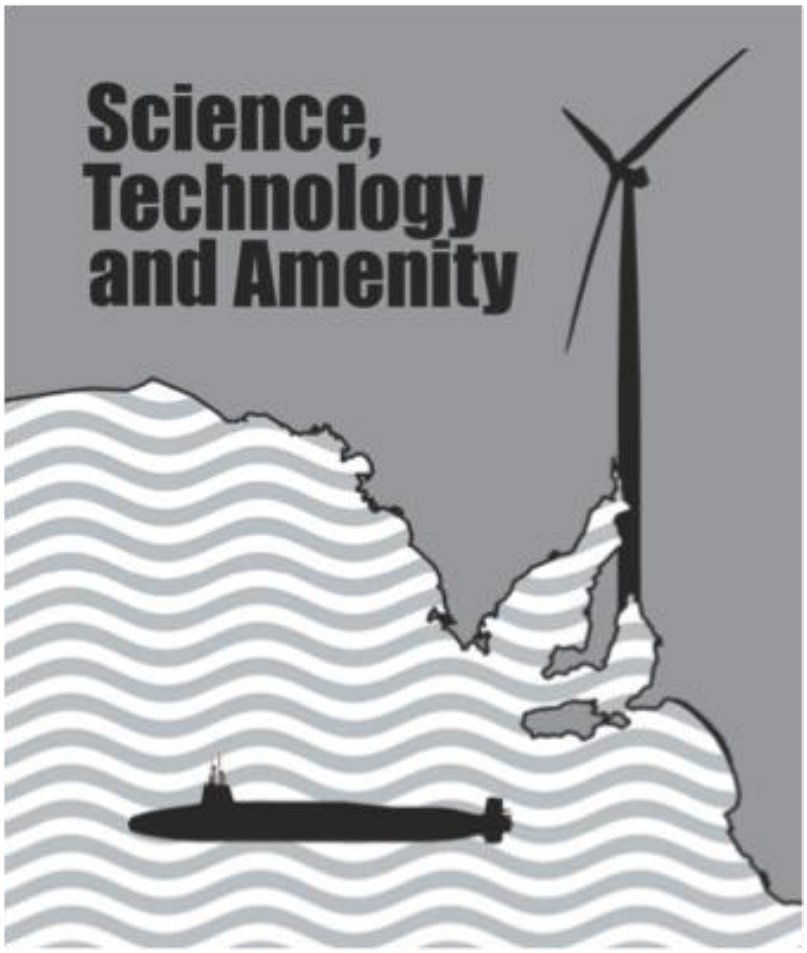
ACOUSTICS 2013 VICTOR HARBOR

Science, Technology and Amenity

VICTOR HARBOR, SOUTH AUSTRALIA
NOVEMBER 17-20, 2013

The 2013 Conference of the Australian Acoustical Society

Program and Book of Abstracts



McCracken Country Club, Victor Harbor

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Program Summary

Monday 18th November 2013

Time	Room A	Room B
8:00	**Conference Registration (Convention Centre Foyer)**	
8:40	**Conference Opening**	
9:00	Session 1: Identifying and meeting new challenges in shallow-water acoustics Chair: Dr Adrian Jones	
9:45	Session 2: Legislation and Standards Chair: Peter Heinze	
10:25	**Morning Tea (Exhibition Area and Foyers)**	
10:50	Session 3A: Industrial Acoustics Chair: Dr Zebb Prime	Session 3B: Underwater Acoustics Sensors Chair: Dr Alex Zinoviev
12:30	**Lunch (Exhibition Area and Foyer)**	
13:30	Session 4A: Transportation Noise 1 Chair: Dr Valeri Lenchine	Session 4B: Vibration 1 Chair: A/Prof Nicole Kessissoglou
15:10	**Afternoon Tea (Exhibition Area and Foyers)**	
15:40	Session 5A: Architectural and Building Acoustics Chair: Dr Luke Zoontjens	Session 5B: Instrumentation Chair: Dr Carl Howard
17:30	**Australian Acoustical Society AGM**	
19:00	**Conference Dinner (Currency Creek Winery)**	

Tuesday 19th November 2013

Time	Room A	Room B
8:40	Session 1: Wind turbine noise: an overview of acoustical performance and effects on residents Chair: Dr Norm Broner	
9:25	Session 2: Human Response Chair: Prof Lex Brown	
10:25	**Morning Tea (Exhibition Area and Foyers)**	
10:50	Session 3A: Wind Turbine Noise 1 Chair: Dr Norm Broner	Session 3B: Underwater Acoustic Modeling Chair: Dr Adrian Jones
12:30	**Lunch (Exhibition Area and Foyer)**	
13:30	Session 4A: Wind Turbine Noise 2 Chair: Jon Cooper	Session 4B: Underwater Acoustics 1 Chair: Dr Laura Brooks
15:10	**Afternoon Tea (Exhibition Area and Foyers)**	
15:40	Session 5A: Environmental Acoustics Chair: Marion Burgess	Session 5B: Underwater Acoustics 2 Chair: Dr Alec Duncan
17:20	**End of Day 2 Sessions Free Time**	
17:30	Australian Educators in Acoustics Inaugural Meeting	

Wednesday 20th November 2013

Time	Room A	Room B
8:40	Session 1A: Aeroacoustics Chair: A/Prof Con Doolan	Session 1B: Vibration 2 Chair: Byron Martin
10:20	**Morning Tea (Exhibition Area and Foyers)**	
10:50	Session 2A: Transportation Noise 2 Chair: Darren Jurevicius	Session 2B: Miscellaneous Chair: A/Prof Ben Cazzolato
12:30	**Lunch (Exhibition Area and Foyer)**	
13:30	**Conference Close**	

Contents

Session 1 Rooms A and B Monday: Identifying and meeting new challenges in shallow-water acoustics

36 Plenary Presentation: Identifying and meeting new challenges in shallow-water acoustics

Duda, Timothy
Applied Ocean Physics and Engineering Dept, Woods Hole Oceanographic Institution, Woods Hole, MA USA

ABSTRACT
The past two decades have seen steady progress in understanding ocean acoustic effects, including some that are perhaps unique to the outer continental shelf. Progress has come from improved measurements, improved computational modelling, rapidly accumulating theoretical explanations, and the synthesis of these. The improved knowledge presents a new challenge, from an acoustics standpoint, to move beyond treating the ocean as containing slowly evolving but perhaps knowable synoptic features along with unknowable details at smaller scale, and to instead treat the small scales as predictable, to a degree. Another challenge regards how to incorporate the added information into systems. The over-arching challenge is determining how best to apply our new knowledge. The community is addressing the stated challenge of making higher-fidelity predictions of sound propagation conditions by moving towards jointly modelling recently investigated acoustically important small-scale ocean features and phenomenon, and their precise acoustic effects, using coupled computational models.

Session 2 Rooms A and B Monday: Legislation and Standards

39 "A-Weighting": Is it the metric you think it is?

McMinn, Terrance
Curtin University of Technology

ABSTRACT
It is the generally accepted view that the "A-Weighting" (dBA) curve mimics human hearing to measure relative loudness. However it is not widely appreciated that the "A-Weighting" curve lacks validity especially at low frequencies (below 100 Hz) and for sounds above 60 dB. Research in the field of equal loudness has progressed and redefined the shape of the original 40 phon Munson and Fletcher equal loudness curves. Unfortunately, the "A-Weighting" curve has not been revised in the light of this research or ISO 226. This paper highlights some of the changes in the research and problems identified with "A-Weighting" as it has come into current usage.

104 Regulating the control of external noise for new residential development: a South Australian perspective

Jurevicius, Darren
AECOM Australia Pty Ltd, Level 28, 91 King William Street, Adelaide SA 5000

ABSTRACT
Over recent years, a number of councils and State Governments have become aware of complaints in relation to external noise intruding into residential buildings (ABCB 2013). To be most effective however, mitigating external noise for new residential development requires a multifaceted approach that encompasses both the planning and building rules aspects of a development approval process. This paper presents a South Australian perspective of its recently adopted external noise regulation, and outlines the thinking behind the innovations that were developed to enable this multifaceted approach. It may assist other jurisdictions with their approach to managing similar issues. This paper covers aspects related to road and rail noise. It does not cover noise from mixed use development.

Session 3 Room A Monday: Industrial Acoustics

10 The noise of cloud computing

Kochanowski, Radek
Aurecon, Sydney, Australia

ABSTRACT
With Cloud computing and Cloud data storage being sold as the way of the future for storing and accessing our digital information, we are seeing an increase in data centre developments in metropolitan areas throughout the world. However, given their complex building services' and high power requirements, there is potential for significant noise emissions to impact the surrounding area. This paper explores the operational noise emission challenges associated with designing acoustically sound data centres and draws on recent project experience from the development of new data centres in Australia's major cities. Included in the discussion are various power and cooling options, unique noise emitting equipment, building layouts, types of operation and rigorous testing schedules, all of which can significantly affect the environmental noise impact assessment of sensitive receivers in the vicinity of the centre.

14 Prediction of radiated sound power from vibrating structures using the surface contribution method

Peters, Herwig (1); Kessissoglou, Nicole (1); Lösche, Eric (2); Marburg, Steffen (3)
(1) School of Mechanical and Manufacturing Engineering, The University of New South Wales, Sydney, Australia
(2) MTU Friedrichshafen GmbH, Friedrichshafen, Germany
(3) LRT4 – Institute of Mechanics, Universitat der Bundeswehr Munchen, Neubiberg, Germany

ABSTRACT
A common measure for near-field acoustic energy of a vibrating structure is the acoustic intensity, which usually has positive and negative values that correspond to energy sources and

sinks on the surface of the radiating structure. Sound from source and sink areas partially cancel each other and only a fraction of the near-field acoustic energy reaches the far-field. In this paper, an alternative method to identify the surface areas of a vibrating structure that contribute to the radiated sound power is described. The surface contributions of the structure are based on the acoustic radiation modes and are computed for all boundaries of the acoustic domain. In contrast to the sound intensity, the surface contributions are always positive and no cancellation effects exist. To illustrate the method, the radiated sound power from a resonator is presented

51 **Use of noise cancelling headphones to assist recall of spoken information in noisy environments**

Burgess, Marion (1); Molesworth, Brett (2)
(1) School of Engineering and Information Technology, The University of New South Wales, Canberra, 2600, ACT, Australia
(2) School of Aviation, The University of New South Wales, 2052, Sydney, Australia

ABSTRACT
The need to hear, comprehend and be able to recall spoken information can exist in less than ideal listening conditions. Such a situation occurs within an aircraft cabin where, despite improvements in modern passenger aircraft, the acoustic properties of the cabin are less than ideal for understanding speech. It is important that passengers, who are untrained and or new to the environment, hear on-board safety announcements such as the preflight safety brief and recall this information in an emergency situation. The benefits of headphones that incorporate active noise control in such environments are the focus of a series of research studies. In this paper, we discuss the techniques developed to investigate if the use of active noise control headphones can improve the recall of speech in a noisy environment similar to that in a commercial aircraft cabin. The initial studies reflected favourably on the use of active noise control headphones under such condition which has led to a series of additional studies investigating their use under different auditory conditions such as with dual masking (i.e., noise and music) and for English second language speakers as well as seeking a comparable marker to demonstrate the effects of such noise on recall.

71 **Transmission matrix model of a quarter-wave-tube with gas temperature gradients**

Howard, Carl
School of Mechanical Engineering, University of Adelaide, South Australia, Australia

ABSTRACT
A transmission matrix (also known as four pole) model is presented of a duct with anechoic terminations and a quarter-wave-tube, where each duct segment has a linear temperature gradient. The results from simulations conducted using the mathematical model show good agreement with results from finite element simulations using Ansys. Expressions are derived for the four pole analysis method that are relevant when conducting finite element simulations where an incident acoustic particle velocity is specified as the excitation source. A static thermal finite element analysis is conducted using thermal solid elements to determine the nodal temperatures. The nodal temperatures are transferred to the nodes of the acoustic elements and a harmonic analysis is conducted to determine the pressure within the duct

105 **Material property detection by mining pick resonance**

Marston, Brian
Tangential Technologies Pty Ltd, Sydney Australia

ABSTRACT
The characteristics of geological materials being mined can be determined from the audible acoustic response of the picks on the cutting head of the mining machinery. Research has indicated that a simple adaption of existing sound measurement equipment could provide miners with feedback on the hardness and rip ability of the material beingmined. This would provide the mining personnel with a non-intrusive device providing immediate feedback on hard-ness variation allowing the mining personnel to modify their operations accordingly. It has been described as the finalstep to full automation.

Session 3 Room B Monday: Underwater Acoustics Sensors

21 **Keynote Presentation: Australian sonar transducer technology**

Bedwell, Ian
Thales Underwater Systems, Thales Australia, Rydalmere, NSW, Australia

ABSTRACT
Australia is a vast island nation in an increasingly more interesting part of the world. Naval capability is paramount to our defence and economic wellbeing. Of utmost importance to any navy is an effective sonar solution for the myriad of situations that confront them. This paper presents a brief overview of the suit of sonars that a modern defence force uses, including submarine, surface ship, mine-hunting, sonobuoys and fixed arrays. In this paper I will outline some new developments in sonar technology namely the development of fibre laser sensors in collaboration with DSTO and the emergence and implications of the new relaxor single-crystal ferroelectrics that have recently become available

73 **The effect of polyurethane encapsulant on the response of PVDF hydrophones in the frequency range from 30 kHz to 100 kHz.**

Munyard, Andrew (1); Matthews, Dave (1); Killeen, Damien (1)
(1) MD, Defence Science and Technology Organisation, HMAS Stirling, Western Australia

ABSTRACT
PVDF has many properties that make it attractive for use as an underwater sensor and a number of groups have reported on such work. In order to use such sensors it is necessary to encapsulate the piezoelectric material in polyurethane for waterproofing. In terms of ceramic sensors the ceramic itself acts as the acoustic pickup and it is desirable to have a polyurethane encapsulant with an acoustic impedance close to that of water. PVDF however has an acoustic impedance similar to water and consequently the coupling of sound into the PVDF is via the encapsulantor the supporting substrate. In order to fully understand and model the PVDF sensor performance it is

therefore necessary to have a detailed knowledge of the physical properties of the polyurethane encapsulant. However, in our experience, obtaining such information for various commercially available polyurethanes has proven very difficult. This paper reports on the fabrication and characterisation of thin film and coaxial PVDF encapsulated in a Scorpion polyurethane. The effect of the polyurethane on the sensit ivity and directivity of various sensors will be discussed.

77 **Fibre optic towed array: the high tech compact solution for naval warfare**

Souto, Fabio
Maritime & Aerospace, Thales, Rydalmere NSW, Australia

ABSTRACT
High performance lightweight towed arrays can offer significant defence capability benefits when applied to future defence programs. A thin lightweight Fibre Optic Towed Array (FOTA) system was developed by applying the electro-optic (EO) hydrophone technology successfully developed for previous sea bed array demonstrator systems. In early 2013, a FOTA prototype was built and demonstrated in a meaningful environment showing comparable performance with existing towed array systems. The target FOTA product configuration would be similar to existing submarine towed array systems, but thinner and more compact, easing the overall submarine design challenge. The development of FOTA also serves to strengthen the Priority Industry Capability (PIC) of "Acoustic Technologies & Systems", identified by Defence as a capability to be nurtured in the Australian industry context. This paper outlines the advantages of this specific fibre optic towed array technology and identify key actions required to nurture this PIC for the continued self-reliance of the ADF operational capability.

102 **A fibre laser sensor seabed array**

Foster, Scott (1); Tikhomirov, Alexei (1); Harrison, Joanne (1); van Velzen, John (1)
(1) Maritime Division, Defence Science and Technology Organisation, Edinburgh, Australia

ABSTRACT
We have developed an 8-element fibre laser seabed array demonstrating state-of-theart performance characteristics for a fibre laser sensing system and highlighting the potential capability advantage this technology provides in the underwater sensing domain. The system employs sea-state-zero sensitivity hydrophones with a flat acoustic response over a bandwidth exceeding 5kHz and very low inertial sensitivity. Each hydrophone is pressure compensated to an ocean depth exceeding 80m. The system contains no outboard electronics and virtually no metalcomponents making it extremely light, compact, and low complexity. The array may be deployed up to 4 km from a land or sea based platform. Power is delivered optically via a single 2mm diameter optical fibre lead weighing less than 5kg per km. The same optical fibre also serves as the telemetry link to relay full bandwidth data from all 8 sensors back to the platform.

103 **An initial assessment of effects of seafloor roughness on coherent sound reflection from the seafloor**

Jones, Adrian (1); Duncan, Alec (2); Maggi, Amos (2)
(1) Defence Science and Technology Organisation, P.O. Box 1500, Edinburgh, SA 5111, Australia
(2) Centre for Marine Science & Technology, Curtin University of Technology, GPO Box U1987, Perth WA 6845, Australia

ABSTRACT
A roughened seafloor may be expected to scatter incident sound at non-specular angles, but also to reflect coherently at the specular angle, with some loss of amplitude attri buted to the scattering and some loss attributed to sound transmission into, and absorption within, the seafloor. Our in itial expectation was that a reasonable estimation of the total coherent reflection loss, at a given grazing angle, might be obtained simply from a combination of the loss attributed to a flat seafloor based on its geoacoustic properties, and the separate coherent loss due to the roughness scattering described for a pressure release surface. To test this hypothesis, loss values obtained using this simple additionof model outputs were produced for several seafloor material types with prescribed roughness profiles. These results are compared with loss values obtained using the perturbation approach for rough surface scattering from stratified media described by Kuperman and Schmidt (JASA, 86, Oct. 1989). The latter is a model which describes the coherent plane wave reflection from a rough surface of stratified material which has specified geoacoustic properties.

Session 4 Room A Monday: Transportation Noise 1

1 **Noise reduction and energy savings of standard sound insulation packages for the control of road traffic noise**

Huygregts, Neil (1); Morphett, Adrian (2); McIntosh, James (3)
(1) Marshall Day Acoustics Pty Ltd, Collingwood, Victoria, Australia
(2) Earth Systems, Kew, Victoria, Australia
(3) VicRoads, Camberwell, Victoria, Australia

ABSTRACT
Sound insulation of noise-sensitive buildings is a common means of mitigating road traffic noise. Methods for selecting appropriate sound insulation measures varies, with some Australian States requiring compliance with Australian Standard AS2107 or other internal noise criteria. An alternative used in some States is to specify standard packages of sound insulation measures based on external noise levels; noise-sensitive buildings (usually dwellings) exposed to higher external noise levels are required to have measures with higher noise reduction ratings incorporated into the building facade. VicRoads recently commissioned Marshall Day Acoustics and Earth Systems to undertake a study that broadly reviewed practises in some other Australian States; investigated the noise reduction achieved by a range of standard packages for both existing dwellings and, in the case of new residential estates near existing roads, new dwellings; and estimated the energy savings attributable to the standard packages.

8 **Issues in the measurement of sleep-related noise events in road traffic streams**

Brown, A.L.
Urban Research Programme, Griffith School of Environment, Griffith University, Brisbane, Australia

ABSTRACT
The sleep literature reports that integrated measures of road traffic noise levels by themselves (eg Lnight) do not account for all of the observable effects of traffic noise on human sleep, and that level and numbers of noise events in road traffic streams need to be measured. Each of the END and the Night Noise Guidelines for Europe refer to both integrated energy descriptors and noise event descriptors as measures relevant to assessment of human sleep disturbance. At Griffith University we are investigating the occurrence and nature of noise events arising from road traffic streams. Here we examine, based on the literature of experimental and field sleep disturbance studies of road traffic noise, the noise event stimuli utilised in that sleep research. While the notion of an "event" in a noise stream is conceptually unambiguous, there are issues with the application of the noise event concept to streams of road traffic noise, vis-à-vis air and rail traffic noise, that need further consideration.

9 **Response to change in noise exposure: an update**

van Kamp, Irene (1); Brown, A.L. (2)
(1) Netherlands Institute of Public Health and the Environment, Centre for Sustainability, Environment and Health, Bilthoven, Netherlands
(2) Griffith School of Environment, Urban Research Programme, Griffith University, Brisbane, Australia

ABSTRACT
Environmental appraisals of transport infrastructure plans are generally conducted in situations where there will be an abrupt change in noise exposure. In 2009 we reviewed the literature on response to step changes in exposure. The weight of evidence was that for road traffic studies with changes in exposure, there is a change effect in addition to an exposure effect. In a subsequent paper we cataloged and reviewed the different explanations for this excess reaction to change. This paper provides a partial update of the two reviews by considering more recent change studies. The focus is on further evidence for the existence of the change effect and its explanations. Also, while the focus of our earlier reviews was on adverse effects of the acoustic environment, here we extend the concepts to include community response to changes in the acoustic environment resulting from measures designed to enhance positive experiences (e.g. soundscaping projects).

16 **A practical review of traffic noise model simplifications**

Miller, Heath (1); Parr, Fiona (1)
(1) Aurecon, Auckland, New Zealand

ABSTRACT
The use of computational noise modelling is commonplace for the prediction of noise levels from transport corridors. Results of such noise models are used as basis for the assessment of environmental noise against local statutory regulations. Non-compliance with the regulations would often trigger the requirement for the assessment of acoustic mitigation measures such as noise walls or building modifications to provide suitable amenity. However, due to the geographic scale of transport projects and the large number of potentially affected properties, simplifications of building geometry are frequently employed to decrease the time spent developing the noise model. With the use of a computational noise model and site measurements, this paper investigates the potential impacts of typical simplifications of building geometry and discusses the implications for the internal noise limits and requirements for building modifications as defined in New Zealand Standard NZS 6806:2010. It is shown that typical simplifications of building geometry can lead to significant over–prediction of incident traffic noise levels and that including additional detail into the computational model can be an effective method of achieving better correlation with on–site measurements.

98 **Tyre/road noise reduction of poroelastic road surface tested in a laboratory**

Sandberg, Ulf (1); Świeczko Żurek, Beata (2); Ejsmont, Jerzy (2); Ronowski, Grzegorz (2)
(1) Swedish National Road and Transport Research Institute, SE-58195 Linkoping, Sweden
(2) Technical University of Gdansk, ul. G. Narutowicza 11/12, PL-80-952 Gdansk, Poland

ABSTRACT
A so-called poroelastic road surface (PERS) is being developed in Europe. This contains a large percentage of rubber particles mixed with hard aggregate (stone and sand) and bound with polyurethane. This gives high air void content (around 30 %), high elasticity and smooth texture, all of which should give low noise properties. Inthis experiment anominally 30 mm thick sample of PERS was mounted on a steel drum. Various car tyres were then run on the PERS surface at a range of speeds, while measuring noise levels and frequency spectra. Similar measurements were made when the drum was equipped with a replica of a dense as phalt surface as well as a rough-textured surface dressing. These measurements indicated a 9-10 dB reduction in A-weighted noise level compared to the replica of the dense asphalt surface, and even higher when compared to the surface dressing. In addition, rolling resistance measurements were made with similar equipment and facility. The results showed that the rolling resistance was almost as low as that on a smooth sandpaper surface (a standard surface allowed in ISO tests), which is likely to give lower rolling resistance than most conventional road surfaces.

Session 4 Room B Monday: Vibration 1

32 **Vibration assessment of Adelaide's new riverbank foot-bridge**

Lee, Yong-Keat (1); Mackenzie, Neil (1)
(1) Building Sciences, Aurecon, Adelaide, Australia

ABSTRACT
The new Riverbank Bridge in Adelaide is a light-weight steel superstructure for pedestrians, with the main span being approximately 135m long with an internal radius of 182m in the horizontal plane. Due to the relatively light-weight bridge structure, the response of the bridge structure to pedestrian and wind loads was of concern. Pedestrian induced excitation

of bridges can occur vertically, horizontally or torsionally. Vertical vibrations are absorbed by legs and joints, with pedestrian movements not synchronised with bridge motion, however pedestrians adjust their walking pattern to synchronise with the lateral motion of a structure, resulting in a potentially significant response. This paper will detail the approach taken by Aurecon to assess and mitigate pedestrian and wind loads.

35 **Dynamic assessment of wind sensitive stadium structures**

Gaekwad, Jason (1); Mackenzie, Neil (1)
(1) School of Computing and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

ABSTRACT
World class stadium structures feature tall light-towers with significant head-frames and long-span cantilevered roof forms. This paper describes the assessment of dynamic effects due to wind loads for two stadia currently under construction; Simonds Stadium and the Adelaide Oval Redevelopment. The contribution of dynamic loads to the alongwind response for the Simonds Stadium Light Towers is detailed, along with cross-wind serviceability response. Similarly the dynamic effects of the Adelaide Oval Southern Grandstand Roof are assessed, with structural loads determined using the innovative load-response correlation method. The light towers and long span grandstand roof are examples of one and two dimensional structures analysed using wind engineering statistical methods.

95 **Footfall vibration and the dynamic response of different structures – a case study comparing predicted and measured results**

Miller, Aaron (1); Duschlbauer, Dominik (1)
(1) SLR Consulting, Sydney, Australia

ABSTRACT
Excessive floor vibration in buildings can adversely impact on human comfort or the operation of vibration sensitive equipment. Design procedures with varying degrees of sophistication have been developed over the last decades for both concrete and steel building structures. Key input parameters are the dynamic floor properties (with required in_formation ranging from the fundamental frequency to a mobility spectrum of up to 4 times the fastest stepping frequency) and footfall characteristics (from stepping frequency only to a force spectra of up to four times this frequency). This paper discusses floor vibration criteria for human comfort. Footfall vibration measurements taken on different suspended floors (concrete and composite structures) are presented. The measured results are compared against different prediction methods of varying degrees of sophistication. The effects of individual and two person walker combinations are discussed as well.

96 **Use of block pseudo angular acceleration for engine misfire diagnosis**

Chen, Jian (1); Randall, Robert (1)
(1) Mechanical & Manufacturing Engineering, UNSW, Sydney 2052, Australia

ABSTRACT
A study has shown that misfire causes angular rotations of the engine in its mounts, dominated by roll motions around an axis parallel to the crankshaft, and that it is possible to detect and quantify misfire using this. This can be aviable alternative to measuring torsional vibration of the crankshaft, possibly using accelerometers already mounted for other monitoring purposes. By making a kinematic/kinetic model of the engine as a rigid body in the engine mounts, and updating it on the basis of a small number of measurements, it has been found possible to simulate mis-fires of different severities and locations, and use the simulated angular accelerations to train neural networks to recognise a much wider range of faults than the small number of measurements used to validate the model. The paper describes the successful use of this approach for misfire detection and diagnosis in a 4-cylinder spark ignition engine

106 **Impact generating mechanisms in damaged rolling element bearings**

Singh, Sarabjeet (1); Köpke, Uwe (2); Howard, Carl (1); Petersen, Dick (1); Rennison, David (2)
(1) School of Mechanical Engineering, The University of Adelaide, South Australia, Australia
(2) Trackside Intelligence Pty Ltd, Kent Town, SA, Australia

ABSTRACT
Standard condition monitoring techniques for assessing the health of rolling element bearings are widely used in numerous engineering industries. It is well known that the appearance of impulses in measured acceleration signals indicates the presence of a defect within a bearing. Although a large amount of technical content related to the signal processing of measured time-domain signals has been published in the literature and new data analysis methods are continued to be developed and enhanced, the mechanism by which the defect-related impulses are generated has received much less attention and has not been investigated in detail. This paper provides an explanation of the mechanisms by which defect-related impacts are produced in damaged rolling element bearings on the basis of findings from numerical modelling conducted using an explicit dynamics finite element software package, LS-DYNA. In-depth analysis of the numerically obtained impact-contact forces between the rolling elements and raceways of a bearing, which are not measured in practice, are presented in this paper

Session 5 Room A Monday: Architectural and Building Acoustics

18 Acoustic absorption and fire retardant property of natural fibers

Mohammad, Hosseini Fouladi (1); Satesh, Narayana Namasivayam (1); Chong, Chong Chien Hwa (1); Masomeh, Ghassem (2); Pang, Zong Xin (1); Sim, Yeng Peng (1); Hamidreza, Soheili Najafabadi (3)
(1) School of Engineering, Taylor's University, 47500 Subang Jaya, Selangor, Malaysia
(2) Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Selangor, Malaysia
(3) School of Industrial Engineering, Iran University of Science and Technology, Narmak, Tehran, Iran

ABSTRACT
The primary focus of this study is to use the abundant Malaysian natural fibers as sound absorbers. Four natural fibers, namely; coir, corn, sugar cane and grass were chosen and their acoustic absorption properties examined by using impedance tube complying with the standard ISO 10534-2. Comparison with synthetic materials having the same thickness showed that these fibres have generally better absorption coefficient throughout the frequency spectrum and are good alternative for household and industrial applications. Then the next challenge is to improve the fire retardant property of fiber to comply with the building safety rules and regulations. The last part of the paper is focused on the effects of three potential fire-retarding chemicals on coir fiber, namely, Di-Ammonium Phosphate (DAP), borax and urea. In conclusion, DAP was shown to exhibit superior ability to retard fire in coir fiber over other additives based on mass loss and low degree of hazards in terms of health, flammability and reactivity.

31 Acoustic design aspects of the Brisbane supreme & district courts

Naidu, Magaesh (1); Dawson, Bill (1); Lee, Yong-Keat (1); Naidu, Magaesh (1)
(1) Building Sciences, Aurecon, Adelaide, Australia

ABSTRACT
The $600 million Brisbane Supreme & District Courts is the largest and most complex courts projects undertaken to date in Australia. The design intent was to use a palette of few materials - concrete, timber and glass - all of which reflect sound making the task of controlling acoustics within spaces critical for speech intelligibility very challenging. The internal vision was to have spaces filled with light to reflect the transparency of justice, with glass walls between courts, and fully glazed facades. Additionally, the internal spaces used displacement ventilation to provide airconditioning, with no ceiling available to relieve air, and open air paths integrated into walls between courts. This paper will detail the approach taken to overcome these challenges, with the outcome facility that has been acclaimed by the judiciary.

60 The regulation of voice levels in various room acoustic conditions

Yadav, Manuj (1); Cabrera, Densil (1); Lee, Doheon (1); Miranda, Luis (1); Martens, William (1)
(1) Faculty of Architecture, Design and Planning, The University of Sydney, 2006, Australia

ABSTRACT
Talking-listeners show a systematic variation in their voice level due to changes in the ambient noise level (Lombard effect) and the perception of their own voice. While these effects have to be interpreted in the context of the communication task, some studies point out an additional influence of room acoustics. This pilot study investigates the changes in the voice levels of participants in various room acoustic conditions that were simulated in anechoic conditions. The participants vocalized three vowels at a comfortable level to a manikin at a distance of 5 meters, while listening to the sound of their voice in a simulated room. The results are in some agreement with recent findings that show a negative relationship between thevoice level of a talking-listener and the level of the room reflectionsre-turned from their own voice (quantified as room gain). However, the overall trend was not uniform across the room acoustic conditions studied here, and current results are discussed in comparison to results from past studies.

78 Micro-perforated sound absorbers – applications

Nocke, Christian (1); Stuart, (2)
(1) Akustikbuero Oldenburg
(2) Barrisol Australia

ABSTRACT
In 1975 Prof. Daa-You Maa introduced the theory of micro-perforated sound absorbers. This kind of sound absorber has found many applications. Some of these applications will be reported in this contribution.

In 1999 the first author of this contribution had the opportunity to work with Prof. Maa in Beijing. During this exchange visit a micro-perforated sound absorber made out of metal has been applied as a reference sound absorber in a standard reverberation chamber to investigate the modal sound field in that room. This work will be reported.

Furthermore other applications in technical acoustics as well as in architectural acoustics will be reported. Micro-perforation in metal, wood, polycarbonate and flexible foils will be discussed. Finally applications will be shown.

97 Auralisation of stage acoustics for large ensembles

Jimenez, Daniel (1); Vandenburg, Nicholas (1); Miranda, Luis (1); Yadav, Manuj (1); Cabrera, Densil (1)
(1) Faculty of Architecture, Design and Planning, University of Sydney, NSW, 2006, Australia

ABSTRACT
Computational room acoustics models are frequently used to derive room acoustical parameters, and also for auralisation of sound from stage to audience area of auditoria. Auralisation of sound on stage is much less common. This paper considers how auralisation can be implemented for a musician within a large ensemble. Using a computer model of an auditorium, impulse

responses are derived from various source positions on the stage to the auralised position for the musician (also on the stage). For the playback, anechoic recordings of individual instruments within a small or large ensemble are convolved with the appropriatiately synchronised and spatialised impulse responses. The room-reflected sound for the musician's own instrument or voice is auralised separately using a real-time convolution system previously developed for auralising the sound of one's own voice in rooms. This paper describes the integration of these processes, which are illustrated using a case study.

Session 5 Room B Monday: Instrumentation

2 New acoustical pattern recognition approach to identify different stages of a cooking process. the boiling water case

Tabacchi, Mattia (1); Asensio, César; Pavón, Ignacio; Recuero, Manuel
(1) Hibbs & Associates Pty Ltd

ABSTRACT
Although pattern recognition technique has been largely used in many fields, it seems that very few studies have applied this technique to cooking processes. In this preliminary research, a new methodology has been developed and tested on a simple case of water boiling. Besides defining and analysing the efficacy and the performance of a statistical pattern recognition approach when applied to different signals (sound and vibration), an optimisation module has been proposed to boost the classification rates by adding syntactical analysis that enables to consider the inertia of the process. In the specific case of boiling water, almost 100% successful recognition has been reached. These results prove the validity of this methodology, opening new research lines for new scenarios such as different cooking process, acoustically polluted environments, sensors optimisation, etc

5 A comparison of popular beamforming arrays

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ABSTRACT
Beamforming is a popular method of acoustic source localisation using an array of microphones. When beamforming over a plane or a series of planes, these microphone arrays are often two-dimensional sparse patterns of various designs. The design of these patterns is non-trivial, and influences the achievable resolution, also referred to as the beamwidth, and the Maximum Sidelobe Levels (MSL), a measure of the ability of the array to reject sources that the array is not focussed on. Although recent deconvolution techniques such as DAMAS aim to remove properties of the array from the results of beamforming, in practice the properties of the array will still influence the quality of the results. For this reason, it is important that the array exhibit good resolution and MSL for the intended beamforming application. In this paper, several popular two-dimensional array patterns such as the patented Underbrink and B&K spirals, as well as Doherty spirals and log-spirals are critically compared for both resolution and MSL for a variety of source locations, including both near (spherical propagation) and far (planar propagation) sources. Each array compared has an aperture of 1m, and uses 63 microphones in a typical arrangement found for each of the types. As array resolution scales linearly with wavelength, the resolution is calculated at a single frequency of 3 kHz, and normalised against wavelength. The MSL levels are calculated at the one-third octave band centre frequencies from f = 1 kHz - 31.5 kHz. Results show that the Underbrink design outperforms other array patterns in both resolution and MSL over the majority of frequencies analysed.

7 Factors influencing the successful measurement of the sound power absorption coefficient using cepstral techniques

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ABSTRACT
The sound power absorption coefficient of a surface can be measured by insonifying it with a broadband signal. The incident wave and reflected wave are then compared to determine the absorption coefficient. In principle the Cepstral analysis allows one to directly extract the ratio of the reflected wave to the incident wave. The ratio is then transformed into the frequency domain, and the squared magnitude is subtracted from 1 to give the absorption coefficient. This paper explores the factors in the measurement chain that limit the accuracy of the measurement. The results of measurements performed on four surfaces using the cepstral technique are correlated to measurements performed using the impedance tube and presented.

30 Simulation and design of a microphone array for beamforming on a moving acoustic source

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ABSTRACT
A microphone array was designed and tested for the purpose of measuring the noise radiated by a moving acoustic source. Beamforming is used to enhance the signal-to-noise-ratio (SNR), with interfering sources moving at the same speed and along the same straight path as the measured source. A method is described for calculating moving source beam patterns that illustrates the SNR enhancement. The beamforming algorithm includes a de-Dopplerisation process to correct for the Doppler shift that occurs in the signals received at the array. This process leads to SNR enhancements that differ depending on whether the interfering source leads or lags the measured source when passing the array. The de-Dopplerisation process also causes grating lobes associated with spatial aliasing to move to lower frequencies when the interfering source leads the measured source. The described effects of the de-Dopplerisation process become more pronounced at higher speeds and when the interfering sources are farther away from the measured source. Hence, when designing a microphone array, it is important to conduct simulations that involve the use of a moving, rather than stationary, acoustic source, especially when the source moves at high speed. The modelling method presented in this paper

was used to design an array which was tested in an anechoic chamber. The measured beam patterns for a stationary source are presented.

82 **Vibration energy harvesting for aircraft, trains and boats**

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ABSTRACT
A vibration energy harvesting approach has been developed to harvest energy from low frequency mechanical vibrations (i.e. < 20 Hz). The energy harvester reported consists of an oscillator created using a spherical permanent-magnet, wear-pad and wire coil arrangement. A magnetic restoring force acts on the spherical magnet, and as the magnet oscillates it steers magnetic field through the transducer thereby producing an oscillating charge that can be harvested. Measured stochastic-like vibrations from three different vehicle types (i.e. jet plane, train, and boat) were reproduced on a vibration shaker. The non-optimised energy harvester's response to the three vibration spectra was examined. The largest output was in response to the train vibrations which produced a peak power of 18.5 mW and a longer term RMS power of 1.28 mW.

Session 1 Rooms A and B Tuesday: Wind turbine noise: an overview of acoustical performance and effects on residents

108 **Plenary Presentation: Wind turbine noise: an overview of acoustical performance and effects on residents**

van den Berg, Frits
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ABSTRACT
Sound from modern wind turbines is predominantly aerodynamic noise with most audible sound energy at medium and higher frequencies. Wind turbine sound is relatively annoying, probably due to acoustical characteristics, such as amplitude modulation, that increase the risk for annoyance and disturbed sleep. Other health effects, all resembling stress symptoms to at least some degree, are attributed to infrasound, but this is not supported by existing knowledge of noise or noise annoyance and the claims lack substantiation. There is certainly room for the reduction of noise and noise annoyance, perhaps at the expense of maximum energy yield. This paper gives an overview of knowledge about wind turbine noise and its effects on neighbouring residents. It emphasizes robust knowledge, from both the (psycho) acoustics and public health arena. But also attention has been paid to relatively new knowledge and ideas such as presented at the 5th International conference on Wind Turbine Noise in August 2013.

Session 2 Rooms A and B Tuesday: Human Response

107 **Keynote Presentation: Caring for the sound environment in hospitals - a health issue for patients and staff**

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ABSTRACT
Hospitals should be conducive to patient recovery and safety as well as employee health and productivity. Medical advances and technical developments contribute to this goal while a supportive acoustic environment hitherto has been largely neglected. A large number of studies show that hospitals are unacceptably noisy, and up to date no study has measured noise levels in intensive care units or neonatal wards that comply with the WHO recommendations. While some sounds are unavoidable, many are unnecessary. Noise in hospitals has been suggested to increase the risk for cardiovascular response, pain, intensive care delirium, fragmented sleep and reduced recuperation. For patients, the cause of these outcomes is multi-factorial, however the impact of the sound environment can, as opposed to most other factors, be abated. For the personnel, noise may cause annoyance, stress, fatigue and in some settings lead to hearing related disorders, however these outcomes are less well studied. The paper will give a summary of what is known today, specifically focusing on personnel response and point to the most important areas for further improvements in research.

81 **Noise exposure in the Australian workforce**

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ABSTRACT
This paper presents a new methodology for the estimation of the number of noise exposed workers Australia. Previous methods relied on the statistics from the annual rate of application for workers' hearing loss compensation claims, both successful and unsuccessful; the generalisation of small scale surveys to the broader population; or larger scale telephone surveys. This new method relates measured noise exposure data from sampled industries to official demographic data on the numbers employed in the respective industries. From Australian data it is estimated that around 20.1% of the workforce regularly work in noise above the recommended Exposure Standard (LAeq,8h= 85 dB)and 9.4% above and exposure of 90 dB. These figure lie within the range of estimates indicated using other methodologies.

85 **Residential noise exposure and chronic stress in children**

Evans, Gary
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ABSTRACT
One of the suspected impacts of chronic noise exposure on children is elevated stress. Airport studies and a few road traffic studies show associations with ambient noise exposure and children's blood pressure. Few studies have examined these linkages in terms of interior noise levels or used

neuroendocrine assessments of chronic stress. Nine year old children living in nosier homes have higher levels of chronic physiological stress. Overnight, urinary (12 hour) levels of cortisol, epinephrine, and norepinephrine, are each elevated. Two, 2 hour assessments of noise exposure (Leq, dBA) were completed on two different days in the home. Poverty, duration of residence in the home, gender,family composition, and maternal education were incorporated as statistical controls given the reliable association of socioeconomic status with both noise exposure and chronic stress. The potential health implications on children of noise levels well below those necessary to produce hearing damage warrant further attention by scientists and policy makers alike

Session 3 Room A Tuesday: Wind Turbine Noise 1

24 Analysis of unweighted low frequency noise and infrasound measured at a residence in the vicinity of a wind farm

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ABSTRACT
To characterise the noise at several residences located nearby a South Australian wind farm, time-data files as well as the third-octave spectra have been measured indoors and outdoors using low-frequency microphones fitted with various wind shields. Five consequative nights of data have been analysed and four cases are presented here to highlight the importance of atmospheric stability and the relative wind direction between the wind farm and a residence on the measured results. In the downwind cases, two low frequency tones were detected around 28 Hz and 46 Hz and significant levels of amplitude modulation of these tones at the blade pass frequency were observed. This amplitude modulation was most prominent when atmospheric conditions were stable. The presence of these tones and the associated amplitude modulation was also observed in the vibration results, however another amplitude modulated tone at 16 Hz was found to be more significant in terms of vibration. It was also found that low-frequency indoor noise levels varied by as much as 20dB with position in a room, due to the existence of room resonances

34 Meteorological stability impacts on wind turbine noise assessments

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ABSTRACT
Current wind farm noise regulations stipulate wind speed dependant criteria (referenced to wind speed at the hub height of the turbines), under the assumption that during high-wind speed conditions (when wind turbines generate higher noise levels), there will be a corresponding high wind speed and masking noise level at nearby receivers. However, under very stable conditions, high wind speeds at the turbine hub height will create significant noise, while low wind speeds at the receiver will not be sufficient to provide a masking effect. This has been considered in assessment guidelines by filtering day/night background data, but this approach ignores the impact of changes in the level and spectral content of turbine noise due to high shear velocities across turbine blades. This paper examines meteorological data in the vicinity of an undisclosed future wind farm site in South Australia, which was used to filter noise and wind speed data based on stability criterion, and discusses the potential impact on the noise criteria used for wind farm developments.

89 Effects of different meteorological conditions on wind turbine noise

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ABSTRACT
The accuracy of wind turbine noise predictions is sometimes the subject of debate during assessments of proposed wind farms. Theoretical questions are raised about the potential effects of different meteorological conditions on noise emission and propagation. In particular, periods of higher wind shear, temperature inversions and inflow turbulence have been raised as concerns. This paper presents noise measurement data gathered at operational wind farm sites where the meteorological wind shear, temperature gradient, turbulence and inflow angle variables are monitored. The effect of these factors on both noise emission and noise propagation from modern wind turbines are investigated and it is found that there is only a small influence on noise emission and negligible influence on noise propagation for the range of operating conditions of typical wind farms. An increase in noise emission was identified at lower frequencies when a turbine was operating under inflow turbulence but this only occurred at low wind speeds with no difference observed when the wind speed increased. Noise propagation from wind turbines was not found to increase with either wind shear or temperature gradient. It is theorised that this may be due to the height of the noise source as well as the fact that the operation of turbines would disrupt stable conditions immediately downwind of the blades.

91 Automated detection and analysis of amplitude modulation at a residence and wind turbine

Cooper, Jonathan (1); Evans, Tom (1)
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ABSTRACT
A small degree of amplitude modulation is a normal feature of wind turbine noise but most assessment guidelines for wind farm noise state that, where excessive amplitude modulation occurs, an additional penalty should be applied to the measured noise. Excessive amplitude modulation is typically defined as a situation where the peak to trough levels (either overall or in particular frequency bands) exceed a nominated level. The assessment of amplitude modulation outdoors at receptor locations near wind farms over a wide range of wind conditions can be difficult due to the need to undertake unattended measurements in an environment where background noise regularly interferes with the measurements. This paper describes a methodology for the assessment of amplitude modulation over an extended period at a residence, and the specific techniques used to identify amplitude modulation resulting from the wind farm. The methodology has been employed at an operational wind farm and the results at both a residence and wind turbine assessed to identify

conditions which contribute to modulation judged to be 'excessive' using the modulation test provided in New Zealand Standard 6808:2010.

Session 3 Room B Tuesday: Underwater Acoustic Modeling

6 A study of the effects on transmission loss of water column features as modelled for an area off the east Australian coast

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ABSTRACT
The improved accuracy of ocean and atmospheric models permits the description of water column features, and sea surface wind stress, at a resolution which suggests employment in underwater acoustic transmission applications. In an investigation of aspects of linking modelled ocean data with range-dependent acoustic transmission models, a PE transmission code was used with data generated by the BLUElink suite of ocean and atmospheric models for a deepwater region off the east Australian coast for a particular summer period. The typical presence of warm and cold core eddies was found to result in a highly variable acoustic environment. Variations in expected range to particular levels of Transmission Loss were found to be mainly related to changes in the depth of the mixed surface layer, but also due to changes in the sound speed gradient in the thermocline. The study also made a brief consideration of the likely impact of wind speed variation over the region, and the effects of modelled ocean currents on acoustic transmission

53 Approximate solutions for an acoustic plane wave propagation in a layer with high sound speed gradient

Zinoviev, Alex (1); Jones, Adrian (1)
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ABSTRACT
The present authors previously obtained an exact solution for propagation of the incident acoustic plane wave in a wind-induced bubbly surface layer where sound speed gradient is high. Based on the solution, the dependence of the grazing angle of the energy flux vector of the incident wave at the surface on the grazing angle of the incident wave at the bottom of the layer was obtained and utilised for calculations of the surface reflection loss. However, the solution in its original formulation is represented via an infinite slowly converging series which makes the use of the solution in practical calculations difficult. In this paper, this solution is simplified with the assumption that the grazing angle at the bottom of the layer as well as some other parameters depending on the frequency and wind speed are small. The convergence of the infinite series is improved using a special technique. Approximate solutions are obtained for the cases where the small parameters can be neglected and where the terms up to the third order with respect to the small parameters are taken into account. Zones of validity are derived for the approximate solutions as well as for the Snell's law of ray acoustics. The results of this paper allow the prediction of the grazing angle at the surface within the zones of validity of the approximate solutions using simple calculations with only the wind speed, the frequency and the equilibrium sound speed as the input parameters.

69 Efficient modelling of mid to high frequency underwater acoustic propagation

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(2) Maritime Division, Defence Science and Technology Organisation, Western Australia

ABSTRACT
Accurate prediction of the acoustic interference field at mid to high frequencies is computationally intensive, even for ray theory based models, and is of little practical use because the fine detail of the interference pattern is sensitive to the exact values of environmental parameters, such as bathymetry and sound speed, that are inherently uncertain. This paper considers an alternative approach in which a much faster incoherent beam model is used to compute the mean acoustic field, and the interference is treated as a statistical process based on a Rayleigh amplitude distribution. Excellent agreement was found between interference field statistics obtained using this hybrid approach, and those resulting from a full coherent transmission loss calculation whenever the horizontal separation between source and receiver was sufficiently large that there were many contributing ray paths.

70 Shallow water sound propagation over a layered calcarenite seafloor: an exercise in benchmarking various models

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ABSTRACT
The sediment deficient western and southern Australian coastal seafloors consist of semi-compact layered calcarenite. Although there is a large body of work investigating and modelling the characteristics of underwater sound propagation over a layered elastic seafloor, there are still difficulties associated with modelling complex shallow water environments like the Australian shelf. For a range independent marine environment with a calcarenite bottom, the acoustic propagation characteristics have been previously modelled using numerical methods based on wave number integration theory. This work investigates the ability of other sound propagation models to accurately predict the acoustic field over calcarenite seafloors, specifically models based on normal mode theory. The benefits and draw-backs of this alternative modelling approach are discussed.

Session 4 Room A Tuesday: Wind Turbine Noise 2

23 3D atmospheric tomography using UAVs

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ABSTRACT
This paper presents a method for tomographically reconstructing spatially varying three-dimensional atmospheric temperature profiles and wind velocity fields based on measurements of the acoustic Doppler shift between a small Unmanned Aerial Vehicle (UAV) and ground-based microphones. The frequency measurements are used to estimate the acoustic propagation time between the UAV and the ground microphones, which in turn are affected by the atmospheric temperature and wind speed vectors along each sound ray path. The parametric fields are modelled as the weighted sum of Radial Basis Functions (RBFs), which also allow local meteorological measurements made at the UAV and ground receivers to supplement any Doppler Shift observations. The 3D tomographic technique has already been demonstrated using simulation. This paper summarises the tomographic technique and reports on the results from initial field trials. The technique has practical applications such as atmospheric research, boundary layer meteorology, air pollution measurements, analysis of wind shear, and wind farm surveys

29 Development of a technique to minimise the wind-induced noise in shielded microphones

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ABSTRACT
Environmental noise measurements are usually performed in atmospheric conditions where wind and thus turbulent flow over the microphone is present. In such conditions the measured noise is highly affected by the wind-induced noise generated by turbulence structures present in the flow and microphone generated wakes. A novel approach has been employed to distinguish the contribution of wind-induced noise from the acoustic signal using Incoherent Output Power analysis between two microphone signals. Various experimental arrangements were investigated to examine the influence of the experimental parameters on the results obtained. The technique was successfully tested and validated in a series of indoor experiments in a small anechoic wind tunnel. Finally, a new approach for minimising wind-induced noise using the Coherent Output Power between two shielded microphones is proposed and tested.

45 Indoor Infrasound and low-frequency noise monitoring in a rural environment

Zajamsek, Branko (1); Doolan, Con (1); Moreau, Danielle (1); Hansen, Kristy (1)
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ABSTRACT
This paper presents the results of recent indoor noise monitoring test that was conducted in a room of a home near a wind farm whose resident claims to be annoyed by wind farm noise. The testing uses low-frequency microphones that can resolve noise below 0.5 Hz. The aim of the study is to examine the relationship(s) between the sound pressure level, weather conditions, resident rated annoyance to sound and wind farm output power data. The study concentrates on sound in the low and infrasonic frequency ranges. Additionally, the methodology records two-minutes of audio data at the same time a resident claim to be annoyed by noise from wind turbines. Annoyance was found to have some correlation with the overall noise level; however, noise levels are also correlated with local wind speed

88 Forecasting low frequency noise from wind farms

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ABSTRACT
Wind farm noise is commonly forecast as an overall A-weighted noise level for comparison against legislative requirements. In Australia various regulatory bodies have begun considering low frequency noise criteria which can be applied to industrial facilities, including wind farms. One such example is the NSW Draft Wind Farm Noise Guidelines which presents criteria of 60 dB(C) for the night-time and 65 dB(C) for the daytime. Whilst the forecasting of overall A-weighted noise levels from wind farms is well documented and validated against measured wind farm noise levels, the forecasting of low frequency noise (noise above 20Hz but below 200Hz) has not been widely validated. This paper analyses wind farm compliance noise monitoring adjacent wind farms in Australia and compares the measured low frequency noise levels against forecast low frequency noise levels. The influence of various factors of the monitoring and modelling chain is discussed, including the effect of wind noise on the measurement microphone. It was found that modelling of C-weighted noise levels can be performed using the same model as used for forecasting A-weighted noise levels and the results obtained would likely be a conservative estimate of C-weighted windfarm noise levels in most cases.

37 Environmental Noise Assessments of existing and new major resource developments

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ABSTRACT
With environmental noise becoming an increasing issue from new and existing industrial developments, it is critical that regulators, councils and developers place a larger importance on the planning and assessment of such noise impact on the nearest sensitive receivers. For new developments, such as the

proposed Wandoan coal mine, existing background noise can be maintained by determining the current background limits and ensuring the new development maintains historical levels, but for existing industrial developments, such as those in the Latrobe Valley, encroached on by new sensitive receiver developments we must determine what constitutes acceptable levels and background noise. This paper will detail approaches taken to overcome these challenges.

Session 4 Room B Tuesday: Underwater Acoustics 1

43 Keynote Presentation: Hydroacoustic characterisation of the AMC cavitation tunnel

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(2) Australian Maritime College, University of Tasmania, Launceston, Tasmania
(3) ASC Pty Ltd, Osborne, South Australia

ABSTRACT
This paper presents recent results from an Industry-University-Defence collaborative project whose aim is to characterise the hydroacoustic environment of the Australian Maritime College Cavitation Tunnel. After summarising the operation of the tunnel, a methodology for measuring and processing the hydroacoustic measurements is presented that includes a technique for reducing the level of turbulent wall pressure fluctuations on the hydrophone measurement. The background noise levels of the tunnel are presented for a variety of operating conditions and they compare favourably with other hydroacoustic test faciltities internationally.

41 Clean data training approach to active sonar classification

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ABSTRACT
An approach to forming a training data set for active sonar classification from the free-field noiseless echoes of underwater objects is considered. The approach has been tested on simulated data based on laboratory measurements. Both the test and the training data are generated from the clean data by applying two environment parameters: noise and a channel maltipath. It was investigated how well the parameters of the channel used for forming the training data should match those used for generating the test data. The dependence of classification accuracy on the pulse frequency bandwidth was also investigated and shown to increase with increasing bandwidth. Some knowledge of the environment is required for the application of this approach to real sonar data.

65 Transformation Acoustics and Acoustic Metamaterials: Review of Developments and Discussions

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ABSTRACT
Originated in electromagnetics, the field of metamaterials has been rapidly growing in the last decade and expanded into acoustic and elastic waves. Metamaterials are engineered material with cavities or composites with sub-wavelength scale spatial structures. Waves interacting with these structures produce a synergistic effect that the material appears to have effective dynamic properties which are distinctively different from the averages of the corresponding properties of its constituents. The freedom offered in manipulating space in the design of such structural units offers unexploited opportunities for wave control. The essence of metamaterial science is to design, fabricate, and use such composites to control and guide waves as one desires. Transformation acoustics is a mathematical tool and methodology, which can be used, among other things, to specify the spatial distribution of material properties needed to guide sound to behave in prescribed ways. In this talk, I will introduce the emerging field of acoustic metamaterials and review some current developments in cloaking, shielding, focusing, absorbing, and super-resolution imaging. I'll also give some examples in underwater acoustics where the principles of metamaterials were used by sonar acousticians well before the establishment of acoustic metamaterials as a research field. Marine mammals also appear to generate similar effects for their advantage.

66 Investigation of sound radiation from a water-loaded cylindrical enclosure due to airborne noise

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(2) School of Mechanical and Manufacturing Engineering, The University of New South Wales, New South Wales, Australia

ABSTRACT
This paper models and analyses the noise radiation due to internal acoustic excitation of a cylindrical enclosure submerged in a heavy fluid. The enclosure consists of a cylindrical shell filled with air and attached to rigid end plates. To model the airborne noise transmission and radiation, the noise sources were characterised as monopoles. The predicted far-field noise from the shell due to interior airborne noise shows a dominance of sharp peaks due to interior resonances. The effect on far-field sound pressure of different thickness and length of the cylindrical shell, as well as different excitation locations, are discussed. Excellent agreement is obtained between the analytical results and results from numerical finite element / boundary element models.

67 **Effects of mass distribution and buoyancy on the sound radiation of a fluid loaded cylinder**

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ABSTRACT
Earlier studies have shown that the radiated sound power due to excitation of bending modes of a submerged cylindrical body depends strongly on the relative distributions of mass and buoyancy. A fluid-loaded cylindrical shell closed at each end by hemispherical shells and driven by transverse forces is examined. The effects of stepwise mass distribution in the axial direction of the cylindrical shell on the radiated sound power are observed. The influences of different buoyancy values and thickness of the shell are also investigated

Session 5 Room A Tuesday: Environmental Acoustics

4 **Sound directivity from high temperature exhaust stacks**

Cazzolato, Ben (1); Hansen, Colin; Robertson, William (1); Zhao, William (1)
(1) The University of Adelaide

ABSTRACT
Simple cycle gas turbine power stations are commonly used for meeting peak load requirements for electricity supply. These systems exhaust the hot gases via a stack into the atmosphere. There is evidence that these systems can lead to increased sound levels in the community compared to stacks from other systems with similar exhaust sound power levels. It is hypothesized that the hot, fast flowing gases refract the sound downwards, in addition to the diffraction that occurs around the edge of the stack outlet. This paper presents experimental results showing the effects of temperature and the shear layer on the directivity of a hot stack with flow.

22 **Sound localization of mechanical equipment/ mobile plants in median and vertical plane during environmental noise survey**

Lau, Akil
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ABSTRACT
Human sound localization relies on binaural difference cues for sound-source azimuth and pinna-related spectral shape cues for sound elevation as well as changes in all these cues during head motion. The interaural time difference (ITD) and interaural intensity difference (IID) cues are weighted to produce a perception of sound azimuth in the lateral plane. Sound source on the median plane is equidistant from both ears, IID and ITD cues are therefore invariant. Consequently, directional filtering by the external ears and scattering by listener's shoulders and upper torso provides the sole localization cues for sources in median plane. Localization distortion refers to the incorrect localization of the sound source due to various psychoacoustic phenomenon. This paper discusses the localization distortion for mechanical equipment and mobile plants on median and lateral plane during an environmental noise survey based on a frequency analysis.

55 **Numerical study of noise barrier designs**

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ABSTRACT
Noise barriers are commonly used for reduction of highway traffic noise. Optimising the acoustic performance of a barrier is an important task for those involved with designing cost effective barriers. In this paper numerical models for various barrier designs which have been developed using the finite element method are described. The acoustic performance of noise barriers with vertical, arrow, T-shape, Y-shape, wedge-shape and inclined profiles are compared. The effects of the locations of the source and receiver relative to the various noise barrier designs are examined.

46 **Estimating underwater Sound Pressure Levels that correspond to maximum legal disturbance of seals and turtles**

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ABSTRACT
Loud underwater sounds can disturb the behaviour of aquatic animals, and potentially affect their populations and hence biodiversity. A method is described for determining the Sound Pressure Levels (SPL) of multi-pulse signals to which seals and turtles may be exposed without contravening the Australian Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. For seals, it is deduced from reported behaviour in response to incident SPL that the corresponding legal wideband SPL has a range of values with a median of 195 dB re 1 µPa. The corresponding "Noise Sensation Ratio" (NSR) in the frequency band of seals' best hearing (10-20 kHz) is between 40 and 50 dB. For the turtle, it is deduced from reported behaviour in response to an airgun that the corresponding legal wideband SPL is 166 dB re 1 µPa. For this wideband SPL, the NSR in the frequency band of turtles' best hearing (100-200 Hz) is either 30 or 50 dB, depending on species. Thus for a given disturbance response, the NSRs for the groups are similar, whereas the wideband SPLs differ by around 30 dB. Although these NSRs appear large, they are comparable with NSRs encountered by humans during conversational speech in the frequency band of humans' best hearing (3.5-4 kHz). Since there is a large difference in wideband SPLs but only a small difference between the NSRs, noise exposure criteria should be based on NSR rather than wideband SPL.

Session 5 Room B Tuesday: Underwater Acoustics 2

49 Transient underwater acoustic channel simulator development

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ABSTRACT
The underwater communication channel is often characterised by transient reinforcement and fading of multiple transmission paths, such that no single transmission path can be generally relied upon to provide a continuous communication channel. For smooth to moderate seas the transient real ocean channel may be conceptualised as a timeseries of static channel 'snap-shots'. For a static channel geometry and transmission medium, ray-tracing methods enable calculation of the channel impulse response for the relatively high frequencies associated with data communications. This leads to the modelling challenge of how a series of static channel responses may be seamlessly joined to create a transient channel response simulation that achieves realistic multi-path fading, and arrival time spreading (or synonymously Doppler frequency spreading) of an arbitrary communications signal. This paper describes algorithms that have been explored to identify emergent, continuing and extinguishing channel transmission paths from one 'snapshot' impulse response to the next. The calculation architecture being developed to simulate the transient channel response is described.

64 A review of current marine mammal detection and classification algorithms for use in automated passive acoustic monitoring.

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ABSTRACT
The detection and classification of marine mammal vocalisations is an important component in noise mitigation strategies and in the tracking of animals for research purposes. These complex vocalisations span a broad range of frequencies with differences between and within species, and with temporal and geographical variations adding further complexity. Passive Acoustic Monitoring (PAM) systems can be deployed for long periods and can collect large volumes of data, becoming impractical for human operators to manually process due to the significant effort required. Many signal processing algorithms to automate this process have been produced with mixed results. Some are focused on the identification of single species while others handle a variety. No single algorithm is ideal for detecting and classifying all species concurrently, so any automated system requires a suite of these algorithms. A number of these algorithms are summarised here as part of an initial step in the construction of a PAM system incorporating real-time detection and classification.

79 Track-before-detect for an active towed array sonar

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ABSTRACT
Conventional active sonar processing systems typically reduce the sensor data from an intensity map to a point-measurement form via a detection thresholding process. This approach is often sufficient for detecting and tracking high signal-to-noise-ratio (SNR) targets but becomes more challenging for low SNR targets. Track-Before-Detect (TkBD) is an alternative tracking technique that supplies raw sensor data to the tracker to determine the presence and kinematic state of a target. This paper considers the application of TkBD to an active sonar tracking problem using the Histogram-Probabilistic Multi-Hypothesis Tracking (H-PMHT) algorithm. To aid in the detection of targets in the sensor image, the measurement model for the standard H-PMHT algorithm is extended to incorporate a bearing-dependent point spread function. Using real data gathered from sonar trials, the performance of the resulting multi-target TkBD algorithm is shown to be more robust at low SNR levels when compared against a conventional point measurement tracker based on Integrated Probabilistic Data Association.

83 Modelling and tracking of dynamic spectra using a non-parametric bayesian method

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ABSTRACT
We consider a problem of modelling and tracking dynamic time-frequency spectra where the number of spectral components is allowed to vary in time. The proposed approach involves representing spectral densities as mixtures of normal distributions with an unknown number of components using a time-varying non-parametric Bayesian method. A multi-target tracking algorithm is applied to track the spectral mixture components, where the inference is done using a Rao-Blackwellised particle filter. The algorithm estimates the time-varying mean and variance of each spectral component using a specifically designed Bayesian filter, and allows for the inclusion of outliers or clutter measurements. The spectral features extracted in this way can be applied for signal smoothing and classification, or in conjunction with tracking algorithms to improve data association and filtering.

109 Increasing whale numbers have substantially increased ambient noise in Australian waters.

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(3) Curtin University

ABSTRACT
By the 1970s, widespread whaling had depleted stocks of southern right whales and humpback whales to the point

where there were doubts that they would ever recover. Since then, however, numbers of both species in Australian waters have increased substantially. Southern right whales are now commonly seen in Victor Harbor and other parts of our southern coastline in winter and spring. Tens of thousands of humpback whales now migrate along the east and west coasts of Australia each year, and their sounds form a major component of the ambient noise. The first recordings in Australian waters of both species were made in 1979. The sounds, like the whales were rare events. Now the sounds of these whales contribute substantially to the ambient noise. This paper discusses the sounds produced by these species, in terms of the characteristics, the occurrence and the contribution to ambient noise. Vocalisations and sounds of surface activity (such as breaching) appear to be used for communications. Humpback whales also produce a long, complex and repeating song thought to be a breeding display.

Session 1 Room A Wednesday: Aeroacoustics

3 Noise modelling of wing-in-junction flows

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ABSTRACT
It is important to be able to accurately model the flow and noise generated by wing-in-junction flows because of the many engineering applications in which these flows occur. An incompressible Reynolds-averaged Navier-Stokes (RANS) simulation of a wing-in-junction flow test case was used with a combination of statistical and semi-analytical acoustic models to predict the far-field noise. These noise predictions were compared with experimental measurements taken in an anechoic wind tunnel. The RANS-based noise prediction models were found to achieve good agreement with experimental data.

13 Localisation of a stationary time-harmonic dipole sound source in flows using time-reversal simulation

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ABSTRACT
This work analyses the accuracy of numerical Time-Reversal (TR) simulations implemented using two different Time-Reversal Mirror (TRM) configurations for localising and characterising a stationary acoustic dipole source in a mean flow. The forward time evolution of the acoustic fields is simulated by means of the numerical solution of the inhomogeneous 2-D Linearised Euler Equations (LEE) with uniform subsonic mean flow. Only the acoustic pressure is recorded with two line arrays (LAs) of boundary nodes in a TRM corresponding to the top and bottom boundaries. The time-reversed acoustic pressure history is used as input data for simulating two numerical TR experiments; (a) one line array (LA) in a TRM corresponding to the top boundary and (b) two LAs in a TRM corresponding to the top and bottom boundaries. The Root-Mean-Square (RMS) of the time-reversed acoustic pressure field obtained by the first experiment indicates only one spatial maxima region (focal spot), therefore incorrectly suggests that the source is a monopole, whereas the second experiment correctly reveals the source to be a dipole. The local acoustic pressure history at two source locations is shown to be coherent with relative phase exactly equal to radian, thereby confirming the dipole source nature. This demonstrates that two LAs in a TRM located on either sides of the mean flow are required to take into consideration, the complete phase information and thereby accurately characterise a dipole.

25 Aerofoil tones produced by a plate with cavity: the effect of acoustic forcing

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ABSTRACT
A streamlined flat plate (herein 'aerofoil') containing a small rectangular cavity on one side was experimentally found to produce aerofoil tones (rather than cavity tones) under certain flow conditions. To clarify the responsible mechanism, the effect of sinusoidal acoustic forcing on the boundary layer was investigated by placing a loudspeaker downstream of the aerofoil. Velocity fluctuations in the boundary layer were then measured using a hot-wire probe. It was found that the boundary layer downstream of the cavity trailing edge responded strongly at the natural aerofoil tonal frequencies. This is due to enhanced feedback – as the naturally-occurring feedback loop is not saturated. However the shear layer over the cavity does not respond to the aerofoil's tonal frequencies. The findings suggest that an aeroacoustic feedback loop exists between the aerofoil trailing edge and cavity trailing edge.

26 Directivity pattern of flow-induced noise from a wall-mounted, finite length circular cylinder

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ABSTRACT
Sound emanating from a wall-mounted, finite length cylinder immersed in cross flow presents a significant engineering problem and is relevant to a range of applications including aircraft landing gear and automobile appendages. However, despite its frequent occurrence in industry, there exists little experimental data on the noise created by such objects. To characterise this type of flow-induced noise source, acoustic directivity measurements have been taken in an anechoic wind tunnel at the University of Adelaide for wall-mounted cylinders of circular cross section. The aspect ratio (the cylinder length to diameter ratio, L/D) and orientation of the cylinders were varied to determine the influence of these parameters on noise directivity. Furthermore, the results were compared with the radiation pattern of the two dimensional case as well as with a dipole source (of equivalent power) at the assumed origin. The experimental data give further insight into the characteristics of the sound generated from wall-mounted, finite length cylinders in cross flow.

42 **An experimental investigation of airfoil tonal noise caused by an acoustic feedback loop**

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ABSTRACT
Airfoils in low-to-moderate Reynolds number flows produce discrete tones which can be annoying to the human ear and potentially impede the design of fans, compressors, helicopter rotors and unmanned air vehicles. This paper discusses an experimental investigation into the generation of tones from a NACA 0012 airfoil for varying angles of attack and Reynolds numbers between 50,000 and 150,000. The investigaton employed acoustic beamforming, hot-wire anemometry, single microphone measurements and surface flow visualisation techniques. The experimental results were used to calculate flow and noise parameters that were used in an acoustic feedback loop model to determine its validity. Surface flow visualisation techniques revealed locations of boundary layer separation. The phase difference between the noise signal and local flow velocities near the airfoil surface was used to measure the convective velocity of the disturbances in the airfoil boundary layer. A good agreement between the experiment and predicted tonal frequencies was obtained when the experimentally determined length and velocity scales were used in the feedback model, supporting the applicability of a feedback model for tonal noise in this case.

Session 1 Room B Wednesday: Vibration 2

27 **Experimental results of a 1D passive magnetic spring approaching quasi-zero stiffness and using active skyhook damping**

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ABSTRACT
The use of permanent magnets has been investigated in recent years to provide load bearing forces for vibration isolation. Using two pairs of magnets in both repulsion and attraction, it is possible to generate a force-displacement characteristic that has an inflection point at zero stiffness, known as the quasi-zero stiffness location. Since vibration isolation performance is known to improve with lower resonance frequencies and therefore isolator stiffnesses, the quasi-zero stiffness location is considered the point at which vibration isolation is best achieved. However, since this location is only marginally stable, for passive operation it is only possible in practice for the equilibrium position of the system to asymptotically approach the quasi-zero stiffness point. The proximity to this point that can be achieved depends on the loads to be borne and the amplitude of vibration to be isolated. In previous works, this particular magnetic system has seen theoretical treatment. A prototype of the magnetic system will be presented that uses magnet pairs mounted on a rigid lever arm to constrain their motion to a single degree of freedom. Experimental results are presented that demonstrate the quasi-zero stiffness behaviour of the practical system. Finally, a novel electromagnetic actuator is incorporated into the design to attenuate the resonance peak via active skyhook damping using accelerometer measurements. The limits of this feedback are shown to be caused by the filter poles of the accelerometers used to measure the vibration.

33 **Vibration transmission in a double-leaf plate with random rigidities and junctions**

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ABSTRACT
Predicting vibrations of composite structures such as double-leaf plates is difficult because of the large number of components. In the low and high frequency ranges, the components may be homogenized, so that a structure becomes simple enough to be mathematically and computationally tractable. However the vibrations in the mid-frequency range cannot be predicted using such methods because the wavelengths are comparable to the size of the components and junctions between components. In this paper a double-leaf plate is modelled using the Kirchhoff plate and Euler beam theories. The elastic moduli and junctions are allowed to be inhomogeneous. These inhomogeneities are simulated as smooth random functions rather than discrete random numbers. The random functions are incorporated into the model using the variational formulation. Response of the plates are studied with various parameters.

44 **Application of polynomial chaos expansions to analytical models of friction oscillators**

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ABSTRACT
Despite past substantial research efforts, the prediction of brake squeal propensity remains a largely unresolved problem. The standard practice to predict the brake squeal propensity is to analyse dynamic instabilities using the complex eigenvalue analysis. However, it is well known that not every predicted unstable vibration mode will lead to squeal and vice-versa. Owing to nonlinearity and problem complexity (e.g. operating conditions), treating brake squeal with uncertainty seems appealing. Another indicator of brake squeal propensity, not often used, is based on negative dissipated energy. In this study, uncertainty analysis induced by polynomial chaos expansions is examined for 1-dof and 4-dof friction models. Results are compared with dissipated energy calculations and standard complex eigenvalue analysis. The potential of this approach for the prediction of brake squeal propensity is discussed.

56 **A nonlinear dynamic model of the vibration response of defective rolling element bearings**

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ABSTRACT
This paper presents a nonlinear dynamic model of the contact forces and vibration generated in rolling element bearings due

to a surface defect in a raceway. A rectangular shape defect with sharp edges is selected for modelling because previous models were not able to predict the low frequency vibration event that occurs when a rolling element enters the defect. Simulations are presented for two defect sizes. In the first simulation, the defect length is small such that the rolling elements do not strike the bottom of the defect. The simulated results compare well with experimental results, and predict the low and high frequency events that occur when a rolling element passes through the defect observed in the experimental results. In the second simulation, the defect length is increased such that a rolling element strikes the bottom of the defect. This simulation demonstrates the benefits over models that do not consider the mass of the rolling elements. The benefits are illustrated by a detailed analysis of the contact forces that occur as a rolling element passes through the defect. The developed model can be used to simulate the vibration response of bearings with a defect in the raceway to aid in the development of new diagnostic algorithms.

86 **Modal analysis of structures with uncertainties using polynomial chaos expansion**

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ABSTRACT
Engineering structures are complex and structural uncertainties are generated from variability in the material or geometric properties, or in the manufacturing and assembly process. Such variations generate differences in the dynamic responses of the structures across an ensemble of nominally identical systems, for example, vehicles off the production line. This work describes the theory and application of polynomial chaos expansion to examine the natural frequencies and mode shapes of structures with uncertainties. The modal statistics of a two degree-of-freedom mass-spring chain is examined. The structural uncertainty across an ensemble of nominally identical mass-spring chains is generated using mass and stiffness perturbations. The parameter uncertainty is constructed using log-normal and uniform distributions. Results obtained using the polynomial chaos expansion method are compared with Monte Carlo simulations.

Session 2 Room A Wednesday: Transportation Noise 2

59 **Assessment of rail noise based on generic shape of the pass-by time history**

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ABSTRACT
Assessment of intermittent noise events is normally based on evaluation of sound pressure levels (SPLs) associated with the noise sources. Calculation of the noise contribution requires knowledge of equivalent SPLs for each of the pass-by events. It frequently involves significant efforts to extract necessary information for each of the transport pass-bys. Although it may not be difficult for rare events, it may not be appropriate for noise evaluation of frequent pass-bys, such as train traffic on a busy rail line. The estimate of noise during a train pass-by requires knowledge of the beginning and end of the event and associated equivalent SPL. Rather than estimating each individual pass-by, it is suggested to use information about generic shape of the pass-by time history and average pass-by time. The equivalent SPL can then be calculated from the knowledge of maximum equivalent SPL during the pass-by. It is relatively easy to extract this parameter after processing time histories of SPLs. Day and night time levels associated with rail noise can be calculated from information about noise levels exceeding a certain limit. The procedure was tested during a long term noise monitoring program. Information from a noise monitoring station was assessed utilising the simplified procedure and conventional post-processing. It indicates good agreement between the data and therefore potential to be employed for rail noise assessment. It may be recommended for long term monitoring programs which involve post-processing of a large volume of monitoring data.

87 **Change in traffic noise levels after road pavement maintenance using diamond grinding or milling**

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ABSTRACT
Where asphalt roads are pot-holed, uneven, and in poor condition, road maintenance often involves repairing or relaying the asphalt surface. In Sydney, current suburban road maintenance projects are increasingly refraining from relaying the asphalt, and instead leaving the concrete base exposed, using fine milling or diamond grinding techniques to finish the road surface. Whilst concrete pavements are commonly noisier than asphalt pavements on high speed roads, this is not necessarily the case on low speed suburban roads due to the smaller contribution of tyre noise to the overall traffic noise level. Furthermore, recent developments in low-noise diamond grinding techniques have led to lower noise concrete surfaces. This paper analyses pre-works and post-works roadside noise measurements conducted for low speed suburban roads where diamond grinding or milling has been performed, with the aim of quantifying any noise level difference or change in tonality.

99 **A comparison of diesel and electric locomotive noise emissions from coal terminal rail loop and spur line**

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ABSTRACT
The noise emissions from rail loops and spur lines are of great interest to residents near coal terminals and the operators of the terminals for proposed new or expanded port developments. The recent boom in coal and iron ore exports has increased the pressure on existing terminals to increase capacity and to expand terminal facilities. The assessment of noise impact of the locomotives moving the rolling-stock is critical, particularly for the assessment of the maximum noise levels emitted by trains passing or unloading. Noise measurements of coal train passbys were conducted at two different Queensland coal terminals which used either diesel or electric locomotives exclusively for coal train haulage and for unloading. Noise levels were measured near the spur-line and rail loop at each terminal facility. Sound power levels of each

locomotive type were determined for slow train movement around an unloading rail loop and at higher speeds on the spur line. The noise emissions associated with electric and diesel locomotives hauling coal trains on both rail loops and spur lines will be presented compared along with a discussion of the implications of this comparison for new port or port expansion developments.

Session 2 Room B Wednesday: Miscellaneous

12 Sound Transmission Loss of Double Layer Impervious Membranes with an Internal Microperforated Membrane

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ABSTRACT
Double layer impervious membranes are commonly used as building materials. This paper provides results of experiments that show the effect on sound transmission loss associated with the incorporation of a microperforated membrane (MPM) layer. Four types of MPMs with different perforation ratios are considered inserted between the two impervious membranes and the effects of the perforation ratio on the sound transmission loss of the combined system are investigated. The measurements employ two reverberation chambers and are conducted in accordance with the AS/NZS ISO 717.1 standard (2004). The test results show that an internal MPM is able to significantly increase the sound insulation of double layer impervious membranes. This double layer structure with an internal MPM is suitable for lightweight sound barriers and is promising and worthy of further study.

19 A review of MD simulations of acoustic absorption mechanisms at the nanoscale

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ABSTRACT
The use of nanoscopic fibres for acoustic absorption can potentially result in thinner liners than for conventional acoustic materials. Modelling acoustic mechanisms at the nanoscale requires molecular simulations as the flow behaviour at the nanoscale is in the transition regime (based on Knudsen number). Molecular Dynamics (MD) was identified as a suitable method for simulating the physical phenomena for acoustics. This paper presents a review of previous MD simulations of relevance to the physics of acoustic absorption mechanisms at the nanoscale that have included micro- and nano- scale flow properties and acoustic wave propagation. The paper also discusses additional simulations that can be performed to verify that MD models can be used to correctly simulate acoustic absorption at the nanoscale.

28 Planar analysis of a quasi-zero stiffness mechanism using inclined linear springs

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ABSTRACT
Negative stiffness mechanisms have seen renewed attention in recent years for their ability to reduce the resonance frequency of a structure without impeding their load-bearing ability. Such systems are often described as having quasi-zero stiffness when the negative stiffness is tuned to reduce the overall stiffness of the system as close to zero as possible without creating an instability. The system analysed in this work consists of a vertical spring for load bearing, and two symmetric inclined springs which behave with a snap-through effect to achieve negative stiffness. While this structure has been analysed extensively in the literature, generally only the stiffness in the vertical direction has been considered in the past. Here, the horizontal stiffness is assessed as well, and it is shown that it is possible to achieve quasi-zero stiffness in both directions simultaneously if the spring stiffnesses and pre-loads are chosen sufficiently. Attention is paid to the tuning required in order to set the equilibrium point at a position which is arbitrarily close to having quasi-zero stiffness while avoiding issues arising from mechanical instability.

68 A CFD-BEM coupling technique for low Mach number flow induced noise

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ABSTRACT
A technique to couple computational fluid dynamics (CFD) and boundary element method (BEM) models is proposed that allows the total sound pressure field produced by low Mach number flow past a rigid body to be predicted. An incompressible CFD solver is used to calculate the transient hydrodynamic flow field. Acoustic sources based on Lighthill's analogy are then extracted from the flow field data. The CFD/BEM coupling technique is used to compute the acoustic field incident on the body. The incident acoustic field is calculated based on a near-field solution of Lighthill's analogy, which employs numerical techniques to accurately evaluate singular and near-singular integrals. This incident field is combined with a BEM model of the cylinder to predict the scattered sound pressure field. The results from this CFD/BEM coupling technique are presented for flow past a circular cylinder with Reynolds number, ReD=100 and Mach number, M=0.02. The directivity of the sound pressure field at the vortex shedding frequency is compared with results of alternate methods available in the literature.

111 **Vibration Monitoring - Future Directions and Best Practice for Infrastructure Projects**

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(2) AVA Monitoring AB Vädursgatan 6 412 50 GÖTEBORG SWEDEN

ABSTRACT
Large infrastructure projects are gaining increased community exposure and have heightened environment concerns during the project delivery and operational phase. Best practice techniques for vibration monitoring are considered with a view to future directions. The key areas considered are information dissemination to the community, alerts and alarms for the design team of trigger levels and finally cost effective techniques for vibration monitoring. Future directions in vibration monitoring include increased feedback between monitoring and construction / demolition activity with measured levels and multipoint / long term monitoring.

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