society 36th Annual meeting, 1992.
5. R. Guski, "Psychological methods for evaluating sound quality and assessing acoustic information," Acustica, 83 (1997) 765-774.
6. J. IH, D. Lim, and etc., " Experimental design and assessment of product sound quality: application to a vacuum cleaner." J. of Noise Control Engineering, 51 (4) 2003, Jul-Aug. 244-252.
7. LMS, "More than a quiet Car"
8. D. Vastfjall, M. Gulbol and M. Kleiner, " Wow, what car is that?: Perception of exterior vehicle sound quality, " J. of Noise Control Engineering, 51(4), 2003, 253-261.
9. M. Ishihama, "Sound quality R&D in the Japanese automotive industry," Journal of noise control engineering, 51(4), 2003, 191-194.
10. N.C. Otto, B.J. Feng, G. H. Wakefield, "Sound quality research at Ford – past, present, and future," Sound and vibration, May, 1998, 20-24.

NCAD Information

Founded in 1979, and established as a **Division in 1981**, The Noise Control and Acoustics Division meets yearly, usually at the ASME IMECE. Our division works in noise and vibration control, using computational techniques and measurements to study complex aero-acoustic, hydro-acoustic, and structural-acoustic systems. Our symposia usually include sessions on flow-induced vibration and sound, structural acoustics, and active control. Recently, we're run successful symposia on band-gap materials (sometimes called 'phononic structures') and sound quality – see this newsletter for more on these emerging areas in NCAD.

668 ASME members list NCAD as their primary division, 631 members list NCAD as their secondary division, and NCAD has 2805 other members (3rd through 5th choices of division). NCAD is part of ASME's Environment and Transportation Group. Our website is: **http://divisions.asme.org/ncad/** The website includes past newsletters, along with selected Rayleigh lecture and tutorial presentations from past conferences.
ASME Journal of Vibration and Acoustics

Two ASME NCAD members, Jeff Vipperman and Steve Hambric, are Associate Editors for ASME's **Journal of Vibration and Acoustics**. Jeff and Steve encourage authors of well reviewed ASME NCAD conference papers to submit their work to the journal. We will work with you to minimize review times by using, as much as possible, the reviewers of the conference papers. Final papers are usually published in the journal about six months after acceptance.

Please contact Jeff or Steve if you'd like to pursue submitting your work to the journal.

Technical Committees and Chairs:

- **Flow Acoustics** – Brent Paul
- **Structural Acoustics** – Liang-Wu Cai
- **Active Control** – Jeff Vipperman

If you'd like to become involved with any of these committees and help plan future meetings, please contact the chairs.

Executive Committee Members:

Lonny Thompson, Clemson University, Vice-Chair
Joe Gavin, General Dynamics/Electric Boat, Chair
Michael Jonson, ARL/Penn State, Program Chair – NCAD 2007 meeting (at IMECE)
Stephen Hambric, ARL/Penn State, Program Chair – NCAD 2008 meeting (at NoiseCon 2008)
Jeff Vipperman, University of Pittsburgh, Member