Abstracts and Conference Guide for

Acoustics 2009: Research to Consulting

Annual Conference of the Australian Acoustical Society

The University of Adelaide
Adelaide, South Australia, Australia
23-25 November 2009

Australian Acoustical Society
South Australian Division
ACN 000 712 658

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Editors: Anthony C. Zander and Carl Q. Howard

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Acoustics 2009 Organisation

Symposium Chairman	Byron Martin
Technical Chair	Anthony Zander
Organising Committee	Benjamin Cazzolato Jonathan Cooper Colin Hansen Peter Heinze Carl Howard Darren Jurevicius Valeri Lenchine Peter Maddern Byron Martin Simon Moore Marc Simpson Peter Teague Anthony Zander
Administrative Secretariat	Vicky Samra Wendy Brown Yvette Knapp
Proceedings Editors	Anthony C. Zander Carl Q. Howard
Exhibition Coordinator	Norm Broner

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http://www.adelaide.edu.au/
Venue Sponsors

Information for Higher Education Research Data Collection (HERDC)

The HERDC is the annual collection of statistics from Australian universities about research output and income. It is currently collected by the Department of Innovation, Industry, Science and Research. The following information is provided for authors intending to claim their research publications as part of the HERDC.

Title of conference publication	Acoustics 2009: Research to Consulting Proceedings of the annual conference of the Australian Acoustical Society
Name of Conference	Acoustics 2009: Research to Consulting
Publisher	The University of Adelaide School of Mechanical Engineering
Publication format	CD-ROM
Editors	Anthony C. Zander and Carl Q. Howard
Location of Conference	The University of Adelaide Adelaide, South Australia, Australia
Date of Conference	23-25 November 2009

Proof of peer review

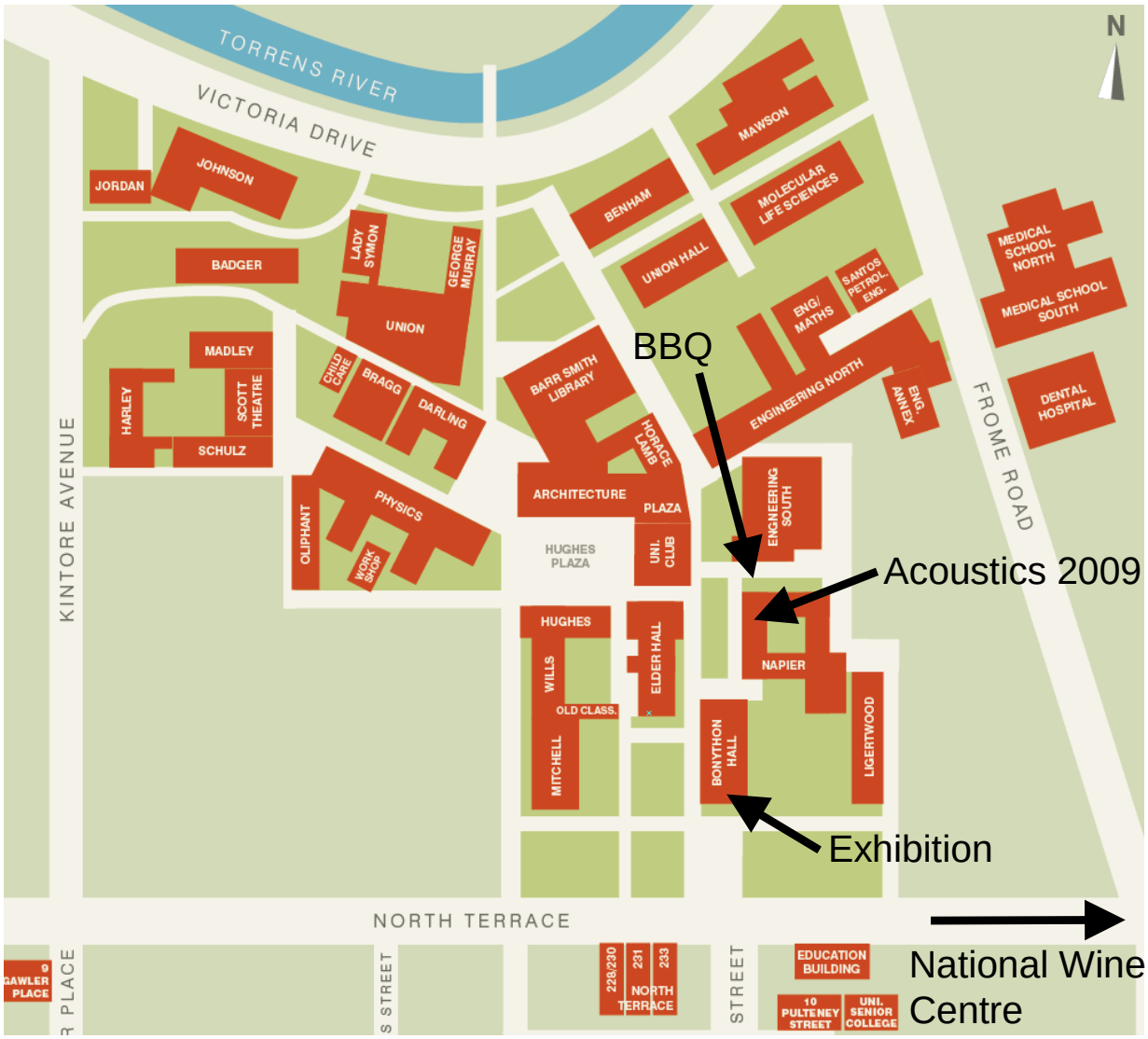
Each of the manuscripts accepted to 'Acoustics 2009: Research to Consulting' were anonymously reviewed by two members of a scientific committee comprising 41 members. The names of referees were kept anonymous from the authors. The referees reviewed the papers to ensure they were of high standard for the conference, and provided written feedback on the quality of the manuscripts. Where doubt remained after this process, the papers were reviewed by the scientific committee chairman. The referee criteria included: technical content, originality, clarity, English expression, technical significance. Papers were matched where possible to referees in the same field with similar interests and area of expertise as the authors. Authors were advised to make all changes recommended by the reviewers, or provide the editor with a technical justification for not making particular changes. The responses from authors were then reviewed by the editor.

The organising committee wishes to thank the scientific committee and the authors for their cooperation and time to enable this review process to occur.

Scientific Committee

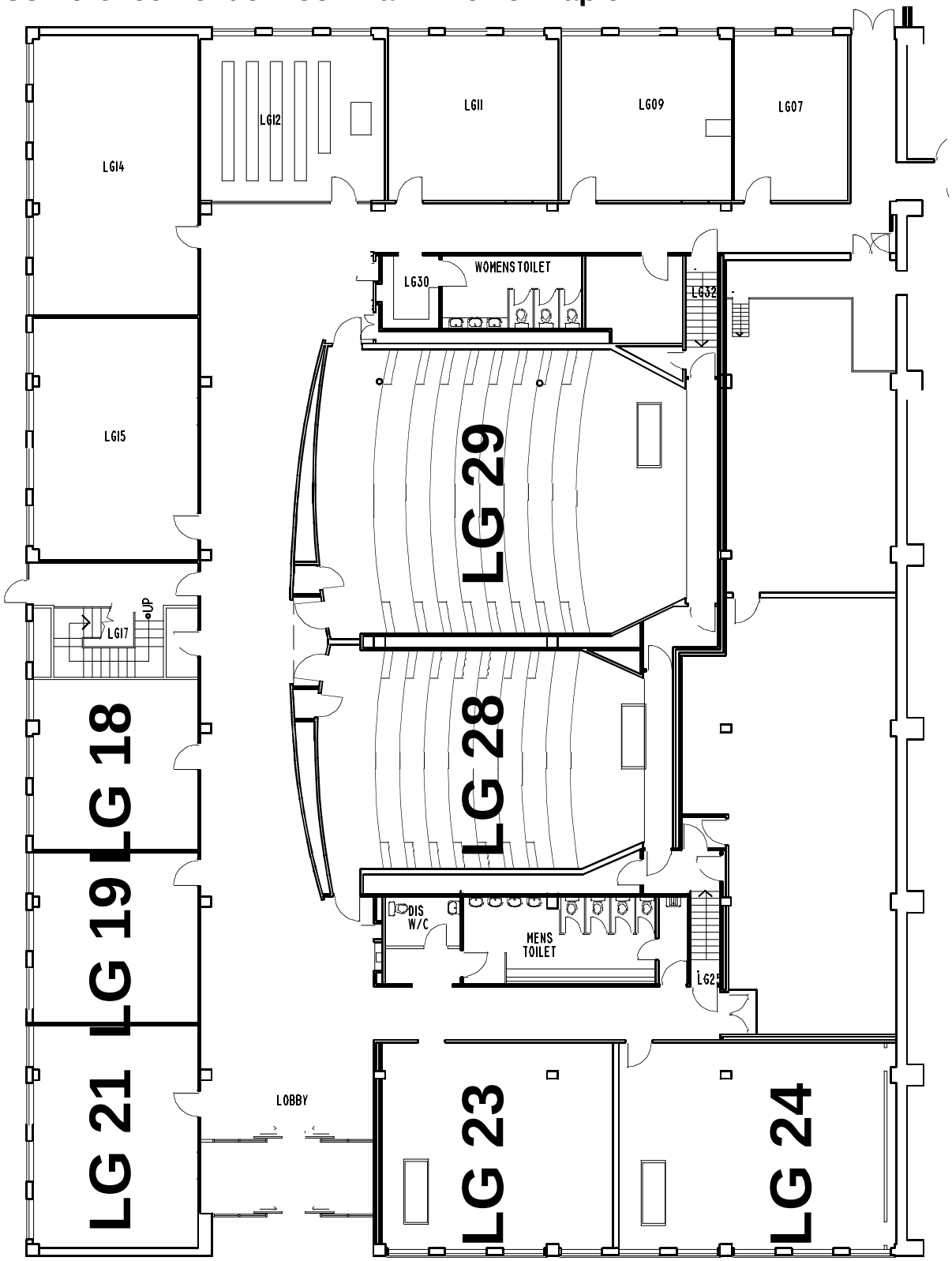
Laura Brooks, Marion Burgess, Densil Cabrera, Mauro Caresta, Dragana Carevic, Benjamin Cazzolato, Lei Chen, Paul Clarke, Jonathan Cooper, Duc Do, Con Doolan, Alec Duncan, James Forrest, Colin Hansen, Peter Heinze, Carl Howard, Adrian Jones, Ross Juniper, Darren Jurevicius, Rodney Kennedy, Nicole Kessissoglou, Mike Kidner, Joseph Lai, Valeri Lenchine, Kam Lo, William Martens, Byron Martin, Robert McCauley, Paul Meehan, Simon Moore, Danielle Moreau, Philippa O'Neill, Jie Pan, Robert Randall, Michael Smith, Matthew Stead, Hongmei Sun, Doug Sweet, Peter Teague, Anthony Zander, Yong Zhang, Alex Zinoviev

Map of Conference Venues



Additional detail of the University of Adelaide, including the National Wine Centre is shown in the separately provided North Terrace Campus Map.

Conference Venue Floor Plan – Lower Napier



Exhibitors

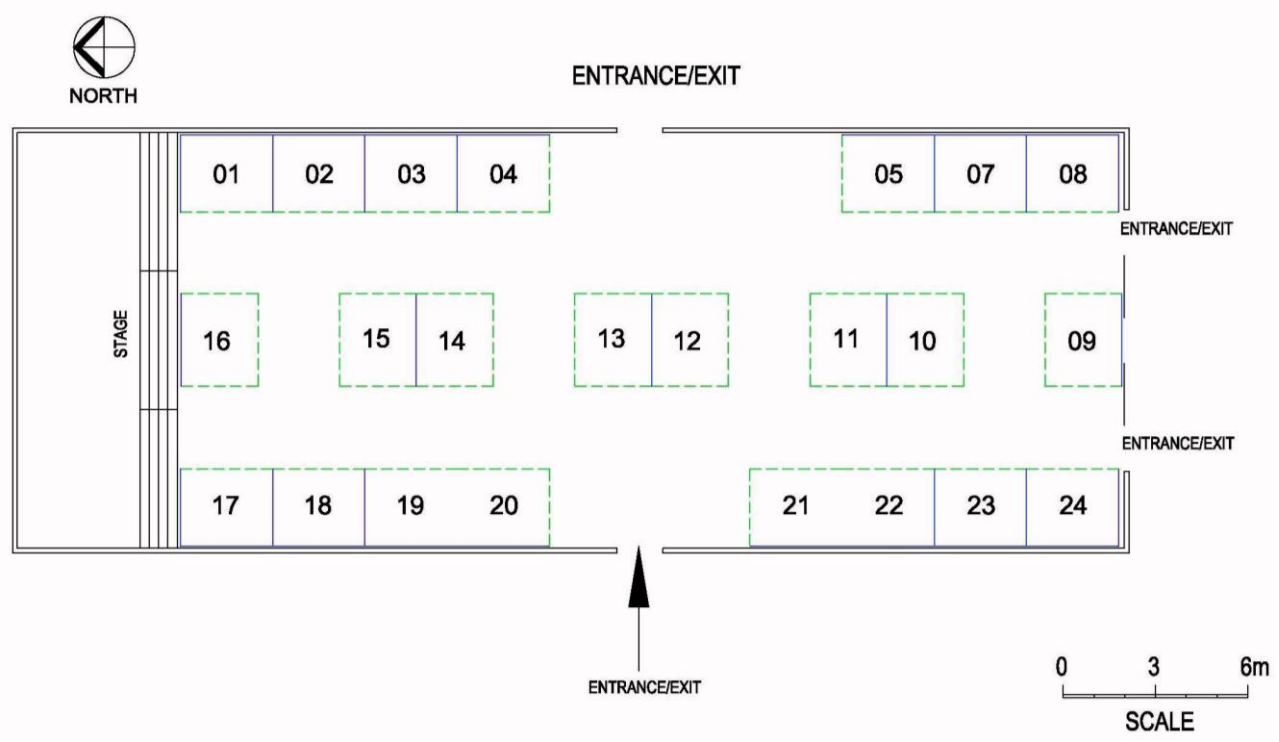
01. SoundPlan
02. Schrey and Veit GmbH
03. Renzo Tonin & Associates (NSW) Pty Ltd
04. ACU - VIB ELECTRONICS
05. Enviro Acoustics
07. Embelton
08. BioLab (aust) P/L
09. Autex Pty Ltd
10. Acoustic Research Laboratories P/L
11. Texcel P/L
12. Bruel & Kjaer
13. Pyrotek
14. KINGDOM PTY LTD
15. Instru-Labs
16. SAVTech Sound & Vibration Technology
17. HW Technologies
18. Max Bell Acoustics

19-20. CSR Bradford Insulation

21-22. Ortech Industries Pty Ltd

23. The PA People Pty Limited
24. H B Fuller

Map of Exhibition, Bonython Hall



Social Program

The overview of the social program is as follows:

Sunday Evening, 22 November	Welcome Reception at the National Wine Centre
Monday Evening, 23 November	Banquet at The Stamford Grand, Glenelg
Tuesday Evening, 24 November	No events
Wednesday Afternoon, 25 November	Closing ceremony and BBQ at the conference venue

Conference delegates and the accompanying persons that have paid to attend the social functions are invited.

The detailed program of events is listed below.

SUNDAY 22 NOVEMBER 2009		
Sunday 22 Nov 2009 17:00 to 20:00	**Welcome Reception** Guests will be provided with superb wine from six SA wine regions and gourmet canapés from 6:00pm in the great Hickinbotham Hall of the Wine Centre. Guests are invited to go on a 'closed-door' tour of the wine centre from 5:00pm (Interactive Wine Discovery Journey). Registrations will be done in Wine Centre foyer from 5:00pm. The Young Adelaide Voices will provide an atmospheric choir performance. The formal part of the evening will be to welcome conference delegates and declare the start of the conference.	National Wine Centre Cnr North Terrace & Hackney Road See inset on the separate North Terrace Campus Map Walk from your hotel to the venue

MONDAY 23 NOVEMBER 2009		
Monday 23 Nov 2009 08:00 to 16:00	**Registration Desk Opens** Conference delegates will be able to collect the conference compendiums that contains the CD-ROM of proceedings, book of abstracts, pen, notepad, guide books of Adelaide, etc.	Lower Napier Building Foyer [J11 on separate North Terrace Campus Map]
Monday 23 Nov 2009 08:30 to 09:15	**Welcome Speeches** The conference chairman and Vice Chancellor will give welcome speeches.	Lower Napier Building Room LG29
Monday 23 Nov 2009 09:30 to 10:30	**Plenary Keynote Presentation**	Lower Napier Building Room LG29
Monday 23 Nov 2009 10:30 to 11:00	**Morning Tea / Coffee Break**	Bonython Hall [L11 on separate North Terrace Campus Map]
Monday 23 Nov 2009 11:00 to 12:40	**Technical Presentations**	Lower Napier Building
Monday 23 Nov 2009 12:40 to 14:00	**Lunch**	Bonython Hall
Monday 23 Nov 2009 14:00 to 15:00	**Plenary Keynote Presentation**	Lower Napier Building Room LG29
Monday 23 Nov 2009 15:00 to 15:30	**Afternoon Tea / Coffee Break**	Bonython Hall
Monday 23 Nov 2009 15:30 to 17:10	**Technical Presentations**	Lower Napier Building
Monday 23 Nov 2009 18:00 to 23:30	**Conference Banquet** Walk from your hotel to Victoria Square (by 6:30pm) and trams will take us down to Glenelg.. Victoria Square is the Green Square at the intersection of King William Street and Wakefield Street. A sumptuous 3-course gourmet dinner with SA wines overlooking the beach. Guest speaker will be Prof Barry Brook from University of Adelaide Institute for Climate Change & Sustainability.	Stamford Grand Glenelg

TUESDAY 24 NOVEMBER 2009		
Tuesday 24 Nov 2009 09:30 to 10:30	**Plenary Keynote Presentation**	Lower Napier Building Room LG29
Tuesday 24 Nov 2009 10:30 to 11:00	**Morning Tea / Coffee Break**	Bonython Hall
Tuesday 24 Nov 2009 11:00 to 12:40	**Technical Presentations**	Lower Napier Building
Tuesday 24 Nov 2009 12:40 to 14:00	**Lunch**	Bonython Hall
Tuesday 24 Nov 2009 14:00 to 15:00	**Plenary Keynote Presentation**	Lower Napier Building Room LG29
Tuesday 24 Nov 2009 15:00 to 15:30	**Afternoon Tea / Coffee Break**	Bonython Hall
Tuesday 24 Nov 2009 15:30 to 17:10	**Technical Presentations**	Lower Napier Building
Tuesday 24 Nov 2009	No events for Tuesday evening	

WEDNESDAY 25 NOVEMBER 2009		
Wednesday 25 Nov 2009 09:00 to 10:20	**Technical Presentations**	Lower Napier Building Room LG29
Wednesday 25 Nov 2009 10:20 to 11:00	**Morning Tea / Coffee Break**	Bonython Hall
Wednesday 25 Nov 2009 11:00 to 12:00	**Technical Presentations**	Lower Napier Building
Wednesday 25 Nov 2009 12:00 to 12:20	**Australian Acoustical Society Annual General Meting**	Lower Napier Building Room LG29
Wednesday 25 Nov 2009 12:20 to 12:30	**Closing Ceremony and Paper Prizes**	Lower Napier Building Room LG29
Wednesday 25 Nov 2009 12:30 to 13:30	**BBQ Lunch**	Lawns outside conference venue [H11 on separate North Terrace Campus Map]
	END OF CONFERENCE	

Conference Schedule

The keynote addresses will be held in room LG29 and occur first session in the morning and after lunch.

If you are a presenter in a session please contact the session assistants in the room during the coffee break prior to the sessions. They will help you load for files onto the computer.

If you move between rooms during the sessions, please keep disturbances to a minimum moving during the question time and change over period.

Please turn off your mobile phones or put them on silent during the conference.

Sunday 22 November 2009

Sunday 9:00-12:30	AAS Federal Councillors meeting, *Davis Room, Engineering South building*
Sunday 12:30-1:30	Lunch, *Davis Room, Engineering South building*
Sunday 1:30-5:00	AAS Federal Councillors meeting, *Davis Room, Engineering South building*
Sunday 5:00-8:00	Welcome Reception, *National Wine Centre*

Monday 23 November 2009

Monday 8:00-10:00	Registration, *Lower Napier Foyer*
Monday 8:30-8:45	Vice Chancellor's Opening Address, *LG29*
Monday 8:45-9:15	Conference Chairman's Opening Address, *LG29*
Monday 9.30-10.30	KEYNOTE ADDRESS, *LG29* Acoustical properties of ancient Chinese musical bells, **Jie Pan**, Paper 61
Monday 10.30-11.00	MORNING TEA, *Exhibition - Bonython Hall*

	LG28 ***Noise and Vibration***	LG29 ***Acoustic Measurements + Acoustics of Wind Turbines***	LG24 ***Workshop***
Monday 11.00-11.20	Construction noise and vibration impacts on sensitive premises **Cedric Roberts**, Paper 11	HRTF measurement on KEMAR manikin **Mengqiu Zhang et al.**, Paper 8	SoundPlan Workshop - Computer noise simulations and associated problems discussed from the perspective of SoundPLAN **Arne Berndt**, Paper 91
Monday 11.20-11.40	Load control frequency injection cell – structure-borne noise attenuation **David Borgeaud**, Paper 16	Transient detection in impulsive noise using low-variance spectrum estimation **Dragana Carevic**, Paper 59	
Monday 11.40-12.00	System identification with mean differential cepstrum using random decrement **Wee-Lee Chia et al.**, Paper 25	Sound power assessment on earth-moving equipment **Ruisen Ming**, Paper 76	
Monday 12.00-12.20	Tuned vibration absorbers for control of noise radiated by a panel **Swee Kuik et al.**, Paper 31	Amplitude modulation in wind turbine noise **Valeri Lenchine**, Paper 47	
Monday 12.20-12.40	Modal analysis of a five-storey building **Helen Wu**, Paper 66	Nonsense on stilts **Philip Dickinson**, Paper 6	
Monday 12.40-2.00	LUNCH, *Exhibition - Bonython Hall*		
Monday 2:00-3:00	KEYNOTE ADDRESS, *LG29* Sense from sensing sound, **Brian Ferguson**, Paper 63		
Monday 3:00-3:30	AFTERNOON TEA, *Exhibition - Bonython Hall*		

Monday 23 November 2009

	LG28 ***Noise and Vibration + Psychological and Physiological Acoustics***	LG29 ***Ship Acoustics + Acoustic Guideline Workshops***	LG24 ***Workshop***
Monday 3:30-3:50	Tunnelling induced ground-borne noise modelling **Colin Speakman and Stephen Lyons**, Paper 69	A design strategy in the propulsion system attachment to a submarine hull to minimise radiated noise **Mauro Caresta and Nicole Kessissoglou**, Paper 79	SoundPlan Workshop - Open Question Session **Arne Berndt**, Paper 91
Monday 3:50-4:10	Simulation of gas turbine blade measurement from unsteady casing wall pressure **Gareth Forbes and Robert Randall**, Paper 83	Effect of the bending modes on the radiated sound pressure from a submarine hull **Mauro Caresta and Nicole Kessissoglou**, Paper 80	
Monday 4:10-4:30	Extraction of tacho information from a vibration signal for improved synchronous averaging **Michael Coats et al.**, Paper 84	AAAC Workshop for Acoustical Design of Schools Guideline (Draft) **Tim Marks**, Paper 89	
Monday 4:30-4:50	Equal reverberance matching of music **Doheon Lee et al.**, Paper 17	AAAC Workshop for the Child Care Centre Acoustic Guideline **Stephen Gauld**, Paper 87	
Monday 4:50-5:10		AAAC Workshop for Apartments and Townhouses Acoustical Star Rating Guideline **Tim Reynolds**, Paper 88	
Monday 5:00- 6:00	Walk to Victoria Square for Tram Ride to Glenelg		
Monday 6:00-11:30	Banquet Dinner, *Stamford Grand, Glenelg*		

Tuesday 24 November 2009

Tuesday 9.30-10.30	KEYNOTE ADDRESS, *LG29* Industry and university partnerships in acoustic research - factors for success, **David Rennison**, Paper 86
Tuesday 10.30-11.00	MORNING TEA, *Exhibition - Bonython Hall*

	LG28 ***Transport Noise***	LG29 ***Aeroacoustics***	LG24 ***Workshop***
Tuesday 11.00-11.20	Outcomes of two of the recommendations from the Queensland ombudsman's report on the Pacific Motorway with respect to road traffic noise issues **Arthur Hall**, Paper 4	Aeroacoustic simulation of bluff body noise using a hybrid statistical method **Con Doolan**, Paper 3	VA-One Workshop **Paul Croaker**, Paper 93
Tuesday 11.20-11.40	Road traffic noise management in Queensland through the Element Leadership Process **Cedric Roberts**, Paper 10	Vehicle motion parameter estimation using a wide-aperture acoustic sensor array of unknown shape **Kam Lo and Brian Ferguson**, Paper 30	
Tuesday 11.40-12.00	Noise impact of a major transport corridor on a barramundi fish farm **Cornelis Petersen et al.**, Paper 13	Comparison of the Kirchhoff and Ffowcs Williams and Hawkings methods of aeroacoustics in application to the sound radiated by a thin plate vibrating in its own plane in a viscous fluid **Alex Zinoviev**, Paper 35	
Tuesday 12.00-12.20	Road noise aspects of the NSW Infrastructure SEPP's 'Development in Rail Corridors and Busy Roads – Interim Guideline' **Peter Karantonis et al.**, Paper 32	Airfoil noise measurements at various angles of attack and low Reynolds number **Elias Arcondoulis et al.**, Paper 48	
Tuesday 12.20-12.40	Investigation into the effect of asymmetric train speed distribution on rail corrugation growth in cornering **Ross Batten et al.**, Paper 81	Analysis and reduction of blade passing noise of a VTOL aircraft **Jie Pan et al.**, Paper 62	
Tuesday 12.40-2.00	LUNCH, *Exhibition - Bonython Hall*		

Tuesday 24 November 2009

Tuesday 2:00-3:00	KEYNOTE ADDRESS, *LG29* Advanced passive treatment of low frequency sound and vibration, **Chris Fuller**, Paper 64
Tuesday 3:00-3:30	AFTERNOON TEA, *Exhibition - Bonython Hall*

	LG28 ***Transport Noise + Active Noise and Vibration Control***	LG29 ***Underwater Acoustics***	LG24 ***Workshop***
Tuesday 3:30-3:50	Numerical prediction of brake squeal propensity using acoustic power calculation **Sebastian Oberst and Joseph Lai**, Paper 65	Using short-range signals from continuous wave excitation to develop a geo-acoustic model of a shallow-water seabed **Marshall Hall**, Paper 9	Transit Oriented Development Workshop **Darren Jurevicius**, Paper 92
Tuesday 3:50-4:10	Review of adaptive tuned vibration neutralisers **Carl Howard**, Paper 26	Characterising the New Zealand ambient seismic noise field: an oceanographic interpretation of western North Island spectra and beamforming results **Laura Brooks et al.**, Paper 12	
Tuesday 4:10-4:30	Active noise control at a moving virtual microphone using the SOTDF moving virtual sensing method **Danielle Moreau et al.**, Paper 38	Cyclostationarity for ship detection using passive sonar: progress towards a detection and identification framework **David Hanson et al.**, Paper 21	
Tuesday 4:30-4:50	Reduction of the sound power radiated by a submarine using passive and active vibration control **Sascha Merz et al.**, Paper 49	Estimating sonar system losses due to signal spatial decorrelation **Yong Zhang**, Paper 33	
Tuesday 4:50-5:10	Optimal design of a control actuator for sound attenuation in a piping system excited by a positive displacement pump **Xia Pan et al.**, Paper 75	Enhancements to a tool for underwater acoustic sensitivity snalysis, and relative importance of uncertainties in environmental parameters **Douglas Sweet**, Paper 36	

No Social Events for Tuesday Evening

Wednesday 25 November 2009

	LG28 ***Thermoacoustics + Computational Acoustics + Industrial Acoustics + Legislation and Standards***	LG29 ***Underwater Acoustics***	LG24 ***Workshop***
Wednesday 9:00-9:20	Waste-heat-driven thermoacoustic engine and refrigerator **David Gardner and Carl Howard**, Paper 28	Modelling the acoustic reflection loss at the rough ocean surface **Adrian Jones et al.**, Paper 37	Wind Farm Noise Workshop **Peter Teague**, Paper 90
Wednesday 9:20-9:40	An evaluation of current commercial acoustic FEA software for modelling small complex muffler geometries: prediction vs experiment **Peter Jones and Nicole Kessissoglou**, Paper 85	Experimental observation of the frequency dependence of horizontal refraction effect on bearing estimation of hydroacoustic events **Binghui Li et al.**, Paper 40	
Wednesday 9:40:10:00	Optimisation of noise control treatments for staged noise management programs using genetic algorithms **Dave Davis**, Paper 70	Acoustic propagation over limestone seabeds **Alec Duncan et al.**, Paper 41	
Wednesday 10:00-10:20	On the integration of Green Star rating tools with the acoustic design of offices and educational institutions **Aaron James and Luke Zoontjens**, Paper 45	Development of a simple underwater acoustic channel simulator for analysis and prediction of horizontal data telemetry **Grant Pusey and Alec Duncan**, Paper 44	
Wednesday 10.20-11.00	MORNING TEA, *Exhibition - Bonython Hall*		

Wednesday 25 November 2009

	LG28 ***Environmental Acoustics***	LG29 ***Underwater Acoustics + OH&S***	LG24 ***Architecural Acoustics***
Wednesday 11.00-11.20	Effectiveness of alternative audible movement warning alarms **Marion Burgess and Matthew McCarty**, Paper 39	A prototype PVDF underwater pressure-gradient acoustic intensity probe **Damien Killeen et al.**, Paper 46	Evaluation of changes in stereo imagery during progressive optimization of loudspeaker configuration in critical listening rooms **David Spargo et al.**, Paper 15
Wednesday 11.20-11.40	What annoyed me – vibration or low-frequency noise? **Jingnan Guo**, Paper 60	Optimisation of a submarine's resonance changer using the method of moving asymptotes **Sascha Merz et al.**, Paper 50	Towards an active reverberant room **Ken Stewart and Densil Cabrera**, Paper 18
Wednesday 11.40-12.00	CoRTN maximum noise emmissions **Benjamin Hall**, Paper 68	Noise exposure profiles **Warwick Williams**, Paper 7	Normal incidence sound absorption coefficient of direct piercing carved wood panel with star and diamond dominated geometric patterns **Mohamad Ngasri Dimon et al.**, Paper 29
Wednesday 12.00-12.20	AAS Annual General Meeting, *LG29*		
Wednesday 12:20-12:30	Closing Ceremony, *LG29*		
Wednesday 12:30-1:30	BBQ Lunch, *Napier Lawn/Mechanical Engineering Courtyard*		
Wednesday 1:30-2:00	Post AGM AAS Federal Councillors meeting, *LG24*		

Timing for General Presentations

All papers in the conference are arranged into 20 minute slots, which allows for 15 minutes of presentation, 3 minutes for discussion, and 2 minutes to change over between presenters and allows delegates to move between conference rooms.

The timing for each general presentation is as follows:

0 min	Begin presentation
13 min	Two minute warning sound
15 min	Presenters must immediately stop their presentation. Sessions chairs will enforce this time limit strictly. Start of question time.
18 min	End of questions. Change over between presenters
20 min	End of time slot for the presentation

Timing for Plenary Keynote Presentations

The plenary keynote papers in the conference are arranged into 60 minute slots, which allows for 50 minutes of presentation and 10 minutes for discussion. After every plenary keynote presentation is a coffee / tea break, and this time will be used to allow delegates to leave the lecture room.

0 min	Start presentation.
48 min	Two-minute warning sound, keynote presenters should conclude their presentation.
50 min	Keynote presenters must immediately finish their presentation. The session chair will open the floor for questions.
60 min	End of questions, and presentation. End of time-slot for the presentation.

Wireless Internet Access

Wireless internet access is available during the conference and will be available in the area around the Lower Napier Building. See the noticeboard in the conference foyer for details on how to connect to the network.

Technical Equipment and Organisational Details

All lecture theatres will be equipped with a computer video projector and a desktop computer (Microsoft Windows XP) that has a USB port and a CD-ROM / DVD drive to enable the transfer of presentations onto

All lecture rooms will be equipped with a computer video projector and a desktop computer (Microsoft Windows XP) that has a USB port and a CD-ROM drive to enable the transfer of presentations onto the computer.

All presentations must be prepared for viewing using either:

- Microsoft PowerPoint 2007 (this software will read earlier versions), or
- Adobe Acrobat Reader (version 6.0)

without exception. Also note that there is no possibility to install additional software (codecs, viewers, etc) on the computers that are provided for the presentations. Overhead or slide projectors cannot be used. All lecture theatres have amplified audio playback from the desktop computer.

Please provide your presentation on a CD or a USB-stick. We recommend that you transfer your presentation to the computer in the respective lecture room in advance of the beginning of each session. A good time for this is during the coffee breaks. Each computer will have folders identified with the particular sessions taking place at each day. The staff member in the room will help you to copy your file into the corresponding folder.

In general, we urge you NOT to use your own laptop computer as this takes additional time for replugging, rebooting, adjusting the resolution etc. However, some presenters may have specific video or audio presentations that they wish to show, in which case it is preferable that they provide their own laptop that has all the necessary video / audio playing software installed.

Please identify yourself to the sessions' chairperson at the beginning of each technical session so that he/she can know in advance that your presentation will take place according to the schedule.

Please be present in your presentation room at least 5 minutes before the beginning of your allotted session.

A laser pointer will be provided in each presentation room, along with glasses of water.

LG23 will also be available for presenters to practice their seminars.

List of Abstracts

Paper Number: 3
Theme: Aeroacoustics
Con Doolan
School of Mechanical EngineeringUniversity of Adelaide
con.doolan@adelaide.edu.au

Aeroacoustic simulation of bluff body noise using a hybrid statistical method

The prediction of aerodynamic noise generated by bluff bodies is important for a broad range of technologies, such as aircraft landing gear and automotive external mirrors. However, accurate prediction is difficult and time-consuming due to the complicated flow physics that occurs in the near wake. Typically, noise predictions require computationally demanding three-dimensional flow simulations that are usually not practical for engineering use. In this paper, a method is described where two-dimensional flow simulations are used with a statistical model to introduce the effects of flow three-dimsionality into the acoustic source calculation procedure. The result is a noise prediction method that is many times faster than conventional methods. The paper will describe the method, its advantages and disadvantages and use it to simulate the noise (Aeolian tone) from a cylinder placed in a flow where its wake is turbulent (and three-dimensional). The method is shown to accurately capture the spectral broadening about the main tone.

Paper Number: 4
Theme: Transport Noise

Arthur Hall
Design, Environment and Stewardship Division, Queensland Department of Transport and Main Roads, Brisbane, Australia
arthur.m.hall@mainroads.qld.gov.au

Outcomes of two of the recommendations from the Queensland ombudsman's report on the Pacific Motorway with respect to road traffic noise issues

Following a Queensland Government public announcement on 15 April 1996, the Department of Main Roads (DMR) upgraded the Pacific Highway between the Logan Motorway and Nerang to motorway standard. Complaints were lodged with the Queensland Ombudsman (QO), by the community group known as "Residents Against Increased Noise (RAIN)". The complaints concerned the actions of DMR in upgrading the Pacific Motorway, particularly its decision to construct some sections of the pavement surface with concrete rather than asphalt. The decision to use concrete had caused RAIN to be concerned about the effects of road traffic noise on their everyday lives. The QO's responsibility under the Ombudsman Act is to investigate complaints involving the administrative decisions and actions of public sector agencies and to recommend remedial action where appropriate. The QO formed 16

Opinions and made 22 Recommendations. This paper comments on two of the Recommendations of the QO. These recommendations involved DMR offering treatments to individual noise sensitive premises in order to improve the acoustic amenity inside the premises. In general, where a predicted increase of 2 or greater than or equal to 3 dB(A) in noise level occurred at these premises between 1996 and 2011, then the owners are being offered the installation of mechanical ventilation or air conditioning and mechanical ventilation respectively so that they can close their windows to improve their acoustic amenity.

Paper Number: 6
Theme: Acoustics of Wind Turbines

Philip J. Dickinson
Massey University, Wellington, New Zealand
P.J.Dickinson@massey.ac.nz

Nonsense on stilts

The expressions “Environmental Sustainability” and “Resource Management” may seem to be synonymous. In the original concept this could have been the intent, but now that we have in operation a number of alternative energy sources to offset the use of fossil fuels, unforeseen emissions may be affecting local communities in the vicinity with the possibility of public health being compromised. Wind farms are one such alternative energy source and the effects of noise emissions on the health of people living within several kilometres of the wind farms is becoming a concern. The noise level from a wind farm may be quite low, but its characteristics compared to that of the normal background sound make it stand out as something quite different, and its ability to excite room resonances makes it an irritant causing severe loss of sleep and extreme annoyance. Often the sounds are heard more clearly indoors than outside. New Zealand Standard 6808 on the noise from wind turbines has been reviewed and a new draft standard produced for public comment. The draft differs little from the existing standard and closely follows that used in Britain and parts of Europe, even though there are clear indications that the criteria to be met does not fully conform with World Health Organization recommendations, and the methodology used is mathematically, scientifically and ethically wrong. It is clearly biased towards wind farm development for as little cost as possible, and it would appear public health concerns are not being given enough attention. The effects long term have yet to be determined but, unless there is a radical change in the technology and the way sound from wind farms is assessed, a human cost is expected.

Paper Number: 7
Theme: OH&S
Warwick Williams
National Acoustic Laboratories
warwick.williams@nal.gov.au

Noise exposure profiles

How much noise is an individual typically exposed to over their life-time and is it possible to construct a 'noise exposure profile' that could approximate this exposure? This paper proposes how such a profile could be constructed based on both work and leisure noise and why this profile has relevance to those with interest in the relationship between noise exposure, noise injury and hearing loss.

Paper Number: 8
Theme: Acoustic Measurements
Mengqiu Zhang
Wen Zhang
Rodney A. Kennedy
Thushara D. Abhayapala
Department of Information EngineeringResearch School of Information Sciences and EngineeringThe Australian National University
Karan.Zhang@cecs.anu.edu.au

HRTF measurement on KEMAR manikin

Presenting sounds to humans in virtual environments requires convolving the free field signals with a head related transfer function (HRTF), which is a frequency response describing the filtering effects of the pinna, head and torso of a human. Sets of HRTFs are usually measured on the dummy head or human subjects at different directions in an anechoic room. This paper describes the details of an experimental HRTF measurement procedure with emphasis on the design of the test signal and the post-processing to extract HRTFs. We construct a pre-emphasized logarithmic sweep as the excitation signal which separates the nonlinear and time variant distortions from the main desired response. For the received raw data, a series of signal processing techniques are applied to determine the timing offset when the head response begins, to mitigate room reverberation, and to equalize the HRTF measurements. One of the goals of this paper is to provide details of the experimental setup. Also, we intend to publish our processed measurements in the form of a HRTF data base as a resource for the acoustic community.

Paper Number: 9
Theme: Underwater Acoustics

Marshall V. Hall
Midspar Systems Pty Ltd, Oyster Bay NSW(present address: Department of Mathematical Sciences, University of Technology Sydney, Ultimo NSW 2007)
marshallhall@optushome.com.au

Using short-range signals from continuous wave excitation to develop a geo-acoustic model of a shallow-water seabed

Propagation runs, during which a hydrophone was successively placed at ranges from 19 m out to 68 m from a pro-jector, have been conducted in seawater 12 m deep. Tones were emitted at frequencies of 200, 400 and 800 Hz. An inversion has been conducted on the received SPL for the purpose of obtaining a simple Geo-Acoustic Model (GAM) that gives an optimum fit to the data. The GAM was assumed to comprise two homogeneous

layers overlying a ho-mogeneous basement. Five parameters were nominated as unknowns for the inversion: porosities of the two layers and of the basement, and thicknesses of the two layers. In computing the cost function, the data from the three runs were included simultaneously, so that one GAM would be obtained that would be optimum for the frequency band from 200 to 800 Hz. For each porosity tried during the inversion, the acoustic properties of the layers and basement were calculated using published regressions; the second layer and basement were treated successively as uncemented and cemented sediment. Consequent Transmission Losses were calculated using the Ocean Acoustic and Seismic Transmission (OAST) mathematical model. The best agreement with acoustic data was obtained with the second layer uncemented and the basement cemented, but the best agreement with nearby geological data was obtained with both the layer and basement cemented. The former yielded optimum layer thicknesses of 0.76 and 1.07 m, while the latter yielded 1.48 and 6.85 m. The latter also yielded porosities compatible with the geological data, which indicated a 4-m layer of loose silty sand overlying a layer of medium sand limestone and dense sand.

Paper Number: 10
Theme: Transport Noise

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Road traffic noise management in Queensland through the Element Leadership Process

This paper summarises the contents of the controlled document Element Management Plan. Part 1 (Elem Mngr 2008) dealing with Process Description and defines the formal processes for planning investments within a forward program of works for the Road System Manager: Element No 9. Road Traffic Noise Management for the Queensland State Controlled Road Network. The key outcome of this process is to manage road traffic noise to support more liveable communities and minimise negative impacts on the amenity of areas and peoples' quality of life within the road corridor. In general the Element Leader manages the element inventory and condition data base, defines and steers the collec-tion of quality assured data necessary to define element investment needs across the state network and is regularly required to review the medium and long term performance vision for the 'Element'. Traffic noise modelling is essential for the process and requires a number of input parameters for example, Annual Average

Daily Traffic (AADT), % commercial vehicles, distances to and elevation of receptors. A more complete description of essential input parameters is given in a Regional Road Traffic Noise Management Strategy (RRTNMS) (Metro RRTNMS). Essential physical and acoustical attributes of noise barrier structures required to be inspected and an auditing protocol are given in this Part 1 of the Element Management Plan (EMP). Results of inspections will be entered into a Noise Barrier Database and intervention levels for noise barrier maintenance will also be described.

Paper Number: 11
Theme: Noise and Vibration

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Construction noise and vibration impacts on sensitive premises

Construction noise and vibration must be considered an essential part of the development of any transportation facility. Road and tunnel construction is often conducted in close proximity to residential and commercial premises and should be predicted, controlled and monitored in order to avoid excessive noise and vibration impacts. Construction noise and vibration can threaten a project's schedule if not adequately analysed and if the concerns of the community are not addressed and incorporated. Airborne noise - Construction over the length of a project can take place 24 hours a day and for major projects, in excess of 2 to 3 years. Construction equipment can operate in very close proximity to residential and commercial (and even industrial) premises. Many items of equipment can be found operating at any time throughout a project. Equipment types range from mobile cranes, pile drivers, jackhammers, dump trucks, concrete pumps and trucks, backhoes, loaders, dozers, rock-breakers, rock drills, pile boring machines, excavators, concrete and chain saws, and gas and pneumatically powered hand tools. An additional factor of great importance is the presence of low frequency noise (< 200 Hz) in the source sound spectra of many items of equipment for which the 'true' annoyance capability at sensitive receptors is not reflected either in the measurement or prediction using the overall A-weighted sound pressure level, or dB(A). Ground vibration - The total attenuation of vibration from an item of construction equipment to a receptor is estimated from the: spreading loss, a value dependent on whether the source of vibration is considered a point, line or planar source; attenuation due to internal losses in the soil and rock, being a function of loss factor h, velocity of propagation c, frequency

of the vibration and distance to the receptor; and attenuation due to changes in soil or rock along the propagation path, being a function of mechanical impedances of individual differing rock components. Mechanical impedance is derived from the density of the various media and longitudinal wave speeds for each media. Wave propagation is usually surface or Rayleigh (or R-wave) type. Here again the perception of ground-borne vibration within premises is of a low frequency character. This paper describes methods adopted to estimate the airborne spectra at the boundary of sensitive premises and within these premises using various software modelling packages. The indoor receptor levels are then compared to acceptable criteria. Ground-borne vibration at the boundary of premises will be compared to established vibration perception evaluation criteria.

Paper Number: 12
Theme: Underwater Acoustics

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Characterising the New Zealand ambient seismic noise field: an oceanographic interpretation of western North Island spectra and beamforming results

Although seismometers are generally designed to record episodic events such as earthquakes and volcanic eruptions, most of the time they are actually recording ambient seismic noise. At frequencies lower than about one hertz, Rayleigh waves produced by nonlinear ocean wave processes constitute much of the ambient noise field. The seismological community has recently taken advantage of this and there is now much interest in using ambient seismic noise for purposes such as measuring surface wave velocities and thereby inferring the velocity structure of the crust and upper mantle. However, in order to account for spatio-temporal or azimuthal biases in the noise field underpinning surface wave velocities, the characteristics of the noise field itself must first be understood. This study investigates the spatial and temporal characteristics of the New Zealand ambient seismic noise field. Rayleigh waves at the ocean wave frequency are typically generated by direct ocean wave-induced pressure fluctuations at the sea floor, and Rayleigh waves at double this frequency are generated by opposing wave fields. New Zealand's geographic isolation exposes it to a particularly energetic ocean wave climate. Examples of signals generated in the oceans surrounding New Zealand are shown here in spectrograms of seismometer data, and are related to observed wind and ocean wave characteristics.

Data collected on a seismometer array of up to 58 instruments in the Taranaki region (western North Island) were beamformed in order to estimate the relative source directions of incoming seismic noise. Signals with phase velocities corresponding to those expected for both fundamental and higher-order Rayleigh waves are observed. Regions of ambient seismic noise generation highlighted by the beamformer output are shown to agree well with modelled shallow-water (50m isobath) ocean wave heights from around the New Zealand coast.

Paper Number: 13
Theme: Transport Noise

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Noise impact of a major transport corridor on a barramundi fish farm

The environmental noise impact of a proposed major transport corridor on a barramundi fish farm was assessed following concerns about the potential impacts on the barramundi. As part of the assessment, a study into fish hearing and the impacts of noise on fish was conducted. The ambient noise environments within the fish tanks and building enclosure were measured before construction of the transport corridor to establish the existing conditions. The existing environment was found to be relatively noisy and audible to the barramundi, with measured underwater noise levels of 130 to 135 dB re 1 µPa between 10 Hz and 4 kHz. Low frequency noise (<400 Hz) due to water pumps, aeration equipment and other mechanical plant dominated the fish tank environments. Impacts of the transport corridor were identified as negligible because the noisy existing environment masks the predicted traffic noise levels. This paper gives an overview of the assessment process and presents some of the outcomes.

Paper Number: 15
Theme: Architectural Acoustics

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Evaluation of changes in stereo imagery during progressive optimization of loudspeaker configuration in critical listening rooms

While simple approaches to the configuration of loudspeakers in critical listening rooms are well known, there is no standardized practice for optimizing loudspeaker positions that is based upon improvements in the perceived quality of the stereo imagery associated with adjustments to the loudspeaker positions. As the influence of the acoustical response of the reproduction space on stereo imagery is not so simple to predict, a pragmatic solution to this problem has been

developed and is growing in popularity, particularly among recording engineers. This method utilizing changes in stereo image quality that occur when moving either the listening position or loudspeaker positions in an effort to find an optimum configuration within a listening room. While the method gives good practical results, there is as yet no explanation as to how or why the method works, and no consensus regarding the characterization of changes in auditory imagery to which listeners must attend. To provide a more scientific foundation for explaining this method, the steps involved in optimization were documented for a test case, and the changes in the binaural responses during the adjustment of loudspeaker positions were analysed in relation to loudspeaker configurations that were preferred by a group of ten listeners.

Paper Number: 16
Theme: Noise and Vibration
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Load control frequency injection cell – structure-borne noise attenuation

Zone substations are located at various strategic locations throughout the electricity network in Australia. These substations typically include several significant noise sources, transformers being the most common “problem” source. Changing consumer usage and increasing load demand requires ongoing augmentation of substations to keep pace with the changing requirements. Increasing capacity combined with new electrical technology introduces potential new noise sources to be assessed and addressed. Recent projects have seen capacitor and load control frequency injection (LCFI) cells causing significant noise levels on and off-site for substations. The cells are used by energy authorities to control the hours of operation of equipment to reduce peak electrical loads on the network for various devices such as domestic hot water systems. The LCFI cells turn equipment on and off by sending signals (pulses) through the electrical system. This paper discusses the noise and vibration levels generated by a newly installed LCFI cell at a zone substation. The 80kVA, 283Hz LCFI cell was located in a masonry control room, and generated noise levels of over 95dB(A) within the frequency injection room. This resulted in unsuitably high noise levels for staff elsewhere in the building. Analysis of the situation indicated that the noise was primarily structure-borne, and that a combination of vibration and noise control treatments would be required to adequately attenuate the noise. The installed treatments

achieved a significant noise reduction for the building occupants and the results of the noise and vibration control treatments are presented in this paper. The information gathered will assist in addressing noise from similar LCFI cells at other zone substations in the electricity network, to protect the health and amenity of substation staff and nearby residents.

Paper Number: 17
Theme: Psychological and Physiological Acoustics
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Equal reverberance matching of music

This study explores the perceived reverberance of music in simulated auditoria. The stimuli were created by convolving an anechoic music recording with a variety of auditorium impulse responses. The study investigated the change in perceived reverberance of these stimuli that results from changing the overall gain on the sound stimuli, and the gain on added background noise. Based on objective loudness modelling, our hypothesis is that overall gain on the sound stimuli has a positive effect on perceived reverberance (even though it has no effect on reverberation time), while the introduction of background noise has a negative effect (i.e., reducing perceived reverberance). In a subjective experiment, participants adjusted decay rate of auditorium impulse responses convolved with the anechoic music sample in order to match the reverberance of the music stimuli to that of a reference music sample. Also, background noise was added at several gain values according to a randomized trial ordering scheme. Results were compared with those of a previous study in which auditorium impulse responses (without convolution) were matched to the reverberance of a reference sample using the same method.

Paper Number: 18
Theme: Architectural Acoustics
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Towards an active reverberant room

A laboratory reverberant room is used for sound power, sound absorption, and sound scattering measurements, and needs to meet certain volume and absorption criteria in order to make good measurements. This paper examines the possibility of creating or enhancing a reverberant room through a system of electroacoustic feedback. For such a system, signals from a set of microphones are distributed to a set of loudspeakers, with the system's transfer functions between microphones

and loudspeakers (i.e., the gain, delays, and detailed spectrum) established so as to create desired exponential decay of the total system as sound feeds back through the combined physical space and electroacoustic system. This approach can be used to increase the spatial diffusivity of the reverberant soundfield, increase the modal density of a room (by introducing new modes that have an electroacoustic component), as well as an increase in reverberation time. However, introducing such a system means that the assumptions behind statistical room acoustics (used, for example, in calculating absorption coefficients) require an extension to account for the electroacoustic system. Theoretical development of this concept is accompanied by experimental results from a rectangular reverberant room.

Paper Number: 21
Theme: Underwater Acoustics

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Cyclostationarity for ship detection using passive sonar: progress towards a detection and identification framework

As the blades of a propeller pass through the water they produce characteristic amplitude modulated random noise signals which can be detected using sonar. It has recently been shown that the cyclostationary properties of this signal can be exploited to detect the presence of the propeller craft in significant extraneous noise. Using cyclostationary signal processing offers advantages over existing techniques such as Detection of Envelope Modulation On Noise (DEMON) processing, in that no user interaction is required to design pass band filters. Furthermore, superior “cyclic frequency” resolution can be obtained, thereby affording more accurate shaft speed estimates and the ability to discriminate multiple propeller shafts operating at slightly different speeds. This paper presents further development of the detection technique, exploiting cyclostationarity to determine the range, heading and speed of the surface ship. This development is based on array processing using the cyclic autocorrelation function. The performance of this technique is demonstrated using simulation and measured signals.

Paper Number: 25
Theme: Noise and Vibration
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System identification with mean differential cepstrum using random decrement

This paper looks at the recently developed Mean Differential Cepstrum (MDC) method for calculating frequency response functions (FRF) from response signals. It has been shown to work in single-input and multiple-input scenarios, giving both magnitude and phase information. Its applications have been largely confined to transient signals, in accordance to the original definition of the MDC. The key motivation for this paper is to extend this blind system identification method to continuously excited systems, like most machinery in practice. The use of the Random Decrement Technique (RDT) to pre-condition continuous signals, prior to applying the MDC method, is investigated. The idea is to utilise the impulse like derived signals for the identification process. Qualitative comparisons between identification outcomes using RDT derived signals and actual transient signals are presented for single-input systems.

Paper Number: 26
Theme: Active Noise and Vibration Control
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Review of adaptive tuned vibration neutralisers

Tuned vibration neutralisers and absorbers provide an effective method of attenuating tonal vibration within a structure. If the frequency of the tonal vibration alters, then an adaptive tuned vibration neutraliser or absorber can be utilised to track and adapt to changes in the frequency of the source vibration. This paper provides an overview of the development of adaptive tuned vibration neutralisers and absorbers.

Paper Number: 28
Theme: Thermoacoustics
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Waste-heat-driven thermoacoustic engine and refrigerator

Thermoacoustic engines are a suitable technology for capturing waste heat to perform useful work. These engines utilise a temperature gradient to encourage high amplitude acoustic waves in a resonant chamber. A standing-wave thermoacoustic prime mover and refrigerator combination has been designed and built. The waste heat source is the exhaust gas stream from a common internal combustion engine. The device was designed such that the prime mover harvests approximately 8% of the available waste heat at cruise, and the refrigerator heat load approximates that of two people. The prime mover and refrigerator combination has no moving parts, and uses helium as a working gas.

Paper Number: 29
Theme: Architectural Acoustics

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Normal incidence sound absorption coefficient of direct piercing carved wood panel with star and diamond dominated geometric patterns

Direct piercing carved wood panels (DPCWP) are wooden panels carved with numerous patterns and elements. They are used in traditional houses, palaces, mosques and other buildings. In mosques, DPCWP are used as parts of wall panel and for the upper partition of doors and windows. Among the earliest DPCWP were in the Sultan Zainal Abidin mosque in 1700s, Kuala Terengganu, Malaysia. The current DPCWP usage in the modern mosques is mainly for esthetic and as a reflection of traditional Malay wood carving. In contrast, the use of DPCWP in earlier mosques was to help achieving good indoor speech intelligibility. DPCWP has the ability to allow sound waves to pass through the panel, hence sound reflection to the main prayer area is contained. Minimizing sound reflection toward the mosque main area ensures optimization of speech intelligibility. This qualifies DPCWP as a sound absorber material, in line with Sabine, Kutruff and Maekawa definition of sound absorption coefficient. In this paper, the normal incidence sound absorption coefficient of DPCWP with star and diamond dominated geometric patterns are discussed. This star and diamond patterns were chosen and designed for 33% and 38% perforation ratios. Numerical experiments were conducted using Boundary Element Method (BEM) while measured results were obtained using sound intensity measurements technique. Comparisons of sound absorption coefficient obtained through both methods are discussed in details. Analysis of resonance frequencies due to the types and sizes of apertures in relation to sound absorption coefficient are also highlighted. The measured and numerical results suggest that DPCWP dominated with star and diamond dominated geometric patterns are able to act as good sound absorber. This finding suggests that DPCWP could be used as effective sound absorbers in future mosques construction.

Paper Number: 30
Theme: Aeroacoustics

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Vehicle motion parameter estimation using a wide-aperture acoustic sensor array of unknown shape

Ground-based passive acoustic systems exploit the acoustic energy radiated by a target (e.g. ground vehicle or aircraft) for its detection, classification, localization and tracking. As the speed of the target (assumed subsonic) is comparable with the speed of sound propagation in air, the target will have moved to a completely different position by the time its emitted acoustic signal arrives at the ground sensor. For a target travelling at a constant velocity and a constant altitude, this so-called retardation effect is advantageous, for it enables the estimation of some or all of the target motion parameters. The authors previously described a passive acoustic technique to estimate all the five motion parameters of an airborne broadband sound source using a ground-based wide-aperture acoustic sensor array. If the source is a ground vehicle, the number of motion parameters reduces to four. The aperture size of the array is typically on the order of 100 square metres and the motion parameter estimation method requires a priori knowledge of the actual shape (or relative positions of the sensor elements) of the array. However, it is time consuming to deploy a wide-aperture array with all sensor elements precisely located at their desired positions; any sensor positional error will degrade the accuracy of the parameter estimates. Also, in practical situations where the sensor elements are deployed randomly and their positions are either unknown or crudely estimated, the motion parameter estimation method cannot be used. This paper formulates a nonlinear least-squares method to estimate three of the motion parameters of a ground vehicle using a wide-aperture acoustic sensor array of unknown shape. The proposed method measures the temporal variation of the differential time-of-arrival (or time delay) of the acoustic signal at each pair of sensor elements and then minimizes the sum of the squared deviations of the noisy time delay estimates from their predicted values over a sufficiently long period of time for all sensor pairs. The vehicle's speed and the time and range at which the vehicle is at the closest point of approach to the array are estimated simultaneously with the array shape. This passive technique is applied to real acoustic sensor data recorded in a field experiment where a variety of ground vehicles were driven past a 10 m by 10 m planar cross array at constant speeds. Results of the field experiment are presented to demonstrate the effectiveness of the method.

Paper Number: 31
Theme: Noise and Vibration

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Tuned vibration absorbers for control of noise radiated by a panel

A single passive tuned vibration absorber (TVA) that is specifically designed to achieve optimal performance at a particular frequency may not be effective in handling minor changes in excitation frequency. One way of taking this into account is to use multiple TVAs tuned to slightly different frequencies. This paper is concerned with the low- to mid-frequency vibrational behaviour and radiated noise of a panel excited by a point force and controlled using attached multiple vibration absorbers tuned to different frequencies. Finite element analysis is not commonly used to predict the effect of TVAs on the sound radiation by the panel. In this paper, a theoretical model and finite element models (including FEA with and without fluid-structure interaction) are presented for the calculation of the radiated sound power of a panel with multiple TVAs attached. A simply supported panel with two TVAs attached was used as an example to compute the theoretical predictions with the finite element analysis results.

Paper Number: 32
Theme: Transport Noise

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Road noise aspects of the NSW Infrastructure SEPP's 'Development in Rail Corridors and Busy Roads – Interim Guideline'

On 21 December 2007 the State Environmental Planning Policy (Infrastructure) 2007 (known as the 'Infrastructure SEPP') was gazetted and subsequently came into effect in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. Key objectives of this planning policy were to: protect the safety and integrity of key transport infrastructure from adjacent development; and ensure that adjacent development achieves an appropriate acoustic amenity by meeting the internal noise criteria specified in the Infrastructure SEPP. A major initiative of this SEPP is that for the first time a planning instrument has established internal noise levels [35dB(A) for bedrooms and 40dB(A) for other habitable rooms] in new residential developments planned along identified transport corridors. To support the Infrastructure SEPP, the NSW Department of Planning released 'Development in Rail Corridors and Busy Roads – Interim Guideline' in December 2008. This document was developed with significant input from acoustic experts and

other government agencies, and provides guidance on building design, internal layout and architectural principles to achieve an acceptable internal acoustic environment as well as synergies in addressing air and noise impacts. The Guideline also provides general guidance on strategic planning for Councils and other government agencies, or private proponents investigating possible locations for new residential and other sensitive development that require development approval. In addition, it provides guidance on site selection to reduce or avoid the need for mitigation measures for new residential (eg single/dual occupancy, multi-unit, etc) dwellings. The present paper focuses on the aspects of the Guideline which apply to the management of road traffic noise. It presents a summary of the technical background, assumptions and considerations given in relation to all of the road traffic noise information contained within the Guideline. It covers how the road noise triggers were established; how the processes were developed to assess project specific noise levels for residential and other sensitive land uses; how the generic deemed-to-comply building acoustic design requirements were derived to improve the acoustic amenity of building occupants; and discusses the cost-savings in noise mitigation measures that can be achieved through good acoustic planning and design.

Paper Number: 33
Theme: Underwater Acoustics
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Estimating sonar system losses due to signal spatial decorrelation

Sonar performance modelling is often based on a loss budget afforded by the sonar equation, which involves various idealisations and assumptions. Field performance of practical sonar systems is often observed to be below the level predicted by the conventional sonar equation based on system technical specifications. The departure in performance of practical systems from idealised systems is attributed to various extra “loss factors”. These loss factors are usually combined and collectively described as “system losses”. Some of the loss factors are system-related such as those associated with sound projection, reception and processing by the system. Others are caused by the sonar operating environments such as signal de-correlation and time spreads due to medium fluctuations and multi-path propagation. In this paper, we review and discuss theoretical and experimental work in assessing signal spatial de-correlation due to random environmental

inhomogeneities and multipath propagation in both deep and shallow waters. Rough estimates of the resulting losses in array signal gain from conventional beamforming are given where possible.

Paper Number: 35
Theme: Aeroacoustics

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Comparison of the Kirchhoff and Ffowcs Williams and Hawkings methods of aeroacoustics in application to the sound radiated by a thin plate vibrating in its own plane in a viscous fluid

A thin rectangular acoustically small plate vibrating in its own plane in a viscous fluid is considered. The sound radiated by such vibrations is evaluated by using both Kirchhoff and Ffowcs Williams and Hawkings equations. Both of these equations include the sound generated by Lighthill's quadrupole sources which are described by a volume integral over the regions in the fluid containing vorticity. For the purpose of evaluating the volume integral, the fluid is separated into three regions: the viscous boundary layer where the fluid motion is predominantly rotational, most of the fluid where its motion is potential, and a narrow transitional region. It is shown that the boundary layer generates zero sound, whereas the transitional area generates the sound with dipole directivity. As Kirchhoff's integrals over the surface of the plate vanish, it is concluded that all generated sound can be attributed to the Lighthill's volume sources. Ffowcs Williams and Hawkings equation describes, apart from Lighthill's sources, the dipole sound generated by tangential forces acting on the surface of the plate. It is demonstrated that, for the plate considered, the amplitude of this sound is significant, and, therefore, the two methods produce significantly different predictions for the radiated sound. The obtained predictions for the radiated sound are discussed and experimental measurements to verify the obtained results are proposed. Also, recommendations for the practical use of both methods are suggested.

Paper Number: 36
Theme: Underwater Acoustics

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Enhancements to a tool for underwater acoustic sensitivity snalysis, and relative importance of uncertainties in environmental parameters

Current sonar prediction models for an active sonar scenario give outputs such as probability of detection. However, the inputs to the models can be very uncertain, and it would be desirable to present measures of uncertainty in the output, and of sensitivity of the output to uncertainty in each of the inputs. In a previous paper, a tool was developed to predict uncertainty and sensitivity in acoustic transmission loss (TL) to uncertainty in sound speed profile (SSP) and bottom loss (BL). For the Malta plateau environment, it was found that SSP uncertainty was more important than BL uncertainty at some ranges, and vice-versa at other ranges. In this paper, an option has been provided to evaluate the sensitivity measure directly and more accurately than the (albeit faster) Monte-Carlo method used in the previous paper. The tool has been extended to compute probability of detection (Pd) and its uncertainty and sensitivity. For the Malta plateau environment and for some input parameters, it was found that SSP uncertainty was the most important parameter in Pd sensitivity at all ranges greater than 3.2 km, whereas for TL, BL sensitivity was most important at some ranges greater than 3.2 km. An explanation for these results is suggested.

Paper Number: 37
Theme: Underwater Acoustics

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Modelling the acoustic reflection loss at the rough ocean surface

A description of the reflection of underwater sound incident upon a real ocean surface boundary is a necessary component of a sonar transmission model. At low frequencies, the sea surface may be regarded as smooth, with total reflection of intensity at the specular angle. At mid-frequencies (over about 2 kHz), this is no longer the case and an intensity reduction must be included to account for the sound scattered from the surface at non-specular angles. Complications include whether roughness alone causes the acoustic loss effects, or whether near-surface bubbles play a role. In addition, it may be necessary to consider whether the sound reflected in the specular direction consists entirely of a coherent component, or whether an incoherent component is assumed to exist. Due to these complexities in the relevant phenomena, and the non-uniformity of the surface state, the modelling of surface loss remains as an

area yet to be mastered. In response to this unresolved situation, DSTO, Thales Australia and the Centre for Marine Science and Technology at Curtin University have compared the performance of surface loss models in their possession, both against each other and against at-sea data for a number of ocean scenarios, including several for which data have not been published previously. In addition, the output of these models has been compared with that obtained from each of a small-slope approximation model, and a perturbation analysis model, made available for this purpose by the Applied Physics Laboratory of the University of Washington, Seattle. Here, comparisons have been made of the various predictions of surface loss per bounce, as well as comparisons between predictions of transmission loss based on the use of these surface loss models, including comparisons with at-sea measurements of transmission loss. This paper discusses aspects of these surface loss models and the differences between them which have been revealed.

Paper Number: 38
Theme: Active Noise and Vibration Control

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Active noise control at a moving virtual microphone using the SOTDF moving virtual sensing method

Traditional local active noise control systems minimise the measured acoustic sound pressure to generate a zone of quiet at a physical error sensor. The resulting zone of quiet is generally limited in size and as such, placement of a physical error sensor at the location of desired attenuation is required, which is often inconvenient. Virtual acoustic sensors can be used to project the zone of quiet away from a physical error sensor to a remote location. A number of virtual sensing algorithms have been developed in the past and these have shown potential to improve the performance of local active noise control systems. However, it is likely that the desired location of maximum attenuation is not spatially fixed. In this paper, a stochastically optimal virtual microphone capable of tracking a desired virtual location in a modally dense three-dimensional sound field is developed using the Stochastically Optimal Tonal Diffuse Field (SOTDF) moving virtual sensing method. The performance of an active noise control system in generating a zone of quiet at the ear of a rotating artificial head with the SOTDF moving virtual sensing method has been experimentally investigated and experimental results are presented here.

Paper Number: 39
Theme: Environmental Acoustics

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Effectiveness of alternative audible movement warning alarms

The sound from the standard 'beeper', or pulsed tonal alarm, is used to provide a warning of vehicle or plant movement, usually reversing, for those in the vicinity to take the necessary evasive action for their safety. The pulsed tonal signal is widely and instantly acknowledged as a warning signal. However the sound from the common type of pulsed tonal alarms does not stay within the work site and can become a considerable annoyance for those in the surrounding community. The sound can also be an annoyance for those on site who, at that time, are not in danger yet hear a loud signal. There are options for alternative audible alarms including alarms that focus the signal in the area of potential danger, those that allow for the level of the alarm to be adjusted depending on the surrounding noise, alarms linked to proximity sensors and alarms with a pulsed broadband signal. To be an effective movement warning alarms need to provide the 'what', 'where' and 'when' of the hazard. As part of a study on these alternative alarms the authors have reviewed the literature to assess the evidence that the alternative alarms using a non tonal signal do provide these three essential elements for movement warning alarms.

Paper Number: 40
Theme: Underwater Acoustics

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Experimental observation of the frequency dependence of horizontal refraction effect on bearing estimation of hydroacoustic events

The large-scale inhomogeneity of the ocean environment and bathymetry potentially leads to horizontal refraction of underwater sound propagation and, consequently, induces error in estimation of bearing to hydroacoustic events located by a receive array. The mode and frequency dependent horizontal refraction in the ocean region between the Sumatra fault zone and the Comprehensive Nuclear-Test-Ban Treaty (CTBT) Cape Leeuwin hydroacoustic station (HA01) is numerically investigated in this paper. Errors of bearing from the HA01 station to low-frequency seismic events in the Sumatra coastal zone due to horizontal refraction are also calculated for different modes and frequencies. The back-azimuth estimation for the location of the Great Boxing Day Earthquake from HA01 was conducted by analysing the received signals in three different frequency

bands with the central frequencies of 4.5Hz, 7.5 Hz and 10.5Hz. It is noted that the back-azimuth estimates change with frequency. The difference between estimates at 4.5Hz and 7.5 Hz is nearly half a degree, while that between 7.5 Hz and 10.5Hz is noticeably smaller. These observations agree with the numerically predicted results, confirming the frequency dependence of horizontal refraction and demonstrating its effect on bearing estimation of hydroacoustic events.

Paper Number: 41
Theme: Underwater Acoustics

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Acoustic propagation over limestone seabeds

The western and southern Australian continental shelves are mainly composed of a type of limestone called calcarenite, overlain by a thin veneer of unconsolidated sediment. The shear wave speed in calcarenite is slightly less than the sound speed in water, which leads to some important, and rather unexpected propagation effects that are of considerable practical importance for such tasks as predicting the performance of passive sonar, and modelling the environmental impacts of marine seismic surveys. This paper introduces the physics of propagation in such an environment and provides a comparison between modelled and measured data. The implications for common modelling tasks are also discussed.

Paper Number: 44
Theme: Underwater Acoustics

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Development of a simple underwater acoustic channel simulator for analysis and prediction of horizontal data telemetry

This study seeks to identify the various mechanisms affecting the performance of horizontal underwater acoustic communication. In order to better understand the impact of oceanographic parameters on acoustic transmission, a simple channel simulator was developed. This was based on the Bellhop propagation model, utilising Gaussian beam tracing. Using a simulated underwater environment and given parameters regarding transmitter and receiver locations, the impulse response was obtained and a subsequent prediction of a received signal waveform was achieved. Using this model, various methods of underwater data telemetry were investigated for a variety of scenarios including both deep and shallow water. These predictions were also compared to

signals obtained in the field for various environments. From here, the model was evaluated for it's effectiveness in aiding the development of encoding techniques for underwater acoustic communication. In addition, the model provided insight into the effects of separate environmental parameters on acoustic modem signals.

Paper Number: 45
Theme: Legislation and Standards

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On the integration of Green Star rating tools with the acoustic design of offices and educational institutions

The Green Star rating tool promotes initiatives that limit the environmental footprints of new buildings and tenancies, in part achieved with improve efficiencies and productivities in the workplaces. However, we find that current application of the Green Star rating tools is alone insufficient to achieve internal acoustic qualities appropriate to improving productivity. In this paper, we discuss various issues encountered in the practical application of the rating tool and the resultant interior acoustic qualities, good and bad, with regard to the level of building productivity or user comfort. The issues discussed include the effect of using design criteria for compliance, externalities as result of a limited scope and appropriate weighting. Discussion in this paper surrounds Green Star requirements for offices and educational facilities, however many of the arguments apply to other Green Star rating tools.

Paper Number: 46
Theme: Underwater Acoustics

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A prototype PVDF underwater pressure-gradient acoustic intensity probe

This paper reports on a prototype underwater pressure-gradient intensity probe consisting of two parallel PVDF films separated by a thin, rigid plate and potted in polyurethane. Field tests were conducted to measure the acoustic intensity produced by a single source transmitting narrow and broadband signals. Data was recorded from both PVDF elements simultaneously as the probe was rotated. Acoustic intensity was estimated by applying a set of signal processing techniques to the recorded data. The results indicate that the probe can be used to estimate one-dimensional acoustic intensity at ultrasonic frequencies. Details of the signal processing methods and results from the field test will be presented.

Paper Number: 47
Theme: Acoustics of Wind Turbines
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Amplitude modulation in wind turbine noise

Wind farms are gaining more and more popularity as a source of renewable energy. At the same time the public is expressing concerns about the environmental impact from the existing and proposed developments. One of the most challenging tasks in the assessment of possible impacts is the prediction and post-construction measurement of wind farm noise. Amplitude modulation frequently evokes higher annoyance in the perception of wind farm noise. Many environmental noise regulations and policies consider a penalty which is added to the measured noise descriptor if the amplitude modulation is present. The majority of contemporary wind farm noise assessment procedures do not include a penalty for amplitude modulation in the noise emission. Some researches state that in many cases fluctuations in the wind turbine noise level is readily perceivable even at large separation distances from the turbine. This paper details results of investigations of noise immission from modern wind turbine generators (WTG) and possible influence of amplitude modulation on the noise perception. The hypothesis that the modulating character of WTG noise is important is explored in the paper. It also discusses possible role of the noise character in human perception at a distant receiver.

Paper Number: 48
Theme: Aeroacoustics
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Airfoil noise measurements at various angles of attack and low Reynolds number

Airfoils produce tonal noise when operated at low-to-moderate Reynolds number. It is particularly annoying to the human ear and is problematic for the design of fans, compressors, helicopter rotors and unmanned air vehicles. Despite recent advances in the understanding of this phenomenon, there are still many unresolved aspects regarding the aerodynamic source generation mechanism. In this paper, the trailing edge noise characteristics of a NACA0012 airfoil at low Reynolds numbers (50,000 to 150,000) are presented. Experimental measurements show that the noise consists of a multitude of tones centered about a broadband component. Such noise spectra are not observed at higher Reynolds numbers. The effect of angle of attack and Reynolds number will be discussed along with possible source generation mechanisms.

Paper Number: 49
Theme: Active Noise and Vibration Control

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Reduction of the sound power radiated by a submarine using passive and active vibration control

As submarines can be detected due to their sound radiation, it is desired to minimise the radiated sound power. At low frequencies, submarine radiated noise is correlated to sound radiation from the propeller and the hull, where the hull is excited by propeller forces. In this paper, passive and active control of vibration is applied to a numerical model to reduce the low frequency sound radiation from a submarine. The performance of a control system using actuators that are tuned to the hull and propeller/shafting system resonance is investigated. In addition, an optimised resonance changer is implemented in the propeller/shafting system.

Paper Number: 50
Theme: Underwater Acoustics

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Optimisation of a submarine's resonance changer
using the method of moving asymptotes

In order to reduce the sound power radiated by a submarine, the transmission of fluctuating forces from the propeller to the hull can be reduced by implementation of a resonance changer, where the propeller forces are correlated to the propeller blade passing frequency. However changing the dynamics of the propeller/shafting system can lead to increased sound radiation from the propeller. A numerical finite element / boundary element model of a submarine has been developed in order to find optimum design parameters for the resonance changer such that the overall sound power radiated from the hull as well as the propeller is reduced. The global optimum virtual stiffness, damping and mass parameters of the resonance changer have been found by applying the method of moving asymptotes. It is shown that the influence of sound radiation from the propeller is only relevant, if higher harmonics of the blade-passing frequency are assumed to have a similar amplitude as the fundamental harmonic of the blade passing frequency.

Paper Number: 59
Theme: Acoustic Measurements
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Transient detection in impulsive noise using low-variance spectrum estimation

In the warm shallow water environments impulsive underwater noise due to snapping shrimp usually dominates ambient acoustic noise in the frequency range of 1-250 kHz. This noise component consists of a large number of individual transients produced by extremely rapid closure of the shrimps' snapping claws and its statistics is highly non-Gaussian. This paper investigates the problem of detecting unknown bandpass transients in highly impulsive noise such as that produced by snapping shrimp. The time duration of the signals to be detected is assumed to be much longer than the duration of individual snaps. Standard transient detection techniques usually apply the periodogram that is a classical direct nonparametric method for spectrum estimation of a stationary random time series. It is computed as the magnitude-squared discrete Fourier transform of the (possibly zero-padded) windowed time series. Though the periodogram provides a fast method to compute an estimate of the power spectrum, it can be limited due to its poor bias properties resulting from substantial sidelobe leakage. Besides, this estimator is inconsistent in the sense that its variance does not decrease with the sample size. In this paper we use low-variance spectrum estimation techniques such as multiple window (or multitaper) spectrum estimation whereby a number of direct spectrum estimates are computed, each by using different window (or taper), and these estimates are averaged. The tapers are chosen to be pairwise orthogonal and are designed so as to prevent leakage. In addition, the methods for improving power spectrum estimates based on denoising by wavelet thresholding are considered.

Paper Number: 60
Theme: Environmental Acoustics
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What annoyed me – vibration or low-frequency noise?

It has been identified by the Western Australia Department of Environment and Conservation (DEC) that many complaints regarding vibration problems are actually the noise problem. The DEC recently received complaints about railway operations from residents in WA suburb of Canning Vale. The complainants targeted the vibration as the problem, referring that the whole house was vibrating when the freight train passed by. Investigation conducted by the DEC indicated that while the vibration level inside the house was

significantly elevated when there was a train passing-by, the levels were not high enough to cause a problem, as they were all far below the Curve 1 of AS2670.2-1990. The A-weighting noise level inside the house, though also elevated during the train operation, was also below a level that normally attracts complaint. Further analysis of the measured data indicated that the low-frequency noise might be the issue to blame. Very strong low frequency components at the range from 12-32 Hz were recorded inside and outside the house. However, because the building structure is more efficient in attenuating the high-frequency noise, the low-frequency components become more obvious inside the house. The difference of C and A weighting noise levels was increased from 20 dB outside the house to more than 30 dB inside the house. The analysis also identified that the size and shape of a room might also contribute to the higher level of low-frequency noise inside that room.

Paper Number: 61
Theme: Musical Acoustics
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Acoustical properties of ancient Chinese musical bells (Keynote Address)

Ancient Chinese music bells can be traced back to the Shang dynasty (1600–1100 B.C.). In addition to their significance in history and metallurgy, they provide much insight into the design of musical instruments in the early years and continue to make important contribution to acoustics due to their unique acoustical properties and rich physical mechanisms. These music bells differ from carillon/church bells and oriental temple bells by their almond-shaped cross sections, which result in two distinct strike tones (normal and side) in one bell. Through the analyse of the resonance frequencies of 64 music bells cast 2400 years ago, frequency relations are rediscovered between the normal and side-strike tones in individual bells and between the normal-strike tones of adjacent bells. Acoustical qualities of each strike tone are characterised using frequency ratios between the partials and fundamental, as well as the spectrogram of the tone. The study on the scaling rules for achieving the required frequency intervals between adjacent bells also sheds light on our understanding of music scales and sound balance principles in bell acoustics already recognized in ancient times.

Paper Number: 62
Theme: Aeroacoustics
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Analysis and reduction of blade passing noise of a VTOL aircraft

Rotor-stator interaction has been identified as the dominant noise source of a vertical take-off and landing (VTOL) aircraft developed by Entecho. This paper reports field measurement results of blade passing noise of the VTOL aircraft together with its analysis and control. The blade passing event was simulated in a wind tunnel experiment. The flow speed, rotor position and rotor-stator spacing were varied with the chord-wise pressure distribution of the leading surface of the rotor blade being measured by an array of 6 flush mounted microphones. Results show useful features of the pressure distribution on the rotor blade influenced by an up stream stator, which are used for the analysis and prediction of the sound radiation from the VTOL aircraft. The preliminary result of the reduction of the blade passing noise using angled stator blades is also presented.

Paper Number: 63
Theme: Acoustic Measurements
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Sense from sensing sound (Keynote Address)

Smart acoustic surveillance systems are unattended in their operation and are often deployed in remote areas for the automatic detection, localization, classification and tracking of military activities, which are inherently noisy. Acoustic sensors are appealing because they are passive, affordable, robust, and compact. Methods, with examples, for extracting tactical information from acoustic signals emitted by moving sources (air and ground vehicles) are presented. The methods are based on processing either the narrowband or broadband spectral components of the source's acoustic signature. To demonstrate the scientific principles that underpin the operation of such systems, various signal processing algorithms are applied to real acoustic data from both single and multiple sensors. In one example, the acoustical Doppler effect enables the flight parameters and blade-passage frequencies of turboprop and rotary wing aircraft to be estimated from the time-frequency signal analysis of acoustic data. In the case of a transiting ground vehicle, reliable estimates are provided for the speedometer reading, odometer reading, number of cylinders and range at closest point of approach of the vehicle to the sensor. For wideband processing leading to source motion parameter estimation, phase transform prefiltering is

required to suppress the ambiguous peaks in cross-correlograms caused by the presence of strong narrowband lines in the source spectra of air and ground vehicles. In another example, the acoustical Lloyd's mirror effect is used to extract the flight parameters of a jet aircraft. Wideband cross-correlation with differential Doppler compensation is required for the acoustic tracking of high-speed broadband sources such as jets when the sensors are widely separated. Also, weapon firings generate acoustic muzzle blast waves and supersonic projectiles generate ballistic shock waves that propagate in air with spherical and conical wavefronts, respectively. When these wavefronts traverse an acoustic sensor array, the sensor output data are processed to locate the point-of-fire, together with the miss distance and calibre of the bullet. The methods developed for land-based acoustic surveillance using microphone data are also applied to hydrophone data for passive acoustic surveillance of the underwater environment.

Paper Number: 64
Theme: Noise and Vibration

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Advanced passive treatment of low frequency
sound and vibration (Keynote Address)

It is well known that standard poro-elastic materials and visco-elastic damping materials are ineffective at reducing low frequency sound and vibration. This paper overviews two new treatments developed at Virginia Tech which attempt to address this problem. HG material consists of poro-elastic material with embedded multiple small masses. The masses combine with the natural elasticity of the poro material matrix to create multiple vibration absorbers with a range of tune frequencies in the low frequency region. The embedded masses are found to significantly increase the low frequency transmission loss and absorption of the poro-elastic material. DVA's are vibration absorbers whose active mass and spring are spread over a large area while still maintaining a viable damped reactive effect at low frequencies. DVA's are found to provide global reduction of low frequency vibration of structures in a compact, lightweight configuration. DVA's are also observed to provide mid to high frequency damping most likely to air squeeze damping effects. The paper will overview the concepts, development and testing of both devices. Applications of the new treatments to realistic structures will be considered.

Paper Number: 65
Theme: Transport Noise Computational Acoustics

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Numerical prediction of brake squeal propensity using acoustic power calculation

Both low- and high-frequency disc brake squeal, first studied some 80 years ago, remain of concern to automotive NVH departments due to customer warranty claims. Despite both intensive and extensive research, disc brake squeal is still not well understood. It is a very complex problem which involves many different disciplines, such as tribology, structural vibration, acoustic radiation and dynamic instabilities. While there has been considerable research in the first two areas (tribology and vibration analysis), the prediction of brake squeal through acoustic radiation calculations using numerical methods has remained largely unexplored. In this paper, the influence of the geometrical designs of brake pad on brake squeal is studied using a simplified brake setup consisting of an annular disc in contact with one brake pad. The various configurations of a brake pad studied here has been influenced by those used in the industrial testing of a full brake system. In this study, unstable vibration modes were first identified by the conventional complex eigenvalue analysis of a finite element model of the simplified brake system. Then, the acoustic power was calculated for a range of frequencies and friction coefficients using the acoustic boundary element method. It is shown that the performance of the various pads, in terms of brake squeal propensity caused by their geometric differences, could be ranked based on contour plots of acoustic power with friction coefficient and frequency as the independent variables. These results indicate that the inclusion of acoustic power calculations, following a complex eigenvalue analysis of unstable vibration modes, provides improved prediction of brake squeal propensity.

Paper Number: 66
Theme: Noise and Vibration

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Modal analysis of a five-storey building

This paper reports the results of experimental modal analysis of a five-storey benchmark building model with impact excitation using HP-VXI data acquisition system and LMS CADA-X software. A numerical analysis was also conducted. The benchmark building model was identified both in terms of its dynamic parameters, namely, natural frequencies, mode shapes and damping ratios as well as its structural properties, namely, the mass, stiffness and damping matrices. The results showed a good agreement between the analytical and experimental

results. These parameters enabled further analysis and modeling of the building frame in the presence of various control devices using different control algorithms, aimed at reducing earthquake-induced building vibrations.

Paper Number: 68
Theme: Environmental Acoustics
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CoRTN maximum noise emmissions

There is a limit to the number of vehicles that can travel on a road section per hour. As the traffic numbers increase, the traffic speeds decrease. In Queensland, road traffic noise emissions are based on the Calculation of Road Traffic Noise method (CoRTN). This method is dependent on both traffic volumes and speed, among other parameters. This paper presents a method for determining the upper limit of noise emissions from a road string, based on the CoRTN method. It is shown that there is point where due to the higher traffic volumes, there is a reduction of vehicle speed, causing the calculated noise emissions to decrease. These results have implications for the mitigation requirements for high traffic volume roads.

Paper Number: 69
Theme: Noise and Vibration
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Tunnelling induced ground-borne noise modelling

Ground-borne noise caused by tunnelling machinery vibrations can result in significant community annoyance. A three dimensional ground model can be utilised in the modelling of tunnelling vibration and the resulting ground-borne noise. The progress of the tunnelling machinery can be input into the model such that the ground borne noise impact can be predicted for a given machine location, the affected properties can be identified and the duration of the excessive noise can be predicted. This paper presents the results from a noise model that predicts the location and duration of ground-borne noise impact from tunnel boring machines and roadheaders. The model outputs can be utilised to inform the project stakeholders and the community of potential noise issues and to schedule noise management programs.

Paper Number: 70
Theme: Industrial Acoustics

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Optimisation of noise control treatments for staged noise management programs using genetic algorithms

Maximising the cost-effectiveness of noise mitigation treatments for industrial facilities is usually regarded as equally important as achieving

the overall site's environmental noise level limit criteria. The selection of noise control treatments for individual noise sources can therefore be optimised to maximise the total cost-effectiveness of the completed noise mitigation treatment program. Clients may also be interested in staging the implementation of the site's noise management plan, for instance if the noise mitigation budget is only available as an annual allowance. Therefore it may also be important to achieve a significant reduction of the overall site's noise emissions in the first stage of the noise reduction program, in which only a few noise sources are treated, even though the overall criteria will not be met until later stage(s). The careful selection of noise treatments in the first stage can maximise the noise reduction achievable within the first term's budget. Thus the implementation of a site's noise mitigation treatment program can be optimised not only in terms of overall cost-effectiveness, but also in terms of maximising the total noise reduction achieved in the first term, that is the initial slope of the curve representing the progressive reduction of the entire site's noise emissions in the longer term.

Paper Number: 75
Theme: Active Noise and Vibration Control

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Optimal design of a control actuator for sound attenuation in a piping system excited by a positive displacement pump

This paper investigates technology aimed at reducing noise propagated in a piping system. The piping system consists of a long pipe, with one end excited by a positive displacement pump and the other end connected to a water tank. Compared to a centrifugal pump, a positive displacement pump generally produces a larger pressure, so sound attenuation is more difficult. As a first step towards sound attenuation, the current study focuses on attenuating the acoustic wave in the pipe fluid. Before attempting to control the fluid motion in the pipe, a thorough understanding of the dynamic behavior of fluid-filled pipes is required. The first part of this paper reviews the work carried out by other investigators in this area, while the second part of the paper details the experimental program undertaken by the authors. A design of a fluid wave actuator for low-frequency plane fluid waves is provided. The actuator consists of a PZT cylinder which is mounted compliantly and concentrically inside a steel pipe. Since the pressure generating surface of the actuator is axisymmetric, only the radial axisymmetric mode is expected. The induced radial wall motion can in turn drive the fluid through structure-fluid coupling. Next, a practical design is realized for active control of noise propagating from

the piping system by using the actuator. Finally, the properties of the pipe, mounting systems and measurement setup are discussed in detail. The study will provide a guideline for setting up a piping system with active and passive control measures.

Paper Number: 76
Theme: Acoustic Measurements

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Sound power assessment on earth-moving equipment

Sound power level is a measure of the total noise emission from operating equipment and is required for environmental assessment on the proposed operations such as mining or constructions. In-site determination of sound power level of operating equipment is usually difficult task and has many uncertainties. In this paper, earth-moving equipment for mining operations is of concern. Several measurement methods are discussed and their accuracy and uncertainties are studied. Environmental modelling results are presented for assessing the accuracy of noise emission from operating equipment. Suggestions will be presented for improving the accuracy of in-site measurement of sound power level of earth-moving equipment.

Paper Number: 79
Theme: Ship Acoustics

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A design strategy in the propulsion system attachment to a submarine hull to minimise radiated noise

Vibration modes of a submerged hull are excited by fluctuating forces generated at the propeller and transmitted to the hull via the propeller-shafting system. The low frequency hull vibrational modes result in significant sound radiation. This work investigates the reduction of the far-field radiated sound pressure by optimising the connection point of the shafting system to the hull. The submarine hull is modelled as a fluid loaded cylindrical hull with truncated conical shells at each end. The propeller-shafting system consists of the propeller, shaft, thrust bearing and foundation, and is modelled in a modular approach using a combination of spring-mass-damper elements and continuous systems (beams, plates, shells). The foundation is attached to the stern side end plate of the hull, which is modelled as a circular plate coupled to an annular plate. By tuning the connection radius of the foundation to the end plate, the maximum radiated noise in a given frequency range can be minimised.

Paper Number: 80
Theme: Ship Acoustics

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Effect of the bending modes on the radiated sound pressure from a submarine hull

Rotation of the propeller through a non-uniform wake results in fluctuating forces transmitted through the propulsion system to the hull of a submerged vessel. The axial component of the fluctuating harmonic forces excite the axisym-metric modes of the submarine while the component in radial direction is shown to primarily excite the bending modes of the submarine. The hull is surrounded by water and is modelled as a cylindrical shell with internal bulk-heads, ring stiffeners and truncated conical end caps. The structure-borne radiated sound pressure was calculated us-ing the Helmholtz integral formulation. Structural and acoustics results from both the semi-analytical model and a fully coupled finite element/boundary element model are presented.

Paper Number: 81
Theme: Transport Noise

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Investigation into the effect of asymmetric train speed distribution on rail corrugation growth in cornering

The transportation phenomenon known as wear-type rail corrugation is a significant problem in railway engineering, manifesting as an oscillatory wear pattern on the rail head. These profile variations induce unwanted vibrations, excessive noise and other associated problems. Recent studies have shown that uniformity in train passing speed accelerates the corrugation growth process and conversely, widening the probabilistic speed distribution can be used as a mitigation tool. This paper investigates the effects of an asymmetric speed distribution on corrugation growth rate for a train in cornering. A frequency domain corrugation growth prediction model, based on experimental vertical rail receptance, is developed further to achieve this. Results provide insight into optimum conditions required to minimize corrugation growth.

Paper Number: 83
Theme: Noise and Vibration

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Simulation of gas turbine blade vibration measurement from unsteady casing wall pressure

Non-contact measurement of gas turbine blade vibrations has made significant progress over recent years; however, there still exist some limitations in the current techniques available. Specifically with blade tip timing (BTT) methods, some of the

limitations are: the requirement of a large number of sensors for each engine stage, difficulties in dealing with multiple excitation frequencies, and sensors being located in the gas path. An alternative technique is examined here, utilising the unsteady casing wall pressure, which has the potential to rectify some of these limitations. Analytical simulation of the internal casing wall pressure is derived, for the situation with rotor blades undergoing forced vibration. The amplitude of the blade forced vibrations is then reconstructed from the simulated unsteady casing wall pressure, with results showing the robustness of the method to sensor location, measurement noise and a limited number of sensors.

Paper Number: 84
Theme: Noise and Vibration

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Extraction of tacho information from a vibration signal for improved synchronous averaging

Time synchronous averaging (TSA) is a procedure that allows the extraction of a deterministic component from the vibration signal. TSA requires a constant frequency deterministic component. Practically, a vibration signal from rotating machinery contains small frequency variations, even when operating at a constant speed. To remove these variations, the signal is order-tracked with respect to the deterministic component. This is normally accomplished using a reference signal from a tachometer directly coupled to the rotating shaft of interest. When the tachometer cannot be directly coupled to the shaft of interest, alternative methods are required to generate a reference signal. A case presented here is a high pressure shaft (HPS) of a gas turbine engine, where the tachometer is coupled to an auxiliary shaft via a gearbox, with unknown exact gear ratio. This paper proposes two approaches to generate the reference signal for order-tracking. The first is to accurately estimate the gear ratio between the auxiliary shaft and the HPS, which will then be combined with the tachometer to produce a suitable reference signal. The second approach extracts a reference signal directly from the vibration signals using phase demodulation. TSA results derived using both methods are compared to evaluate their effectiveness.

Paper Number: 85
Theme: Computational Acoustics

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An evaluation of current commercial acoustic FEA software for modelling small complex muffler geometries: prediction vs experiment

Mufflers are incorporated into continuous positive airway pressure (CPAP) devices to reduce noise in the air paths to and from the flow generating fan. The mufflers are very small, irregularly shaped, and must attenuate noise up to high frequencies. It is important that the acoustic performance of these mufflers is reliably predicted and optimised, in order to improve the quality of the well-being of the user. In this study, finite element acoustical results for three reactive muffler designs were obtained using four commercial software packages – ANSYS, COMSOL, LMS Virtual.Lab Acoustics and VA One. Experimental results have been obtained using the two-microphone acoustic pulse method. Results of the transmission loss of each muffler obtained from the finite element models are presented and validation of the computational results is discussed. The finite element modelling packages were consistent in their prediction of the resonant frequencies and magnitude of the transmission loss at each resonance. Validation of the models showed good agreement with the experimental results over the lower half of the frequency range however the models appear to over-predict the magnitude of the transmission loss at resonant frequencies.

Paper Number: 86
Theme: Acoustics Education

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Industry and university partnerships in acoustic research – factors for success (Keynote Address)

Cooperation between industries and universities takes many forms – adhoc or regular consultancies, work experience projects that may extend over several years, student project sponsorships, long term research and development contracts usually involving post graduates, and partnerships through cooperative research centres. This paper presents a brief review of the nature and extent of University industrial partnerships in Australia in the area of acoustics; assessed against longevity, income, postgraduate numbers, benefits to partners, and the development of research critical mass. It gives a detailed discussion of cooperative partnerships in the areas of services and product development against a background of Government and industry priority research areas, and Government research and development incentive programs. Case Studies will be used to illustrate the various fundamental attributes and structures for growing and sustaining successful working relationships.

Paper Number: 87
Theme: Acoustic Measurements

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AAAC Workshop for the Child Care Centre Acoustic Guideline

The Association of Australian Acoustical Consultants (AAAC) Child Care Centre Acoustic Guideline sets out a recommended assessment procedure for Child Care Centres, and provides typical recommendations for the control of noise from such Centres. The high density usage of small spaces combined with insufficient variety, diversity and play opportunities are a known cause of a breakdown in children's behaviour with an ensuing increase in noise. In addition, the necessity of locating accessible Child Care Centres in residential neighbourhoods, providing generous and unencumbered outdoor spaces for children to enjoy their activities and the right of neighbours to a reasonable level of noise amenity are potentially at conflict and require a considered approach to planning a Child Care Centre. This guideline has been prepared by members of the AAAC to assist local councils and the community to assess the potential noise impact from proposed Child Care Centres. This workshop with provide an overview and discussion on the guideline.

Paper Number: 88
Theme: Legislation and Standards

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AAAC Workshop for Apartments and Townhouses Acoustical Star Rating Guideline

The Association of Australian Acoustical Consultants (AAAC) Apartments and Townhouses Acoustical Star Rating Guideline provide a logical tool to determine an accepted or expected acoustical result related to multi-dwellings. The Star Rating has been produced by members of the AAAC and fulfils a need identified by the community and is based on the current experience and technical expertise of AAAC members. While the BCA sets minimum standards for privacy, many in the housing industry have interpreted these as absolute requirements, applicable to all types of dwelling. The result has been that owners of luxury apartments built to BCA standards have become dissatisfied with acoustic performances, which in their view are not commensurate with the price they have paid. This workshop with provide an overview and discussion on the guideline.

Paper Number: 89
Theme: Legislation and Standards

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AAAC Workshop for Acoustical Design of Schools Guideline (Draft)

Members of the Association of Australian Acoustical Consultants (AAAC) have been concerned for some time that there are no Australia-wide regulations or standards that encompass all aspects of the acoustical qualities of educational and training facilities, including primary and secondary schools. If a student cannot clearly hear in a classroom, they tend to lose concentration and eventually they are not part of the proceedings. Valuable teaching time is lost and the progress of the student is impaired. Overseas studies have clearly shown that students are at a disadvantage where the appropriate acoustic environment is not present. Whilst the Building Code of Australia (BCA) details minimum acoustic standards for buildings, it does not provide specific recommendations for educational facilities. This workshop will provide an overview and discussion on this draft guideline.

Paper Number: 90
Theme: Environmental Acoustics

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Wind Farm Noise Workshop

The purpose of the workshop is to discuss the current state of the noise assessment and compliance process for wind farms, in light of the newly revised SA Wind Farm Noise Guidelines, draft AS Standard and draft NZ Standard. Discussion will cover the wide range of aspects associated with acoustic monitoring, modelling, assessment and compliance for wind farm developments. In particular, the focus will be on addressing the technical and logistical issues (and how to overcome or allow for) associated with: 1) obtaining statistically relevant datasets, 2) site stability and wind shear effects, 3) diurnal/seasonal variations, 4) modelling limitations, 5) compliance testing and 6) public perception/complaints. Workshop discussion will be supported by some Powerpoint slides showing examples of data/analysis from recent wind farm projects.

Paper Number: 91
Theme: Environmental Acoustics

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Computer noise simulations and associated problems discussed from the perspective of SoundPLAN (Workshop)

With the usage of computers, part of the expertise needed in noise modeling and simulations has been moved from physicists and engineers to computer software. In order not to get completely lost in this process, the engineer using the software, feeding it with data and expecting correct results, must have a

keen understanding of the standards used to produce the computer code. A critical eye requires that from time to time standards should be reviewed and limitations of the standards be discussed out. SoundPLAN, now with its version 7.0 is a standards based approach to noise simulations. The standards act as guidelines, in many cases the limitations they impose cannot be left in an automated software system, voids need to be filled. The limitations of different standards are discussed as well as solutions employed in SoundPLAN. The standards discussed are CoRTN, CoRRN, the European Interims Methods, the upcoming joint European Imagine/Harmonoise standards, Nord2000, ISO 9613 and CONCAWE. The standards most of the time give a user a solution for a point to point acoustical problem, however practice demands area sources, never mentioned in any standard. Geometry often is more complex than any of the standards envisioned. How can an automated system deal with these shortcomings, what are the SoundPLAN solutions? Noise mapping has become standard, now the special focus is on the fringes. How can one optimize an alarm system in factory environment so that the security requirements are met and at the same time the infringement of the plants surrounding environment is minimized? How can environmental desires and financial concerns be brought to push in the same direction? How can effectiveness and efficiency be balanced? What are the limitations of the software and what can be done to overcome them? Using examples from SoundPLAN the workshop will try to address these questions. Plenty of room will be given to questions in the afternoon.

Paper Number: 92
Theme: Environmental Acoustics
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Transit Oriented Development Workshop

Transit Oriented Development (TOD) is becoming increasingly popular in the planning of urban centres. Key elements of a successful TOD include the following: • A TOD gives primary consideration to pedestrian activity (e.g. walk and ride) and pedestrian oriented land uses; • A TOD balances a mix of good jobs, housing choices, access to services and amenities in a walkable, safe and secure setting; • The centre point of activity, height, density and mix of uses in a TOD is a transit station. The station provides a “feel good” public space and a gateway to the surrounding community;

• Successfully attracting people to and moving people within a TOD requires an array of “placemaking” measures; and • There is no single model of a TOD, and the concept can vary in its mix of uses and purpose (i.e. a knowledge based TOD or a residential based TOD). Transport accounts for 40 to 60 per cent of the life-cycle greenhouse gas emissions of urban developments. As a result, promoting a shift to more energy and emissions efficient travel modes in urban areas can considerably reduce transport greenhouse gas emissions and thus constitutes an essential component of a climate change mitigation and sustainability strategy. This type of development has many challenges associated with it, one of these being how to maintain a suitable acoustic environment, particularly for TOD’s integrating major road or rail transit corridors. This workshop aims to discuss the current national acoustic practice, past issues and potential shortfalls in relation to the acoustic design of TOD’s. For example, are the current available design criteria acceptable? Are there any future implications that need to be considered? Key issues to be discussed are sustainable ventilation solutions, lighting (e.g. glazing), vibration isolation, design criteria and the BCA.

Paper Number: 93
Theme: Environmental Acoustics
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VA One Workshop

This workshop will focus on solving challenging air-borne and structure-borne noise and vibration problems using ESI Group's vibro-acoustics simulation environment, VA One. Applications drawn from the building and transportation industries will be used to demonstrate the advanced features and capabilities of VA One.Building acoustics applications: - Transmission loss through complex light-weight wall constructions common in modern buildings; - Assessment of noise levels in buildings due to nearby tunneling/construction; and - Design of isolation mounts to reduce noise and vibration levels in elevators. Rail vehicle applications: - Transmission loss through periodic structures commonly used for floors and sidewalls of rail vehicles; - Sound pressure loads on exterior surface of rail vehicle due to wheel-rail noise, including interaction with tunnel walls; and - Interior noise levels in carriage due to wheel-rail noise, including the effect of leakages and appetures in the doors and sidewalls. VA One combines Finite

Element Method (FEM), Boundary Element Method (BEM) and Statistical Energy Analysis (SEA) solvers within one common modelling environment. Advanced numerical methods enable the user to couple BEM/FEM/SEA solutions together in one model, making VA One uniquely capable of solving complex full-frequency problems.

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