Noise and Vibration Mitigation within the Hospital NICU for Nearby Demolition and Construction

Friday, January 19, 2007 4:00 p.m. in ETC 4.120

Jack B. Evans, P.E.
JEAcoustics
Austin, Texas
http://www.jeacoustics.com

Hospital facility modifications and additions occur frequently as demands change and increase. Existing facilities within the hospital are affected. Nursery and neonatal intensive care units (NICU) are very noise-sensitive spaces. Because they have special facilities and space is at a premium in growing hospitals, it is difficult to temporarily relocate a NICU for construction. Therefore, methods are needed to limit the impact of machine noise and impact noise from demolition and construction. The acoustical criteria within NICUs for nearby demolition and construction are no different than for normal conditions. Each high-risk infant and parents in that facility are there for only a limited time. There is no more justification for temporary exceptions to acoustical criteria than there would be for relaxation of medical privacy or facility hygiene. Comparative measurements of ambient acoustical conditions in NICU and LDR (labor, delivery, recovery) spaces will be shown for normal conditions. Measurements of noise within the NICU from simulated construction tool use at nearby locations will be shown. Conceptual means of mitigating impact and noise at demolition and construction sources, along the path between the construction zone and the NICU, and within the NICU receiver space, will be discussed.

Modeling of Human Lung Response to Low-Frequency Underwater Sound

Friday, January 26, 2007 4:00 p.m. in ETC 4.120

Dr. Mark S. Wochner
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

This work is focused on studying the dynamics of the human lung in response to low-frequency underwater sound, and predicting acoustic thresholds below which lung injury is avoided. Three models have been developed to study the lung's response to acoustic excitation. The first two models developed are lumped element systems that explicitly includƒe the effects of collagen, elastin, and pulmonary surfactant on a microscopic level. One of these algorithms, named the finite aperiodic lung model, treats the system as a finite number of alveoli and accommodates arbitrary geometries, but it is computationally intensive. The other algorithm, named the infinite periodic lung model, treats the lumped elements as an infinite periodic structure whose elastic constants can be determined efficiently. The third is a macroscopic finite element model of the entire lung that approximates lung tissue as an effective medium based on the previously determined elastic constants. Possible causes of lung damage and potential uses of the finite element model will be discussed.

Axial Fan Installation Effects

Friday, February 2, 2007 4:00 p.m. in ETC 4.120

David A. Nelson, INCE Bd. Cert., P.E.
Principal Consultant, Nelson Acoustics
Elgin, Texas
http://www.nelsonacoustical.com

Fan-cooled products often require highly constrained installations of axial fans, with the result that noise emission and airflow performance are often significantly degraded by additional backpressure and by inflow distortions. Anticipation of these effects is a critical part of the successful noise control design of a fan-cooled product. This seminar will include a review of the basics of fan noise, fan aerodynamic performance, and their relationship to fundamental design parameters, followed by a discussion of test results from four mockups of installed configurations.

Case Studies in Architectural Acoustics and Noise Control

Friday, February 9, 2007 4:00 p.m. in ETC 4.120

James Perry, Jr., Associate Principal
Cerami & Associates
New York, New York
http://www.ceramiassociates.com

Cerami & Associates is a nationally recognized firm of acoustical and audiovisual consultants with a reputation for excellence. We consult with prestigious clients on a wide variety of project types ranging from small offices to multi-million square foot buildings, from corporate to educational, hospital to hotel, and government to training centers. Our acoustical services include base building and interior acoustics, computer-modeled reverberation studies, environmental assessments and code compliance, MEP(Mechanical-Electrical-Plumbing) noise control, sound masking system design, performing arts and theater acoustics, troubleshooting, vibration analysis and control, and seismic restraint. Our presentation will include an overview of our firm and case studies for a few of our recent projects. For each type of project, we will explain the problems we typically encounter and the most effective way to mitigate problems, highlighting how to take academic principles and apply them to real-life situations. Some issues that will be discussed are vibration issues from trains and subway systems, acoustical considerations for open plan office environments, the use of floating floors, as well as environmental noise issues from mechanical equipment. Immediate career opportunities with this firm will also be discussed.

Acoustic Design in Austin, a Collaborative Process

Friday, February 16, 2007 4:00 p.m. in ETC 4.120

Mark Holden
Principal, Acoustics
JaffeHolden
Norwalk, Connecticut
http://www.jaffeholden.com

JaffeHolden has been honored to be appointed as acoustician and audio systems designers on some of the most important performance buildings in Austin. The Long Center (Palmer Auditorium), Bass Hall (UT), and Hogg Auditorium (UT) will be discussed, and images shown of renovation plans. Focus will be on the collaborative nature of the process and how teaming with users, owners, design professionals and builders can result in acoustically successful buildings.

This seminar was taped and may be viewed here:
http://coe-jaguar.engr.utexas.edu/mediasite/viewer/?peid=21feebfe-e4ed-443b-bde6-719f8b6a59e0

Biography:
Mark Holden joined JaffeHolden in 1978, he is Chairman of the firm and Director of Design, and he serves as the firm's lead architectural acoustic designer. Among his recently completed projects are: John F. Kennedy Center Opera House in Washington, D.C.; the Bass Performance Hall and Van Cliburn Recital Hall in Fort Worth, Texas; the Cirque du Soliel's Beatles LOVE show in Las Vegas; Chicago Music and Dance Theatre; Marion McCaw Performing Arts Center in Seattle, Washington; Schuster Performing Arts Center in Dayton, Ohio; RiverCenter for the Performing Arts in Columbus, Georgia; Hobby Center in Houston, Texas; and Tokyo International Forum, in Japan. Mark's work in cutting edge museums is highlighted in the Experience Music Project (Seattle, Washington), an interactive museum for contemporary music, and the National Museum of the American Indian on the Mall in Washington, D.C.

Techniques for Measuring the Acoustic Properties of Musical Instruments

Friday, February 23, 2007 4:00 p.m. in ETC 4.120

Alex Mayer
Institute for Musical Acoustics
The University of Music and Performing Arts
Vienna, Austria
http://www.bias.at/index_e.htm

The Institute for Musical Acoustics (IMA) was founded in 1980 at the University of Music and Performing Arts in Vienna with the purpose of developing objective methods for measuring the acoustic properties of musical instruments. Today the lab is home to several full-time researchers and Ph.D. students involved in studying many aspects of musical acoustics. Their work includes diverse subjects such as objective characterization of instrument sound, development of advanced simulation, measurement and optimization tools to aid instrument builders, and comparison of simulation results with subjective listening tests. Members of the lab are heavily involved with teaching, research and consulting with instrument

makers worldwide. This presentation will give an overview of the measurement and analysis methods and tools developed at the IMA. These include systems for measuring and optimizing broadband input admittance of brass and string instruments, as well as an artificial mouth capable of playing reed instruments. Several movies taken with a high speed camera and custom laser vibrometry system will also be presented, which show string and brass instrument response to a number of stimuli.

Acoustic Waves in the Universe as a Powerful Cosmological Probe

Friday, March 2, 2007 4:00 p.m. in ETC 4.120

Professor Eiichiro Komatsu
Department of Astronomy
The University of Texas at Austin
http://www.as.utexas.edu

The parameters that characterize properties of our Universe are called the “cosmological parameters.” These parameters include the age, matter and energy contents, expansion velocity, etc., of the Universe, and have been determined accurately by measuring the form of the acoustic waves propagating through the Universe when the size of the Universe was less than 1/1000 of the present size. Properties of these acoustic waves are now seen in microwaves. In this talk we will summarize how the cosmological parameters have been determined from precise measurements of waves in the microwave sky.

Micro-Ultrasound in the Land of Bioresearch

Friday, March 9, 2007 4:00 p.m. in ETC 4.120

Professor F. Stuart Foster
Department of Medical Biophysics
The University of Toronto
http://medbio.utoronto.ca/faculty/foster.html

Over the past few years biomedical applications of ultrasound have rapidly advanced. This is particularly evident in the development of high frequency micro-imaging of the mouse. The principles of this technology will be described and applications in the areas of cardiovascular and cancer research will be outlined. The development of functional imaging based on the spontaneous contrast of blood at high frequencies and on ultrahigh frame-rate retrospective imaging will be reviewed. The recent introduction of high frequency contrast agents has further expanded the potential for micro-ultrasound to perform functional and targeted imaging in disease models and interventional studies. In this presentation, the current state of the art in high frequency contrast for functional and molecular imaging of the mouse will be examined. Examples of functional imaging of inflammation, cardiovascular disease, and tumor microcirculation will be used to illustrate the potential and limitations of the current implementations. Potential for molecular imaging will be explored in a melanoma xenograft model in which the expression pattern of VEGFR-2 is studied. The current signal processing approaches rely on simple linear subtraction schemes. While simple and practical, these algorithms may not be optimal for quantitative interpretation. Performance improvements will require optimization of the microbubbles themselves, a better understanding of microbubble interactions at high frequencies in both the bound and unbound

state, and improved capabilities in nonlinear excitation and signal processing that are easily translated to commercial instrumentation. These challenges will be discussed and the future of high frequency contrast imaging will be examined.

Combined Ultrasound and Photoacoustic Imaging to Guide Photothermal Cancer Therapy

Friday, March 30, 2007 4:00 p.m. in ETC 4.120

Jignesh Shah
Department of Biomedical Engineering
The University of Texas at Austin
http://www.bme.utexas.edu

Photothermal therapy is a targeted, non-invasive alternative to surgery for cancer treatment. Photothermal therapy works on the principle of converting light energy to heat energy, causing localized tumor necrosis. However, in order to ensure successful outcome of therapy, the tumor needs to be imaged before therapy, the temperature needs to be monitored during therapy and finally, the tumor needs to be evaluated for necrosis after therapy. We propose to use ultrasound and photoacoustic imaging to guide photothermal therapy. Firstly, ultrasound can be used to identify the cancerous tissue. Additionally the photoabsorbers used during therapy provide optical contrast for photoacoustic imaging, thus aiding in tumor detection. Secondly, the temperature change can be estimated acoustically by measuring the thermally induced differential motion of speckle. The photoacoustic signal amplitude is directly proportional to temperature, and this relationship can also be utilized to measure the temperature change during therapy. Lastly, the size and location of the thermal lesion can be detected using ultrasound imaging after therapy. Thus, a combination of ultrasound and photoacoustic imaging provides both anatomical and functional information to guide and assist photothermal cancer therapy.

The Parametric Acoustic Array

Friday, April 13, 2007 4:00 p.m. in ETC 4.120

Professor Mark F. Hamilton
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

The parametric acoustic array has been the most intensively studied technological application of nonlinear acoustics. Its underlying physical principle is the nonlinear conversion of acoustic energy from high to low frequencies. Hallmarks of the parametric array are its narrow beam, low sidelobe levels, and wide bandwidth. The parametric array was predicted theoretically by Professor Peter Westervelt at Brown University in 1960. After Professor Orhan Berktay at University of Birmingham, in the mid 1960s, described applications to exploit Westervelt's basic theory, the potential for novel sonar systems became readily apparent around the world. Over the next two decades, the Applied Research Laboratories at UT was a leader in the development of the parametric array. During this period, ARL demonstrated

experimentally that the parametric array works in air as well as water, thus raising the possibility of applying the technology to highly directional audio transmitters. Audio applications had to await the 1990s, when acoustic transducers could be fabricated that were capable of generating sufficiently intense ultrasound in air. Today the parametric array is manufactured commercially for audio applications ranging from museums to automobiles. One of these commercial devices will be demonstrated at the seminar. The seminar will also review the history and theory behind the parametric array, and it will describe a current DARPA project involving ARL and Stanford University in which MEMS transducers are incorporated for novel applications of the parametric array.

Acoustical and Ocular Human Effects Analysis of Flashbang Devices

Friday, April 27, 2007 4:00 p.m. in ETC 4.120

James Parker
General Dynamics
San Antonio, Texas
http://www.generaldynamics.com

Flashbang devices are designed to startle, distract, and/or warn an individual or group of individuals through the use of a bright flash and loud bang. In order to quantitatively compare the effectiveness of various devices, the physical parameters that characterize a flashbang device need to be mapped into hazard and effectiveness metrics pertinent to humans. This seminar will outline the measurement suite used to characterize the physical parameters of interest, and the modeling efforts used to map the physical parameters into physiological metrics. A majority of the talk will highlight acoustical effects, but will also discuss optical, thermal and blast effects.

Penetrating Bubble Clouds Acoustically with Dolphin-like Signals

Friday, September 7, 2007 4:00 p.m. in ETC 4.120

Daniel Finfer
Institute of Sound and Vibration Research
University of Southampton
Southampton, Hampshire, United Kingdom
http://www.isvr.soton.ac.uk

Man-made active sonar does not operate well in bubbly water. However some acoustically-active dolphins and porpoises are able to compete effectively in bubbly, shallow, coastal waters. Possible physics solutions to target detection in bubbly water are proposed, and the validities of such proposed acoustical solutions are explored through theory, simulation and experimentation. Whether the solutions are exploited by cetaceans is uncertain, but their efficacy in test tanks and implications for man-made sonar are demonstrated.

Employing Engineering Design Constructs to Improve Acoustic Material Performance

Friday, September 14, 2007 4:00 p.m. in ETC 4.120

Dr. Mike Haberman
Applied Research Laboratories
The University of Texas at Austin
http://www.arlut.utexas.edu

Recent research in the material sciences has focused an enormous effort on leveraging new technologies and computational power to create designer materials. The associated field of study, called materials design, is a science that attempts to create materials to meet specific demands of a given application (shock, fatigue, thermal stresses, etc). This seminar presents an attempt to employ materials design concepts for the design of materials to meet specific acoustic performance goals. The approach employs traditional engineering design constructs and optimization algorithms paired with detailed multiscale material models. The strength of this methodology is displayed through an example of an automobile windshield design that considers the influence of the material microstructure on sound transmission. The design scheme integrates a quasi-static self- consistent micromechanical model into a Compromise Decision Support Protocol (CDSP) to explore the microstructural design space of the constituent materials of an automobile windshield. The results yield insight into unexpected microscale material behavior which leads to highly attenuating macroscopic behavior. Design space exploration results and implications for the future of highly absorptive materials are discussed. The seminar concludes with a discussion of the applicability of this methodology for the design of several other types of acoustic materials.

Acoustic Piezoelectric Transducers

Wednesday, September 19, 2007 4:00 p.m. in ETC 4.120

Dr. Fernando Garcia-Osuna
Sugar Land Technology Center
Schlumberger Corporation
http://www.slb.com

Acoustic piezoelectric transducers are widely used in the medical, oil, gas, automotive, audio, NDT, and underwater applications. This talk describes the basic and fundamental science of piezoelectric materials and transducers to generate and detect sound in borehole measurements and NDT applications. Recent developments of piezoelectric ceramics, crystals, and multilayer components to replace the popular Lead Zirconate Titanate (PZT) material will be discussed.

Laser Vibrometry: An Introduction to Non-Contact Vibration Measurement

Friday, September 28, 2007 4:00 p.m. in ETC 4.120

Dr. Vikrant Palan
Polytec Incorporated
Tustin, CA
http://www.polytec.com/usa/default.asp

Laser Doppler vibrometry has come a long way since its conception in early 1970s. It is now widely used for non-contact and non-invasive vibration characterization of micro-, macro and meso-structures. Some of the applications where non-contact measurement methods become indispensable are vibration analysis of light structures (due to mass loading), hot surfaces, rotating structures, long range surveillance and submerged part testing. A laser Doppler vibrometer (LDV) is a non-contact velocity and/or displacement sensor that is used to measure magnitude and frequency content of the structure under test. Laser vibrometers are very sensitive optical instruments capable of measuring sub-picometer displacements from quasi-DC to several MHz. Because of the wide amplitude and frequency range, laser Doppler vibrometers are used in various industries such as automotive, aerospace, data storage, medical and production testing to name a few. The following topics will be covered: 1) Introduction to different vibrometer designs. 2) Typical components of a vibrometer system. 3) Applications-based case studies including ODS analysis of a motherboard, vibration testing of hard-drive housing, full-field vibration analysis on a Volkswagen Passat, vibration characterization of a comb drive, and design optimization of an acoustic transducer (under water).

Mathematical Models of Sand

Friday, October 12, 2007 4:00 p.m. in ETC 4.120

Professor Charles Radin
Department of Mathematics
The University of Texas at Austin
http://www.ma.utexas.edu/dev/math/index.html

Sand exhibits some unusual mechanical properties, for instance: dilatancy, the Janssen effect and random close packing. Attempts to develop a theory to explain such behavior usually begin with analyses of dense packings of large numbers of spheres. I will discuss this effort, which is still at an immature stage, and its relation to recent experiments performed in the Swinney laboratory at UT (Center for Nonlinear Dynamics, http://www.ma.utexas.edu/dev/math/index.html).

Intravascular Photoacoustic Imaging

Friday, October 19, 2007 4:00 p.m. in ETC 4.120

Bo Wang
Department of Biomedical Engineering
The University of Texas at Austin
http://www.bme.utexas.edu

Intravascular photoacoustic (IVPA) imaging has the potential to characterize atherosclerosis based on the optical absorption differences of various tissue types. Combined intravascular ultrasound (IVUS) and IVPA imaging can visualize both the structure and composition of atherosclerotic lesions needed to detect vulnerable plaques. Previously, we designed and built a combined IVUS/IVPA imaging system and tested the developed imaging system using tissue-mimicking phantoms and ex-vivo rabbit arteries. The IVPA imaging of molecular or cellular specific components of the plaques can be further enhanced by introducing plasmonic nanoparticles as contrast agents. IVUS and IVPA imaging was performed on phantoms containing either nanoparticles only or murine macrophages loaded with gold nanoparticles. The results of our recent studies suggest that IVPA imaging is capable of imaging gold nanoparticles in tissue. Furthermore, IVPA images at multiple optical wavelengths can distinguish aggregated nanoparticles thus allowing to specifically enhance the contrast in IVPA images to selective identify the targeted components in the arterial tissue and vulnerable plaques.

Case Studies in Architectural Acoustics and Noise Control

Friday, October 26, 2007 4:00 p.m. in ETC 4.120

James Perry
Cerami & Associates
New York, New York
http://www.ceramiassociates.com

Cerami & Associates is a nationally recognized firm of acoustical and audiovisual consultants with a reputation for excellence. We consult with prestigious clients on a wide variety of project types ranging from small offices to multi-million square foot buildings, from corporate to educational, hospital to hotel, and government to training centers. Our acoustical services include base building and interior acoustics, computer-modeled reverberation studies, environmental assessments and code compliance, MEP (Mechanical-Electrical-Plumbing) noise control, sound masking system design, performing arts and theater acoustics, troubleshooting, vibration analysis and control, and seismic restraint. Our presentation will include an overview of our firm and case studies for a few of our recent projects. For each type of project, we will explain the problems we typically encounter and the most effective way to mitigate problems, highlighting how to take academic principles and apply them to real-life situations. Some issues that will be discussed are vibration issues from trains and subway systems, acoustical considerations for open plan office environments, the use of floating floors, as well as environmental noise issues from mechanical equipment. Immediate career opportunities with this firm will also be discussed.

Wind Turbine Noise: Achieving Realistic Expectations

Friday, November 2, 2007 4:00 p.m.

David A. Nelson, INCE Bd. Cert., P.E.
Nelson Acoustics
Elgin, Texas
http://www.nelsonacoustical.com

Texas currently produces about one quarter of the US's 12.6 GW of wind-generated electricity. Wind power development is currently concentrated in remote areas of West Texas where noise impacts on communities are typically minimal. Preparations are being made however to bring an additional 25 GW of wind power onto the grid over the next decade or so. Therefore it seems likely that future wind parks will gradually find themselves closer to residences and communities. Realistic expectations regarding noise impact are a critical part of successful wind turbine siting; unrealistic expectations can lead to significant conflict in current installations and jeopardize community acceptance of future projects. The true noise impact of wind turbines may be difficult to assess because of the use of A-weighted criterion sound levels and long-term averages, the prevalence of large wind shear gradients, unfavorable nighttime propagation characteristics, and some potentially troublesome perceptual characteristics. A general overview of wind turbine noise and recent developments in the field will be presented. Recently published work regarding the use of sound quality concepts to improve the assessment of ambient masking of wind turbine noise will also be demonstrated. This work shows that comparing sounds based on their A-weighted levels may reveal little about the extent to which one masks the other.

Imaging of Iron Oxide Nanocomposites Using Magneto-Motive Ultrasound

Friday, November 9, 2007 4:00 p.m.

Mohammad Mehrmohammadi and Jung Hwan Oh
Department of Biomedical Engineering
The University of Texas at Austin
http://www.bme.utexas.edu

With the development of targeted ultrasound contrast agents including microbubbles, liposomes, and perfluorocarbon particles, the role of ultrasound in molecular and cellular imaging has been redefined. Generally, nanoscale particles are required to achieve pathology- specific imaging with high sensitivity. Unfortunately, the echogenicity of small particles in tissue is too weak to be imaged directly. We have developed an ultrasound imaging method capable of detection of iron oxide nanocomposites. This so-called magneto-motive ultrasound imaging is based on ultrasound detection of motion in tissue that contains nanoparticles and is subjected to a time-varying magnetic field. Phantom cells and tissue experiments were performed using superparamagnetic iron oxide (SPIO) nanoparticles. In phantom studies, cylindrical inclusions with various concentrations of nanoparticles were embedded into an otherwise homogenous background. Silica particles were added to act as ultrasonic scatterers. In ex- vivo tissue studies, small animals were injected with different concentrations of unlabelled and targeted nanoparticles and, after some circulation time, the liver and other organs were excised and imaged. To induce motion, the specimens were exposed to harmonic magnetic fields. Ultrasound images of the tissue were obtained using either a linear transducer array or single element transducers. The induced tissue

motion was detected using various quantitative and qualitative techniques including cross correlation, Doppler ultrasound, and color/power Doppler.

Characteristics and Applications of Sonoluminescence Phenomena

Friday, November 16, 2007 4:00 p.m.

Dr. Ho-Young Kwak
Chung-Ang University
Seoul, Korea
http://www.cau.ac.kr/english

Sonoluminescence (SL) is the light emission associated with the catastrophic collapse of a micro bubble oscillating in an ultrasonic field. However, the exact mechanism of the light emission, which is characterized by picosecond flashes of continuous spectrum, has not been identified. Thermal blackbody and/or bremsstrahlung radiation are possible origins. SL characteristics from a single bubble such as pulse shape, spectrum radiance from micro and submicron bubbles in water and a new paradigm of SL, which displays alternating pattern of on/off luminescence pulses in sulfuric acid solutions will be discussed, along with our hydrodynamic model. Molecular dynamics (MD) simulations of a collapsing microbubble in sulfuric acid solutions and a submicron bubble in water are discussed and the simulation results are compared with theoretical results, which are in good agreement with observations. Syntheses of specialty nanoparticles such as ZnO powder used as reinforcing filler for elastomer, various core/shell type nanocrystals such as ZnO and ZnS-coated TiO2 nanoparticles, which are likely to be useful for dye-sensitized solar cells and LTO (Li4Ti5O12) used as an anode materials for rechargeable lithium batteries at the multi-bubble sonoluminescence condition are also discussed.

Diffraction of Waves on Periodical Structures: Acoustic, Ultrasonic and Acousto-Optical Diffraction Phenomena

Monday, December 3, 2007 4:00 p.m.

Professor Nico F. Declercq
Georgia Institute of Technology
Atlanta, GA, USA
http://www.me.gatech.edu
and
Georgia Tech Lorraine
Laboratory for Ultrasonic Nondestructive Evaluation
Metz-Technopole, France
http://www.georgiatech-metz.fr

Diffraction effects, caused by the interaction of sound with periodical structures, occur in many fields of acoustics. In ultrasonics those effects are often used to generate surface acoustic waves. Understanding of the cause of some of the phenomena that occur is only possible by incorporation of complex analysis, physics and mechanics. Apart from the many points of interests in ultrasonics, diffraction effects also occur in audible acoustics. They are responsible for the Quetzal chirp at the El Castillo pyramid in Chichen Itza in Mexico. Recently this historical site has been named one of the new 7 wonders of the world. But also Greek and Roman theaters exhibit acoustic diffraction effects. The Hellenistic theater of Epidaurus, on the Peloponnese in Greece, attracts thousands of visitors every year who are all amazed by the fact that sound coming from the middle of the theater reaches the outer seats, apparently without too much loss of intensity. The theater, renown for its extraordinary acoustics, is one of the best conserved of its kind in the world. It was used for musical and poetical contests and theatrical performances. It has been shown recently that the seat rows of the theater, unexpectedly play an essential role in the acoustics, at least when the theater is not fully filled with spectators. The seats, which constitute a corrugated surface, serve as an acoustic filter that passes sound coming from the stage at the expense of surrounding acoustic noise. Understanding and application of corrugated surfaces as filters rather than merely as diffuse scatterers of sound, may become imperative in the future design of modern theaters.