Proceedings of the Annual Conference of the Australian Acoustical Society

Acoustics 2021

Wollongong Australia

21-23 February 2022

Program & Abstracts

Acoustics 2021 WOLLONGONG making waves

For covid19 travel & vaccine pass requirements please check the website: acoustics2022.com/covid-info

ACOUSTICS 2022

JOINT NEW ZEALAND & AUSTRALIAN ACOUSTICAL SOCIETIES CONFERENCE

THE NATURE OF ACOUSTICS

31 OCT – 2 NOV 2022

TE PAPA, WELLINGTON, NEW ZEALAND

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The Acoustical Society of New Zealand

Contents

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Program and Abstracts book
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Welcome

On behalf of the organising and scientific committees, it is my great pleasure to welcome you to experience 'Science at the Beach' in the form of Acoustics 2021, the annual conference of the Australian Acoustical Society. As you would be well aware, it has been a difficult time to host an event of any shape or form for the past 2 years. Following the cancellation of our national conference for 2020, this event was originally proposed as a gap filler after our joint meeting with the Acoustical Society of America was postponed until 2023. It was hard to believe then, that even this current national event would also suffer a 3 month postponement, but it did! However, taking inspiration from the Tokyo Olympics, we kept the 2021 logo and pressed ahead into 2022, otherwise we would not have an acoustics conference on Australian soil between 2019 and 2023.

At this point, I would like to thank all of you that have made the effort to attend in person, particularly those who have travelled from interstate.

Our acoustical society is truly unique in that it brings together, academia, industry, consultants, government, defence and equipment manufacturers. When this occurs, good things can happen, particularly when we meet in person rather than virtually. We have all these ingredients at this conference, so I hope all of you will reflect on this and look for ways in which we can further collaborate to improve our understanding, utilisation and management of noise and vibration.

This year brings us to the Novotel North Beach on the beautiful NSW South Coast where we will enjoy an excellent technical program including five keynote lectures and around 70 presentations. In recognition of the current role that rail infrastructure developments are having in most States, there will be a dedicated session on rail related noise and vibration challenges. The program will also include sessions on underwater acoustics, building acoustics, aeroacoustics and structure-borne noise to bring us up to speed on developments in those areas over the last 2 years.

Acoustics 2021 would not have been possible without the dedicated work of the organising committee and especially the technical proceedings editors, Nicole Kessissoglou and Marc Buret, who have put in an extraordinary effort in compiling such high quality proceedings. As we all know, a conference has two main requirements, papers and money. To this extent, I also extend my gratitude to those of you who have gone the extra yard by preparing conference papers, and to Norm Broner and Julie Sobolewski who have worked with the sponsors and exhibitors to underpin the success of Acoustics 2021 and ensure recognition goes to those who support us. A big thanks also goes to Julie as the conference secretary who has had the responsibility of making sure it all runs smoothly, as well as those have agreed to chair sessions.

I hope that you will enjoy the technical and social program that we have planned for Acoustics 2021, Making Waves and your stay in Wollongong.

Yours in acoustics,

Jeff Parnell

Jeff Parnell

Conference Chair
Acoustics 2021 Making Waves

Bibliographic Information

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Information for higher education research data collection (HERDC)

The HERDC is the annual collection of statistics from Australian universities about research output and income. The Department of Industry, Innovation, Science, Research and Tertiary Education currently collect this information.

The following information is provided for authors intending to claim their research publications as part of HERDC.

Title of conference publication:	Proceedings of Acoustics 2021 Making Waves Annual Conference of the Australian Acoustical Society
Name of Conference:	Acoustics 2021 Making Waves
Publisher:	NSW Division
Publication format:	USB Key
Editors:	Nicole Kessissoglou, Marc Buret
Location of Conference:	Wollongong, NSW
Date of Conference:	21 - 23 February 2022

Conference organisation

Scientific committee

Proof of peer review

Full papers submitted for peer review and accepted to Acoustics 2021 Making Waves were reviewed by members of the peer review committee. These papers are marked as being peer reviewed in the proceedings. 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. The referee criteria included: technical content, originality, clarity, English expression and technical significance. Papers were matched where possible to referees in the same field with similar interests and area of expertise as the authors.

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

Peer review committee

Session chairs

Copyright notice

General Information

Venue map

Conference rooms, Exhibition and Catering are on Level 1 of the venue up the stairs from the hotel lobby. The Registration desk will be located in the hotel lobby on the Sunday afternoon and thereafter on Level 1 near the top of the stairs.

Parallel Sessions will be held in the Grand Ballroom. Primarily the Throsby and Hoskins rooms will be used. The Exhibition will be in the Banquet Lobby outside the Grand Ballroom.

Registration and information

The Conference Registration desk will act as an information/ enquiries desk throughout the Conference should you require assistance at any time. People identified as Organising Committee on their name badge will also be able to answer any enquiries.

The registration desk will be open during the following times:

Sunday	20 February	1600 - 1800
Monday	21 February	0830 - 1600
Tuesday	22 February	0830 - 1600
Wednesday	23 February	0800 - 1400

Please refer all enquiries to the Conference Registration Desk. In the event the desk is not manned a contact number will be provided. In emergencies, please contact the Conference Secretariat on: **0431 970 049** or **0414 733 471**.

Catering

Morning tea, lunch and afternoon tea will be available during the Conference in the exhibition area located in the Banquet Lobby (Conference Closing lunch will be on The Deck) and is included in your registration fee. Please refer to the table below for catering times.

	Monday	Tuesday	Wednesday
Morning Tea	1100 - 1120	1040 - 1100	0940 - 1000
Lunch	1300 - 1400	1340 - 1420	1300 - 1400
Afternoon Tea	1600 - 1620	1620 - 1640	

Coffee sponsored by Texcel

Barista coffee will be available from the coffee cart located in the Exhibitor's area before Session starts and during the major breaks. Outside of these times, the Organising Committee has a limited number of coffee tokens for redemption in the Novotel Lobby Bar and Ariel's (across the road from the Novotel open 6am - 2pm). See the Conference Registration desk for more information.

Dietary requirements

For those delegates with dietary requirements, there will be options available at the scheduled breaks where all food will be labelled accordingly. For delegates who have notified the Conference Secretariat of any other dietary requirements, for example allergies, please see staff at the Conference Registration desk.

Eateries and establishments

There are 14 coffee shops within 1 km of the conference venue and a number of restaurants and eateries in close proximity. Keira St is Wollongong's 'Eat St' for those with varying tastes. The North Wollongong Hotel is within walking distance and is a big 'old school' pub with a huge outdoor area. The Master Builder's Club is a large registered club with the largest TV screen in the Southern Hemisphere. The Collegians Club is also close and has a great selection of food.

Conference satchel

There will be no Conference satchel provided. Please bring your own bag to collect exhibitor materials and carry the re-usable coffee cup that you will be provided with.

Conference USB sponsored by Pyrotek

The Conference USB will be pre-loaded with the Conference Proceedings.

Disclaimer

The Committee reserves the right to make changes to the Conference program at any time without notice. Please note that this program is correct at the time of printing. Any subsequent changes or modifications to the program will be announced to delegates throughout the Conference as required.

Duplication/recording

Unauthorised photography, audio or video recording, or any other form of duplication is strictly prohibited in conference sessions. If you would like copies of presentations, please approach the presenter with your request.

Exhibition

The Exhibition will be in the Banquet Lobby outside the Grand Ballroom and will be open at the following times:

Monday 21 February	0900 - 1900
Tuesday 22 February	0900 - 1800
Wednesday 23 February	0830 - 1300

Internet

Free WiFi access is available at the Conference, WiFi instructions as per below:

1. Connect to the Novotel Wireless Network
2. Enter password: acoustics21

Liability/insurance

In the event of unforeseen circumstances or events such as industrial disruptions, natural disasters etc, the Organising Committee cannot accept responsibility for any financial or other losses incurred by the delegates. The Organising Committee take no responsibility for injury or damage to persons or property occurring during the Conference. All insurance, including medical cover or expenses incurred in the event of the cancellation of the Conference is the individual delegate's responsibility. The Conference Secretariat will take no responsibility for any participant failing to insure.

Covid 19 policy

With regard to Covid 19, Acoustics 2021 Making Waves will comply with the rules of the day as advised by NSW Health relevant for the Wollongong LGA. It will also comply with the requirements of the respective venues being the Novotel North Beach and the Lagoon Restaurant in regards to social distancing and QR check in.

In regards to refund of registration fees due to restrictions imposed by Covid 19, the AAS policy is that refunds will be provided if:

- The event is cancelled due to a Covid 19 outbreak whereby the government imposes restrictions and prevents the conference being held;
- Closure of State borders or restrictions mean that you cannot travel to the Conference or could not return to your home State directly after the event;
- You would be required to quarantine either prior to the Conference or on return to your home State as a consequence of your attendance at the Conference in NSW;
- You have tested positive to Covid 19 within 10 days prior to the event;
- Other scenarios will be considered on a case-by-case basis.

Unless you have a medical reason, we ask that everyone, where possible be vaccinated prior to the event. If you are unwell, please consider undertaking a polymerase chain reaction (PCR) test or a rapid antigen test (RAT) prior to your attendance.

Please see staff at the Conference Registration desk for assistance.

Mobile phones

Delegates are asked to switch off their mobile phones or set them to silent when in sessions.

Name badges/lanyards

For security purposes, all delegates are required to wear their name badges/lanyards at all times during the Conference. If you misplace your name badge/lanyard, please see the Conference Registration Desk to arrange a replacement.

Smoking

Both the Novotel North Beach and the Lagoon Restaurant are non-smoking venues, however outdoor smoking areas are provided.

Speakers

All speakers are asked to upload their presentation to the desktop of the computers in the scheduled presentation rooms either on the morning of the presentation or during the lunch break. There will be no Speakers Preparation Room at the Conference. Please refer to your guidelines for further details. All presentations are 15 minutes duration – followed by 3 minutes for questions and 2 minutes for change over.

Social Program

Registration welcome

When: Sunday 20 February 2022
Where: Novotel North Beach
Time: 1600 - 1800
Dress Code: Casual
Tickets: Included in full registration.

After registering, please join your colleagues and fellow delegates for a drink at the Lobby Bar and Poolside Cabanas.

Exhibitors reception

When: Monday 21 February 2022
Where: Novotel North Beach
Time: 1800 - 1900
Dress Code: Smart casual
Tickets: Included in full registration.

The Exhibitors Reception will commence after the last presentation for the day on Monday evening with a relaxed informal stand-up cocktail function in the Exhibitors area.

Conference dinner

When: Tuesday 22 February 2022
Where: Lagoon Restaurant
Time: 1900 - 2300
Dress Code: Smart casual
Tickets: Included in full registration.
Additional Tickets: $150.00

The Conference Dinner will be the social highlight of the Conference and give full delegates and their accompanying persons an opportunity to sample fine food and wine surrounded by the stunning beachside scenery of Wollongong. The dinner will be at the Lagoon Restaurant with excellent views over the beach and coastal botanical gardens to the sea. It is located in Stuart Park, about a 300m walk from the Novotel. Make sure you bring your dancing shoes as the band will be ready to go!

For additional tickets, please check at the registration desk.

Entertainment by The Finz

When: Tuesday 22 February 2022
Where: Lagoon Restaurant
Time: 1900 - 2300

The Finz are a 6 piece surf and covers band with a penchant for catchy songs and irresistible groove. Guaranteed to get you on the floor with a repertoire that you will all know from days gone by!

Tours and other activities

Golf

When: Tuesday 22 February 2022
Where: Wollongong Golf Course
Time: TBA

There are several high quality golf courses in the Illawarra including Wollongong Golf Course which has 5 holes adjoining the beach, with a mountain backdrop and great views of the natural landscape. Established in 1897, the club has hosted many tournaments over the years, most recently the NSW P.G.A. Championships (2009 – 2011) and the Jack Newton Subaru State Age Championships (2014 – 2015). Rodney Stevens and John Wassermann will be organising 9 holes outside of the core conference hours for anyone that wishes to join in. Please check the website, or see staff at the Conference Registration desk for options.

Other activities

Whether you want to land next to the conference venue by parachute, sail into Wollongong Harbour or just go for a surf out the front of the conference venue, there are heaps of things to do within minutes of the conference. Please see the Conference Website or Destination Wollongong for lots of options.

Keynote Speakers

Dr Danielle Moreau

Senior Lecturer, School of Mechanical and Manufacturing Engineering UNSW

Presentation title: Flow-induced noise regimes of a three-dimensional airfoil

Danielle obtained her BE(hons) and PhD from the School of Mechanical Engineering at the University of Adelaide in 2005 and 2010, respectively. Danielle's research is in the field of aeroacoustics or the understanding and control of flow-induced noise. She investigates innovative noise control solutions for aircraft, wind turbines, propellers, fans, UAVs and submarines. Her major research contributions have been in (i) wall-mounted finite airfoil aeroacoustics, (ii) airfoil trailing edge noise production and control and (iii) bluff body flow noise.

Dr Benjamin Halkon

Senior Lecturer, School of Mechanical and Mechatronic Engineering at University of Technology Sydney

Presentation title: Making waves in vibration measurement with laser Doppler vibrometry

Ben is an industrially experienced experimental dynamics and instrumentation expert and is a core member of the Centre for Audio, Acoustics and Vibration, primarily based at UTS Tech Lab where he has established and now co-directs the Vibration Laboratory which includes unique non-contact vibration measurement capabilities. Current UTS-led topics include the use of LDVs as remote noise control error signal "listening" devices as well as the removal of another form of "self-noise" due to the vibration of the instrument sensor head itself will receive significant attention, in particular in the context of the incorporation and fusion of these incredible devices into autonomous systems for the enhanced, trusted determination and monitoring of the dynamic characteristics of remote infrastructure and environments. Ben co-supervises a growing team of junior researchers, continues to secure industrially oriented funded research projects while publishing excellent research outputs and takes a full role in and recognises the importance of teaching and learning.

Dr Alex Skvortsov

Principal Scientist, Maritime Division of the Defence Science and Technology Group

Presentation title: Acoustic metamaterials for maritime applications

Alex obtained his PhD from the Moscow University of Applied Physics and Technology in 1987, on the topic of nonlinear phenomena in acoustics and vortex-sound interactions. Alex has extensive experience in defence-related and defence-sponsored projects. His research activities include stealth materials, complex vibration systems, aeroacoustics, nonlinear wave dynamics and epidemics modelling. In recognition that analytical and numerical treatment of acoustic metamaterials is a challenging undertaking, Alex is currently working on the development of some simplified physics-based models and how these can be adopted for the tailored design of acoustic metamaterials for vibro-acoustic coatings.

Dr Kristy Hansen

Senior Lecturer at Flinders University

Presentation title: Wind farm noise prevalence, annoyance, and sleep disturbance

Kristy is a DECRA Researcher and with 9 years of experience in wind farm noise research. She is chief investigator on ARC and NHMRC projects that aim to identify the potentially annoying and sleep disruptive components of wind farm noise. She has co-authored two scholarly books, including one on wind farm noise that was published by Wiley in 2017 and another on general acoustics and acoustic problem solving which was published by CRC Press in 2021. Kristy's research focuses on wind farm noise and other types of environmental noise and she has extensive experience in acoustic and vibration measurements, advanced signal processing, noise propagation modelling, noise synthesis and listening test design. Her recent contributions have included (i) machine-learning-based algorithms to detect specific components in acoustic and sleep signals, (ii) detailed characterisation of amplitude modulation prevalence and magnitude at noise sensitive receivers, and (iii) wind farm noise propagation modelling and uncertainty analysis. Kristy has authored or co-authored over 50 peer-reviewed publications and recently participated in the development of the new IEC technical standard, PT 61400-11-2, on the measurement of wind farm noise at receptor locations.

Dr Dave Hanson

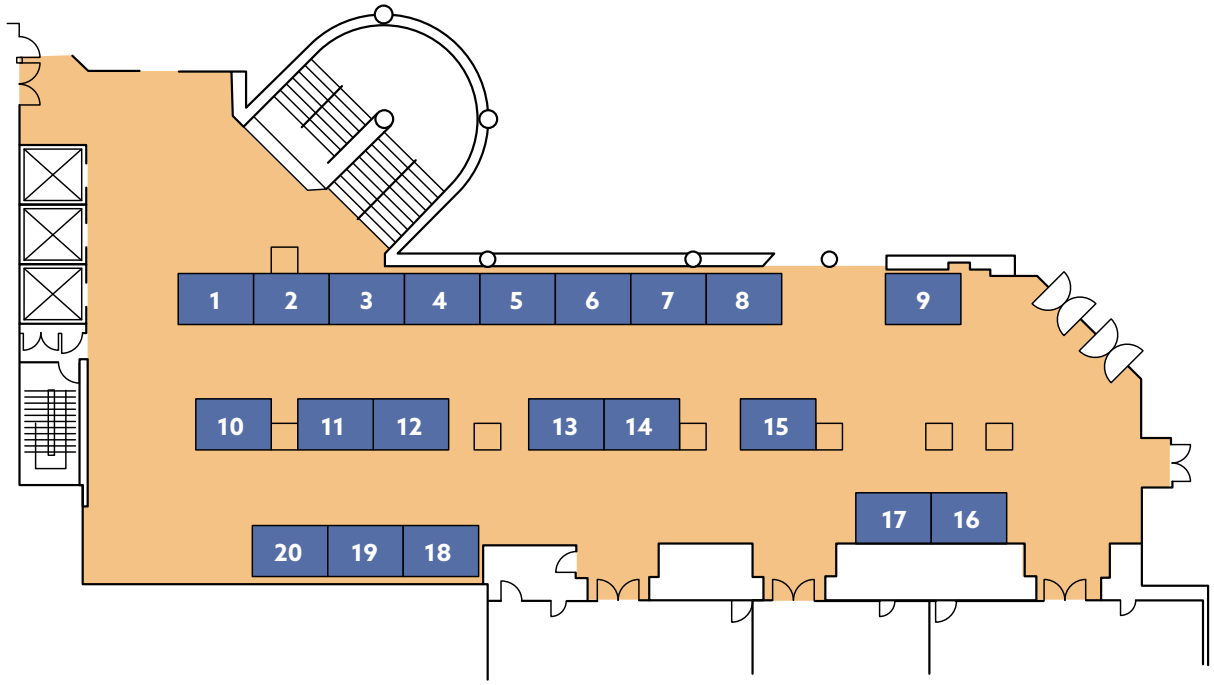
Director, Acoustic Studio

Presentation title:
Are the trains getting quieter?

Dave's career started as an engineering cadet with A Goninan and Co (now UGL) building locomotives, wagons and passenger cars. After graduating with a Bachelor of Mechanical Engineering from the University of Newcastle, Dave worked as a reliability engineer at Maintrain in Sydney before returning to studies and being awarded a PhD by the University of NSW in 2007. Dave then worked for five years for Sinclair Knight Merz in their Advanced Analysis and Test team, delivering a range of rail noise and vibration projects including the first full-scale transfer path analysis on a rail vehicle in Australia. He moved to RailCorp in 2011 as Technical Specialist Noise and Vibration, and then transferred to Transport for NSW in 2013, becoming Senior Manager Freight Performance in 2017. Dave has in-depth experience in rolling stock, track and wheel/rail interface issues associated with noise and vibration from freight and passenger heavy rail and light rail. Dave's experience includes curve noise management, locomotive noise mitigation, rail grinding and rail friction management. He was an author of the Transport for NSW Engineering Standards for wagon steering and rail lubrication, and was a member of the technical committee for AS 7641 Rail Gauge Corner Lubrication Management. Dave has authored or co-authored numerous technical papers and is a reviewer for several journals in the field of rail noise.

Sponsors and Exhibitors

Floorplan



Gold Sponsors

Company Name: Mason Mercer
Booth Number: 13 & 14
Contact: Jonathan Watson
Address details: 30 Chaffey Street, Thomastown. VIC 3074
Phone: 03 9462 2357
Email: info@masonmercer.com.au
Website: www.masonmercer.com.au

Mason Mercer has been operating in Australia for over 40 years, globally for over 65 years. We are the exclusive representatives for Mason Industries and Mercer Rubber in Australia. Mason Mercer provides engineered vibration isolation solutions. With professional engineers based in Melbourne and New York we complete a wide and detailed portfolio of projects.

We hold an inventory of over 2000 lines of product, we are the leaders in engineered vibration isolation solutions in the commercial and multi-residential markets. We have the ability in-house to engineer for large scale public works down to bespoke low volume solutions.

Our offices are in Melbourne, Sydney and Perth with resources and site services in all states and territories. We have some great giveaways at the stand this year, please be sure to visit, we look forward to seeing you.

Company Name: Regupol (Australia) Pty Ltd
Booth Number: 16 & 17
Contact: Kelly Mahon
Address details: 155 Smeaton Grange Road, Smeaton Grange NSW 2567
Phone: 02 4624 0050
Email: kelly@regupol.com.au
Website: www.regupol.com.au

REGUPOL was established in Germany in 1954; our unique products are created by high-quality recycled and reprocessed materials. Throughout our 65-year journey, we have built up a wealth of expertise and forged long-term customer partnerships in 132 countries worldwide. Today, REGUPOL is still a family enterprise, with eleven offices in seven countries, all serving as epicentres for innovation, ingenuity and community. Locally, REGUPOL has been proudly servicing the Australian market for over 30 years.

Caring about the environment is part of the REGUPOL core mission. We strive to protect and sustain our environment every step of the way, from development and production to customer use and disposal. With this approach, REGUPOL has become one of the leading suppliers of commercial, sports, anti-slip mats for load securing, and products for vibration isolation and impact sound insulation. REGUPOL's long-established environmental credentials have widely recognised the brand as a sustainable solution in green buildings. The extensive REGUPOL portfolio of impact sound acoustic underlays, elastic beddings for vibration and noise abatement products provides flexible and economical solutions that give planning certainty.

Silver Sponsors

Company Name: Embelton Engineering
Booth Number: 19
Contact: Umit Baykur
Address details: 147 - 149 Bakers Road, Coburg VIC 3058
Phone: 1800 339 638
Email: gpevicr@embelton.com
Website: www.embelton.com

Embelton is a trusted name in vibration control. Proudly Australian, our business has existed for over 95 years. From machinery foot mounts to complete building isolation, Embelton offers a portfolio of products and services to solve a wide range of vibration and noise issues.

In modern building construction, improved design allows for lighter but inherently more flexible structures. As a result, there is a growing need to safely address unwanted vibration and structure-borne noise from machinery, plantrooms, and auxiliary equipment. Noise generated by vibration can also be a major problem in such structures, intensified by the trend of higher densities living and the demand for quieter living and working conditions. Gymnasiums and swimming pools are very common features of new building complexes that require treatment, but do not have a one-size-fits-all solution.

We combine our industry experience with advanced research and development capabilities to ensure that our customers get solutions that meet or exceed performance requirements without overburdening their budget. Our engineers design, develop and test products with a combination of software analysis tools such as FEA and physical testing in our on-site laboratories. Our clients can also take comfort that our quality management system is ISO: 9001 accredited.

Most importantly, we pride ourselves on our relationships built from the experience and service that we provide to customers, consultants, architects and other stakeholders.

Company Name: Batten and Cradle Flooring Systems
Booth Number: 12
Contact: Pete Snowden
Address details: 26 Queen Street, New Plymouth, New Zealand 4310
Phone: +64 027 555 506
Email: petes@battenandcradle.com
Website: www.battenandcradle.com.au

]The quietest floors that anyone's ever 'heard' of!

At B&C systems, we're all about managing noise. Used by industry professionals and proven in case studies, we provide a high performance acoustic solution for medium and high density housing development. BRANZ appraised and suitable for a range of commercial and residential applications, our independently tested flooring systems exceed Australian and New Zealand acoustic and structural standards.

We're working to make a difference by using recycled tyre waste as our raw material to reduce the amount of used tyres entering landfill and to make construction materials more sustainable. Come see us at booth 12!

Bronze Sponsors

Company Name: Instyle
Booth Number: 7
Contact: Paul Leadbetter
Address details: 6 - 8 Ricketty Street, Mascot, NSW 2020
Phone: 02 9317 0222
Email: pleadbetter@instyle.com.au
Website: www.instyle.com.au

Established by Michael Fitzsimons in 1987, Instyle is a leading wholesale supplier of elegant, highly functional acoustic solutions for interiors, including workplace, hospitality, healthcare, public building, transport, public space and residential spaces. Instyle's Ecoustic collection offers a wide range of acoustic products and finishes with broadband absorption (NRC 0.6 - 1.0) including drop-in ceiling tiles, wall panels, soffit absorbers, baffle systems, acoustic timber products and wall tiles.

Instyle has won or been shortlisted for numerous design awards for its acoustic products, including four international design award wins for its innovative Ecoustic Sculpt. Designed for the environment, the Ecoustic collection achieves Cradle to Cradle and Greentag Level A certification and has featured in many key projects including NAB, Westpac, Melbourne University, UTS, Deakin University, Facebook, Google and Uber.

Company Name: Pyrotek Noise Control
Booth Number: Corporate Sponsor
Contact: Alex Rasa
Address details: 147 Magowar Rd Girraween NSW 2145
Phone: 02 8868 2000
Email: aleras@pyrotek.com
Website: www.pyroteknc.com

Pyrotek is the market leader in manufacturing acoustic solutions with over 45 years' experience. Specialised in proven acoustic, thermal insulation and other exclusive marine approved structural fire protection, we provide advanced materials to designed specifications. Pyrotek offers consultation in design and customised soundproofing plans and are highly equipped to manage tailored solutions in any scenario.

Established in Australia in 1972, we have worked hard to design and manufacture a wide variety of materials for environments where noise reduction is required. By utilising our in-house engineering services, we are able to produce customised soundproofing plans to meet your unique noise reduction needs. Our aim is to help you realise improved cost savings by delivering a level of quality that is scarcely found in other offerings. Our product range is designed to solve common noise and vibration problems found in industries such as: construction, automotive, marine, and residential environments.

The Pyrotek R&D team are continually working on new ways of tackling the problem of noisy environments. The ongoing goal of our specialist engineers is to create advanced materials and innovative products which anticipate changing customer needs. Our expertise is reinforced by the strong ties we maintain with strategic partners. Add to this our state-of-the-art production facilities, which are ISO Quality Assurance Standards certified, and it's no wonder our noise proofing solutions deliver on quality and price time-after-time.

Beverage Sponsor

texcel
Environmental monitoring made easy

Company Name: Texcel
Booth Number: Corporate Sponsor
Contact: Nick Lahman
Address details: Unit 1, 180 Northgate Road, Northgate, Qld 4013
Phone: 07 3237 8111
Email: nickl@texcel.com.au
Website: www.texcel.com

We are Innovators, Creators and Doers whose vision is to translate tech, simply.

Texcel specialises in providing managed environmental monitoring services and equipment to ensure clients in the Mining, Quarrying, Construction and Infrastructure sectors meet their compliance and environmental data collection objectives.

Our services include but aren't limited to:

- Vibration Monitoring
- Noise Monitoring
- Dust Monitoring
- Weather Monitoring
- Blast Monitoring

All our environmental monitoring services are tailored for short or long term turnkey solutions that manage everything from installation, data collection, calibration, maintenance and data reporting requirements. Texcel can also provide standalone, individual compliance monitors for smaller projects.

Texcel is your expert, third party, independent service provider.

Never undertaken a monitoring project before? Texcel will assist you to work through the constraints of your specific site and tailor the equipment, services and data needed for your circumstances.

Exhibitors

Acoustic Research Labs Pty Ltd

Company Name: Acoustic Research Labs Pty Ltd
Booth Number: 9
Contact: Kenneth Williams
Address details: Unit 36, 14 Loyalty Road, North Rocks, NSW, 2151
Phone: 02 9484 0800
Email: reception@acousticresearch.com.au
Website: www.acousticresearch.com.au

ARL was formed in 1990 to develop, service and maintain a long term structural vibration and environmental noise monitoring system for use during the construction of the Governor Macquarie and Governor Phillip towers in the CBD of Sydney. The two year monitoring plan was implemented principally as the means to protect the structural integrity of a series of fragile heritage listed buildings which were situated around the construction site. The success of this initial project led to the further development of standalone monitoring instruments for noise and vibration.

Throughout the 1990's ARL continued to develop noise and vibration monitoring solutions. ARL took on the role as Australia's sole distributor of Rion instruments. In 1999 ARL also became a NATA accredited calibration facility.

Throughout the early 2000s, technology in the field of measurement and acoustics began to advance and as a result our engineering activities were focused on developing advanced monitoring solutions to meet the requirements of an evolving industry.

Instruments were developed with a focus on post-processing and have since been successfully deployed in wide-ranging applications, including permanent long-term remote logging and large-scale multi-logger measurement systems.

Directional noise monitoring came from the development and deployment of the Environmental Noise Compass™ with the environmental monitoring needs of the Australian and world-wide mining industry in mind. The challenge of developing a modern directional noise monitoring system was met by combining advanced acoustic signal processing with directional beamforming techniques employed in some military sonar systems, culminating in an end-result that is intelligent and low-maintenance.

Constantly keeping up with market needs we have moved into the field of remote monitoring with Noise Cloud™. We are very proud of our relationship with Rion and the benefits this allows us to pass on to our clients.

Acu-Vib Electronics
Noise, Vibration, Air Sampling & Radiation

Company Name: Acu-Vib Electronics
Booth Number: 6
Contact: John Gajardo-Cordova and Jack Kielt
Address details: 14/22 Hudson Avenue Castle Hill NSW 2154
Phone: 02 9680 8133
Mobile: 0402 722 709 and 0413 809 806
Email: john@acu-vib.com.au
jack@acu-vib.com.au
Website: www.acu-vib.com.au
www.soundlevelmeters.com.au

Exclusive Svantek Supplier of Sound and Vibration monitoring Instruments. Sales, Hire and NATA Calibration service.

acoem

Company Name: ACOEM
Booth Number: 11
Contact: Raymond Lee
Address details: 40/65 Marigold Street, Revesby, NSW 2212
Phone: 02 8707 7400
Email: info.au@acoem.com
Website: www.acoem.com

At Acoem, our aim is to shorten the path between monitoring and informed action. With a range of multi-parameter noise and vibration sensors, measurement tools and integrated data solutions, we are globally recognised for our class-leading equipment and smart monitoring capabilities. By designing our monitoring instruments — 4G Fusion™ sound level meter, 4G Cube™ noise monitoring terminal and Orion™ vibration monitoring terminal — and on a single ecosystem, we provide users with greater inter-connectivity between devices, components and analysis software.

This translates to ease of operation and the ability to quickly adapt between features and models across the Acoem range.

Our technology empowers environmental consultants, industries, construction sites and airports to make knowledgeable decisions based on accurate and reliable data. It helps them adhere to government regulations, protect businesses and workers from excessive noise and vibration levels, and improve quality of life for affected communities. Together, we create environments of possibility.

Company Name: Autex Acoustics
Booth Number: 18
Contact: Rob Jones
Address details: PO Box 5099, West Heidelberg, Melbourne, VIC 3081
Phone: 1800 678 160
Email: enquiries@autex.com.au
Website: www.autexglobal.com/au

Beautiful acoustics for spaces where people live, work and learn.

Our acoustic solutions are designed to reduce and control reverberation and echo in building interiors, creating comfortable, acoustically balanced environments. The Autex Acoustics range offers a variety of treatments including wallcoverings, panels, baffles, and screens—easily customised to fit the requirements of your space.

For over 30 years our team has been designing, developing and manufacturing innovative acoustics for the built environment—revolutionising the way acoustic treatments are applied within interior spaces. As passionate creators, we're constantly tinkering with new concepts, and expanding our horizons.

For further information on our products, visit us at Booth 18 to speak with our Technical Manager, Rob Jones.

Company Name: Hottinger Bruel & Kjaer Australia
Booth Number: 10
Contact: Neil Rawle
Address details: Suite 4.03, Level 4, 3 Thomas Holt Drive, Macquarie Park NSW 2113
Phone: 02 9889 8888
Email: auinfo@hbkworld.com
Website: www.hbkworld.com

For many decades, HBM and Brüel & Kjær have been trusted across multiple industries to deliver highly accurate technologies and expertise in test and measurement and sound and vibration. In 2019 the two companies joined forces as HBK – Hottinger, Brüel & Kjær to form the world's foremost provider of integrated test, measurement, control, and simulation solutions.

One of our focus areas is to provide the highest quality equipment for measuring and testing sound and vibration. Whether your mission is designing better cars, validating your next satellite launch, evaluating building acoustics, or improving the speech intelligibility and sound quality of smartphones and headphones, then HBK is the logical partner for your sound and vibration challenges.

Company Name: Acoustic Blinds and Curtains
Booth Number: 5
Contact: Cameron West
Address details: 12 Waltham St, Artarmon, NSW 2064
Phone: 1300 911 680
Email: info@acousticblindsandcurtains.com.au
Website: www.acousticblindsandcurtains.com.au

Acoustic Blinds and Curtains is THE brand for Acoustic Blinds and Curtains in Australia.

We offer acoustic solutions in window furnishings - with an industry leading range of acoustic fabrics, including exclusive fabrics, and a custom noise reduction solution. Acoustic Blinds and Curtains are a 'design first' acoustic solution preferred by architects and designers.

Our Acoustic Blinds and Curtains offer simple, cost effective noise reduction and sound absorption compared to other acoustic products and a functional alternative to traditional blinds and curtains!

Company Name: ETMC Technologies Pty Ltd
Booth Number: 15
Contact: Dr Miroslav Dosen
Address: Suite 1A, Level 2, 802 Pacific Highway, Gordon NSW 2076
Phone: 02 9555 1225
Email: contact@etmc.com.au
Website: www.etmc.com.au

ETMC Technologies is a trusted resource you can call on for technical input, operational assistance along with supply of class leading microphones, accelerometers, sound level meters, data capture systems and much more!

This year, we have the newly launched and world's first truly intelligent microphone set - in addition to measuring sound reliably (like all GRAS microphones do), it has the following functionality built into the unit: self-calibration (charge injection with an integral signal generator), sensors (temperature, pressure and humidity) in the form-factor of a standard ½" microphone set (capsule + preamplifier). All of this technology is controlled/accessed via a TEDS interface over a 2 wire (standard IEPE compliant) connection.

For acoustic consultants - we will be showing a very compact high power logging solution that gives you acoustic directionality, integrated modem + remote web interface to your logger or the option to have web-based storage and access of your data.

For those working under extreme conditions - we will be showing three rugged microphones that thrive under conditions that 'kill' normal microphones. They are IP rated, robust, shock+water+dust+oil resistant and give you confidence that they will work under some pretty extreme conditions. If this sounds like what you are doing or need, come and have a chat and we can even arrange a demo for you to get hands-on.

To summarise: we supply professional tools of that trade that will take the guess-work out of 'is it working' or 'did I do it right', etc.

Come and talk with us to see how we can help you and your team get a better outcome.

Company Name: HW Technologies
Booth Number: 20
Contact: Hugo Waibel
Address details: 2/33 Daking Street
North Parramatta NSW 2151
Phone: 02 9683 4008
Email: info@hwtechnologies.com.au
Website: www.hwtechnologies.com.au

HW Technologies will showcase number of different products. From gfaitech in Germany we will demonstrate the following.

The acoustic camera: Showing a spherical array for 3D acoustic analysis and the brand new handheld acoustic camera called "Mikado".

With this latest handheld acoustic camera "Mikado" is equipped with an Intel® RealSense™ depth camera. During the acoustic measurement the depth information is automatically recorded. The innovative module "DynaBeam" generates a 3D-model from the depth information and maps the acoustic information onto it. Sound sources are directly shown on the surface of the model making an interpretation of the information easy for everyone. Even the main beam direction of the sound sources can be displayed.

Also on display will be the worlds first smart modal hammer WaveHitMAX which guarantees fully automatic, reproducible and high-precision excitation of the test object without double hits. This smart modal hammer can be used together with our modal analysis software or your own application software.

Also an Australian first the new WaveCam. Visualising vibrations via a special camera.

From MECALC in South Africa we will showcase the Micro Q. The most advanced compact and highly integrated acquisition and control systems measure and output precise, high-speed analog and digital signals. Both standard and complex multi-channel tasks are addressed by the same Modular platform, which can be freely configured as small troubleshooting solutions or large distributed systems. From 2 to 192 channels.

Company Name: Magnetite (Australia) Pty Ltd
Booth Number: 4
Contact: Adrian Lafleur
Address details: 142A Victoria Rd, Marrickville NSW 2204
Phone: 02 9565 4070
Email: adrian@magnetite.com.au
Website: www.magnetite.com.au

Magnetite will assess, design and deliver solutions for glazing in existing buildings with a specific focus on acoustic insulation.

Offering a range of retrofit systems we are able to maximize the air cavity between the existing window and our secondary glazing to provide maximum sound attenuation through the window. Magnetite's magnetic seals ensure an air tight air cavity which will bolsters the acoustic results but still allow the windows to open for ventilation and maintenance as required.

Ideal for:

- infrastructure noise abatement projects
- construction site noise mitigation
- Green Star projects
- heritage building glazing upgrades
- hotel refurbishments
- office fit outs

With 18 years' experience in the Australian market we have expanded our product range to allow us to customise solutions in order to achieve the best results for our clients. We have recently finished a fit out of 5 Martin Place "Commonwealth Bank Money Box Building" in Sydney. Other notable projects include the Rendezvous Hotel -Sydney, 140 William St restoration - Perth, Legacy Way Noise abatement project – Brisbane as well as landmark noise abatement projects for M7 Motorway, Lane Cove Tunnel and Roads & Maritime Services NSW.

As members of the Australian Window Association our products are independently tested and our operation audited on a regular basis for quality control. Our commitment to excellence leads us to employ teams of trained and licensed installers ensuring the highest quality and efficient installations.

Contact Magnetite for your ideal partner in retrofit glazing projects.

Company Name: Marshall Day Acoustics Pty Ltd
Booth Number: 1
Contact: Christophe Delaire
Address details: 6 Gipps Street Collingwood VIC 3066
Phone: 03 9416 1855
Email: melbourne@marshallday.com
Website: www.marshallday.com

Established in 1981, Marshall Day Acoustics has grown to become one of Australia's largest and most respected acoustic consultants. The engineers in our Adelaide, Melbourne, Perth and Sydney offices provide environmental noise assessment, architectural acoustics and vibration consulting services across Australia.

Our clients are architects, lawyers, planners, engineers, local authorities, developers and individuals who benefit from our creative design solutions to the highest quality standards.

Our staff are linked across our extensive network of offices to form one team of engineers, architects, musicians, designers and scientists. Our company philosophy, technical resources and uniquely creative working environment, result in an enviable level of staff retention that provides our clients with stable and committed project teams.

Our projects represent our proud history as an innovative, creative and specialist acoustic consultancy at an international and local level. Our experience encompasses performing arts design, building acoustics, planning & resource consents, environmental noise, industrial & marine noise control, sound system design and structural dynamics & vibration analysis. Our projects include major centres in the USA, Australia, New Zealand, China, Singapore, Malaysia, Hong Kong, the Pacific Islands and the Middle East.

In 2007, we developed a specialist theatre consulting division, Marshall Day Entertech, enabling us to provide a complete suite of venue consulting services.

To discuss how we can assist with your project, please contact one of our consultants at your closest office.

Company Name: Noise Measurement Services Pty Ltd
Booth Number: 3
Contact: Matthew Dever
Address details: 18 Lade St, Gaythorne 4051 Brisbane
Phone: 07 3355 9707
Email: sales@noisemeasurement.com.au
Website: www.noisemeasurement.com.au

Noise Measurement Services are your Australian representative for the whole range of Larson Davis sound and vibration monitoring equipment. We have been using Larson Davis equipment in our consultancy and rental business for over 15-years and can truly vouch for the quality, reliability, service, and ease of use that Larson Davis equipment offers. We take pride in providing expert and timely after-sales support on all Larson Davis equipment, which is provided by a team of experts who use the equipment on a day-to-day basis. We can provide most repair services in-house and most calibration services within Australia. If you need to measure sound or human vibration, we are sure to have a device to meet your requirements; ask us about the latest pricing and trade-in deals.

Company Name: SoundBlock
Booth Number: 8
Contact: Michael Turtledove
Address details: Suite 2, 206T Alison Rd, Randwick NSW 2031
Phone: 0409 938 606
Email: michael@soundblock.com.au
Website: www.soundblock.com.au

Soundblock is an established, leading supplier & installer of acoustic products & solutions nationally. Soundblock's range includes magnetic acrylic & aluminium sliding secondary windows & doors, Barrierboard secondary walls & ceilings, acoustic underlays, pipe wrap, insulation & a variety of acoustic absorption panels. Soundblock is the exclusive distributor of the unique closed cell polyethylene foam acoustic absorber Stratocell Whisper.

Company Name: Sound Cam
Booth Number: 2
Contact: Matthew Harrison
Address details: Level 5/73 Miller St, North Sydney NSW 2060
Phone: 1800 478 573
Email: info@pwna.com.au
Website: www.pwna.com.au

Pulse White Noise Acoustics are the Australian distributor for the German CAE Software and Systems range of technological products for the measurement of noise and vibration.

We offer solutions for sound source localisation with acoustic cameras or intensity mapping systems as well as solutions for sound power measurement according to international standards. Special data acquisition system, test stands and software can also be developed according to customer requirements.

Program Overview

Sunday 20 February 2022		
16:00 - 18:00	Registration and Welcome drinks - Lobby Bar and Poolside Cabanas	
Monday 21 February 2022		
09:00 - 09:30	Registrations - Exhibition area	
09:30 - 10:00	Barista coffee - Exhibition area	
10:00 - 10:20	Opening Ceremony - Grand Ballroom	
10:20 - 11:00	**Keynote I: Dr Danielle Moreau – Grand Ballroom**	
11:00 - 11:20	Morning tea	
	Throsby Room	**Hoskins Room**
	Aeroacoustics I	**Tribute / Signal Processing**
11:20 - 11:40	1	Anita Lawrence tribute
11:40 - 12:00	2	1
12:00 - 12:20	3	2
12:20 - 12:40	4	3
12:40 - 13:00	5	4
13:00 - 14:00	Lunch	
14:00 - 14:40	**Keynote II: Dr Ben Halkon – Grand Ballroom**	
14:40 - 15:00	Break	
	Aeroacoustics II	**Structure-Borne Noise**
15:00 - 15:20	6	1
15:20 - 15:40	7	2
15:40 - 16:00	8	3
16:00 - 16:20	Afternoon tea	
	Aeroacoustics III	**Building Vibration**
16:20 - 16:40	9	1
16:40 - 17:00	10	2
17:00 - 17:20	11	3
18:00 - 19:00	Drinks in the Grand Ballroom and Exhibition Area	

Program Overview

Tuesday 22 February 2022		
09:00 - 09:30	Registrations - Exhibition area	
09:30 - 10:00	Barista coffee - Exhibition area	
10:00 - 10:40	**Keynote III: Dr Alex Skvortsov – Grand Ballroom**	
10:40 - 11:00	Morning tea	
	Throsby Room	**Hoskins Room**
	Noise Control Materials	**Environmental Noise Policy and Regulation I**
11:00 - 11:20	1	1
11:20 - 11:40	2	2
11:40 - 12:00	3	3
12:00 - 12:20	4	4
12:20 - 12:40	Break	
	Underwater Acoustics and Noise I	**Environmental Noise Policy and Regulation II**
12:40 - 13:00	1	5
13:00 - 13:20	2	6
13:20 - 13:40	3	7
13:40 - 14:20	Lunch	
14:20 - 15:00	**Keynote IV: Dr Kristy Hansen – Grand Ballroom**	
15:00 - 15:20	Break	
	Underwater Acoustics and Noise II	**Soundscapes**
15:20 - 15:40	4	1
15:40 - 16:00	5	2
16:00 - 16:20	6	3
16:20 - 16:40	Afternoon tea	
	Underwater Acoustics and Noise III	**Environmental Acoustics**
16:40 - 17:00	7	1
17:00 - 17:20	8	2
17:20 - 17:40	9	3
17:40 - 18:00	10	4
19:00 - 23:00	Conference Dinner - Lagoon Restaurant	

Program Overview

Wednesday 23 February 2022		
08:00 - 08:30	Registrations - Exhibition area	
08:30 - 09:00	Barista coffee - Exhibition area	
09:00 - 09:40	**Keynote V: Dr Dave Hanson – Grand Ballroom**	
09:40 - 10:00	Morning tea	
	Throsby Room	**Hoskins Room**
	Railway Noise and Vibration I	**Architectural and Building Acoustics**
10:00 - 10:20	1	1
10:20 - 10:40	2	2
10:40 - 11:00	3	3
11:00 - 11:20	4	4
11:20 - 11:40	Break	
	Railway Noise and Vibration II	
11:40 - 12:00	5	
12:00 - 12:20	6	
12:20 - 12:40	7	
12:40 - 13:00	Closing Ceremony - Grand Ballroom	
13:00 - 14:00	Farewell Lunch - The Deck	

Technical Program

Monday 21 February 2022

Monday **10:00 - 10:20** **Opening Ceremony, Grand Ballroom**

Monday **10:20 - 11:00** **Keynote I: Dr Danielle Moreau - Flow-induced noise regimes of a three-dimensional airfoil**
Chair: *Mahmoud Karimi*

Monday **11:20 - 13:00** **Aeroacoustics I, Throsby Room**
Chair: *Paul Croaker*

11:20 - 11:40 Sound radiated by two and three-dimensional supercritical airfoils operating in low Mach number flows
Manuj Awasthi, Tingyi Zhang, Jiawei Tan, Danielle Moreau, Rio Baidya, Charitha de Silva

11:40 - 12:00 Estimating propeller trailing-edge pressure using the BPM method
Richard Howell, Paul Croaker, Christopher Gargan-Shingles, Paul Dylejko, Alex Skvortsov

12:00 - 12:20 Experimental investigation of airfoil-turbulence interaction noise
Roman Kisler, Chaoyang Jiang, Con Doolan, Danielle Moreau, Charitha de Silva

12:20 - 12:40 Application of wall-modelled LES to the prediction of turbulent flow noise
Graeme Lane, William Sidebottom, Paul Croaker

12:40 - 13:00 Aeroacoustics of flow over a forward-backward facing step
Chung-Hao Ma, Manuj Awasthi, Danielle Moreau, Con Doolan

Monday **11:20 - 11:40** **Anita Lawrence tribute, Hoskins Room**
Chair: *Sebastian Oberst*

11:20 - 11:40 Anita Lawrence - Contributions to acoustics in Australia
Marion Burgess

Monday **11:40 - 13:00** **Signal Processing, Hoskins Room**
Chair: *Sebastian Oberst*

11:40 - 12:00 Data verification for ambient vibration tests
Valeri Lenchine

12:00 - 12:20 Dynamic auralisations of two simultaneous sound sources using ambisonics IR convolutions
Daniel Castro, Henry Andrew

12:20 - 12:40 Acoustic based classification of transfer modes in gas metal arc welding
Mitchell Cullen, Sipei Zhao, JC Ji

12:40 - 13:00 Application of improved sliding DFT algorithm for non-integer k
Carl Howard

Monday **14:00 - 14:40** **Keynote II: Dr Ben Halkon - Making waves in vibration measurement with laser Doppler vibrometry**
Chair: *Paul Dylejko*

Monday **15:00 - 16:00** **Aeroacoustics II, Throsby Room**
Chair: *Manuj Awasthi*

15:00 - 15:20 Wavepacket coupling in screeching twin-jets
Petronio Nogueira, Michael Stavropoulos, Daniel Edgington-Mitchell

15:20 - 15:40 Prediction of vortex-shedding noise from flow over a high aspect ratio cylinder using an acoustic analogy
William Sidebottom, Paul Croaker, David Jones, Mattias Liefvendahl

15:40 - 16:00 An experimental investigation of the flow field and noise generation at a NACA 0012 wingtip
Tingyi Zhang, Yuchen Ding, Jeoffrey Fischer, Yendrew Yauwenas, Charitha de Silva, Con Doolan, Danielle Moreau

Monday **15:00 - 16:00** **Structure-Borne Noise, Hoskins Room**
Chair: *Gyani Shankar Sharma*

15:00 - 15:20 Radiation efficiency of planar structures - A case study on its application for estimation of radiated sound power
Vahid Alamshah, Valeri Lenchine

15:20 - 15:40 Parametric study of circular duct breakout transmission loss
Paul Williams, Ray Kirby

15:40 - 16:00 Low frequency noise from vibrating screens
Dominik Duschlbauer, Steven Walker

Monday	**16:20 - 17:20**	**Aeroacoustics III, Throsby Room** **Chair: *Kostas Tsigklifis***
	16:20 - 16:40	Aeroacoustic source contributions to sound power *Esmaeel Eftekharian, Paul Croaker, Steffen Marburg, Nicole Kessissoglou*
	16:40 - 17:00	Surface contribution of a stochastically excited panel to the radiated sound power *Mahmoud Karimi*
	17:00 - 17:20	Acoustic technique for building envelope air permeability test *Andreas Havenstein, Karel Ruber, Matthew Harrison, Con Doolan*
Monday	**16:20 - 17:20**	**Building Vibration, Hoskins Room** **Chair: *Dominik Duschlbauer***
	16:20 - 16:40	Gym noise reduction: Two case studies *Michael Hayne*
	16:40 - 17:00	Structural dynamics, noise and vibration: Buildings adjacent to train lines *Pablo Reboredo Gasalla*
	17:00 - 17:20	Gymnasium vibration isolation within a sensitive medical research building *Andrew Parker*

Tuesday 22 February 2022

Tuesday	**10:00- 10:40**	**Keynote III: Dr Alex Skvortsov - Acoustic metamaterials for maritime applications** **Chair: *Ray Kirby***
Tuesday	**11:00 - 12:20**	**Noise Control Materials, Throsby Room** **Chair: *Michael Hayne***
	11:00 - 11:20	Sound absorption of a soft medium embedded with hard spheres *Gyani Shankar Sharma, Alex Skvortsov, Ian MacGillivray, Nicole Kessissoglou*
	11:20 - 11:40	Acoustic performance of a voided soft medium under hydrostatic pressure *Christopher Levin, Gyani Shankar Sharma, Alex Skvortsov, Ian MacGillivray, Nicole Kessissoglou*
	11:40 - 12:00	Novel resonator geometry for easily manufactured tunable locally resonant metamaterial *Can Nerse, Richard Schadeberg, Sebastian Oberst*
	12:00 - 12:20	An experimental study on the effect of diffusers on the sound absorption measurement *Qiaoxi Zhu*
Tuesday	**11:00 - 12:20**	**Environmental Noise Policy and Regulation I, Hoskins Room** **Chair: *Peter Karantonis***
	11:00 - 11:20	Managing construction noise and vibration on major infrastructure projects in NSW *Tracy Gowen, Mattia Tabacchi, Peter Karantonis*
	11:20 - 11:40	Acoustics, amenity and the vicissitudes of impact *Robert Fitzell*
	11:40 - 12:00	Application of the Objective Impulse Assessment method in AS1055:2018 *Colin Tickell*
	12:00 - 12:20	Development of South Australian building standard for aircraft noise intrusion - Ministerial Building Standard - 010 (MBS 010) *Darren Jurevicius, Jenna MacDonald, Lachlan Newitt, Jingyuan Tan*
Tuesday	**12:40 - 13:40**	**Underwater Acoustics and Noise I, Throsby Room** **Chair: *James Forrest***
	12:40- 13:00	Issues and opportunities for inverting a simple seafloor description for shallow oceans *Adrian Jones, Md Ayub, Paul Clarke*
	13:00 - 13:20	Underwater vector sensor flow noise reduction *John Barnes, Garry Harris*
	13:20 - 13:40	Characterisation of an underwater acoustic seal deterrent system in the Tamar River *Craig McPherson, Mary Anne Lea, Steven Connell, Dana Cusano, Belinda Yaxley, Sam Welch*

Tuesday	**12:40 - 13:40**	**Environmental Noise Policy and Regulation II, Hoskins Room** **Chair: *Najah Ishac***
	12:40 - 13:00	Noise impact of the COVID 19 lockdown in Melbourne *James McIntosh, Marc Buret, Norm Broner, Phil West*
	13:00 - 13:20	Exploration of aircraft noise model validation with noise measurements *Mark Latimore, Daniel Wanasili, Clyton Moyo*
	13:20 - 13:40	Protecting the hearing of divers from underwater noise *Douglas Cato, Neil Tavener*
Tuesday	**14:20 - 15:00**	**Keynote IV: Dr Kristy Hansen - Long-term investigation into wind farm amplitude modulation and annoyance** **Chair: *Marc Buret***
Tuesday	**15:20 - 16:20**	**Underwater Acoustics and Noise II, Throsby Room** **Chair: *Xia Pan***
	15:20 - 15:40	Effect of sound speed profiles on wind-generated ocean noise *Zhi Yong Zhang, Alexander Gavrilov, Robert McCauley*
	15:40 - 16:00	Estimates of the influence of seafloor type on vertical directionality of surface-generated ambient noise in shallow oceans *Adrian Jones, Md Ayub, Zhi Yong Zhang*
	16:00 - 16:20	Reduced order modelling of vibroelastic response of a hydrofoil in homogeneous isotropic turbulence *Konstantinos Tsigklifis, Marcus Wong, Steven De Candia, Paul Dylejko, Paul Croaker, Alex Skvortsov*
Tuesday	**15:20 - 16:20**	**Soundscapes, Hoskins Room** **Chair: *Marion Burgess***
	15:20 - 15:40	Evolution of noise pollution reports during COVID-19 *Marc Buret, Elaine Just*
	15:40 - 16:00	Preliminary exploration of noise and student learning in modern flexible education spaces *Greg Barry, Lisa O'Keeffe, Bruce White, Jill Colton, Leanne Farmer*
	16:00 - 16:20	Noise measurements in an acute Australian hospital *Jesse Coombs, Md Ayub, Tim Shultz, Rick Weichula, Anthony Zander, Lynette Cusack, Joanne Dollard*
Tuesday	**16:40 - 18:00**	**Underwater Acoustics and Noise III, Throsby Room** **Chair: *Adrian Jones***
	16:40 - 17:00	Exploring the effect of underwater burial on the resonant behaviour of simplified shell geometries *Joseph Milton, Marshall Hall, Yan Kei Chiang, Benjamin Halkon, Sebastian Oberst, David Powell*
	17:00 - 17:20	Effect of local masses on radiated sound pressure from an underwater enclosure due to machine noise *Xia Pan, James Forrest, Ian MacGillivray, Stephen Moore*
	17:20 - 17:40	Sound radiation from a cylindrical shell with an acoustic coating *Cikai Lin, Gyani Shankar Sharma, Alex Skvortsov, Ian MacGillivray, Nicole Kessissoglou*
	17:40 - 18:00	Sound radiation from a plate immersed in water near the free surface *Jamie Kha, Mahmoud Karimi, Laurent Maxit, Alex Skvortsov, Ray Kirby*
Tuesday	**16:40 - 18:00**	**Environmental Acoustics, Hoskins Room** **Chair: *Marion Burgess***
	16:40 - 17:00	Predicting outdoor sound propagation in the presence of wind and temperature inversions *Ray Kirby*
	17:00 - 17:20	Sound directivity from a 250kW gas turbine exhaust system *Ben Cazzolato, Orddom Leav, Carl Howard*
	17:20 - 17:40	Comparison of five general noise prediction models and their performance in estimating low frequency noise propagation *Lance Jenkin, Jeffrey Peng, Jeffrey Parnell*
	17:40 - 18:00	A GIS-based heavy vehicle noise emission model *Daipei Liu, Jeffrey Peng, Jeffrey Parnell, Nicole Kessissoglou*

Wednesday 23 February 2022

Wednesday 09:00 - 09:40 **Keynote V: Dr Dave Hanson - Are the trains getting quieter?**
Chair: *Graham Brown*

Wednesday 10:00 - 11:20 **Railway Noise and Vibration I, Throsby Room**
Chair: *Conrad Weber*

10:00 - 10:20 Insights from long-term wayside monitoring of rail vibration
Dave Hanson, Briony Croft, Dave Anderson

10:20 - 10:40 Examining the use of eVDVs to determine VDVs from rail vibration in NSW
Aaron Miller, Jordan McMahon, Dominik Duschlbauer

10:40 - 11:00 Implementation of NSW rail and road traffic noise guidelines on light rail projects
Samaneh Fard, Megan Haberley, Poppy Coleman

11:00 - 11:20 Engine exhaust silencers for older locomotives - A case study
Dave Hanson, Bradley Wolfgang, Paul Williams, Ray Kirby, Michael Neville

Wednesday 10:00 - 11:20 **Architectural and Building Acoustics, Hoskins Room**
Chair: *Jenna MacDonald*

10:00 - 10:20 A case study on the new transmission loss suite built in University of Technology Sydney
Qiaoxi Zhu

10:20 - 10:40 Using lab-based and non-lab-based audio-visual virtual reality experiments for auditorium seat preference studies
Yuxiao Chen, Densil Cabrera

10:40 - 11:00 Predicting patron noise levels in restaurants and bars - An extension to Rindel's Method
Glenn Leembruggen

11:00 - 11:20 Acoustics in gesamtkunstwerk; Design of Phoenix Central Park
Matthew Ottley

Wednesday 11:40 - 12:40 **Railway Noise and Vibration II, Throsby Room**
Chair: *Dave Anderson*

11:40 - 12:00 Maintenance effects on rolling noise - metro and light rail
Briony Croft, Aaron Miller, Arthur Kupper

12:00 - 12:20 Freight rail noise in NSW: Comparisons of recent measurements against the rail noise database
Pri Pandey

12:20 - 12:40 An analytical and experimental study of railway noise emissions from Sydney Harbour Bridge
Graham Brown, David Timms, Peter Lark, Ross Emslie

Wednesday 12:40 - 13:00 **Closing Ceremony, Grand Ballroom**

Abstracts

Keynote I

Flow-induced noise regimes of a three-dimensional airfoil

Danielle Moreau
University of New South Wales Sydney

Abstract
The flow-induced noise produced by a surface-mounted three-dimensional (or finite length) airfoil is important for many aerodynamic and hydrodynamic applications. Examples include wing-fuselage junctions, turbomachinery blade, rotor tip and end-wall flows, and ship appendage and hull-junction flows. This paper provides an overview of the three-dimensional airfoil noise program at UNSW Sydney. In general, there are four flow regimes for a three-dimensional airfoil. These are the airfoil-wall junction flow featuring a horseshoe vortex that wraps around the airfoil base; turbulent flow interaction with the leading edge; trailing edge flow whose structure depends upon the Reynolds number; and the tip flow that consists of vortices that form as the flow wraps around the free-end of the airfoil. The acoustic signature and turbulent noise sources associated with each of these flow regimes will be examined using anechoic wind tunnel measurements obtained with acoustic array, unsteady surface pressure and turbulence measurement methods.

Keynote II

Making waves in vibration measurement with laser Doppler vibrometry

Benjamin Halkon
University of Technology Sydney

Abstract
The impact of the invention of the laser cannot be overstated. In vibration and acoustics engineering, the laser Doppler vibrometer has revolutionised the means by which scientists and engineers can interpret and control the natural and man-made environment, both on and off the planet. Combining high sensitivity, dynamic and frequency ranges, non-invasiveness and high spatial resolution, laser Doppler vibrometers (LDVs) have received significant and increasing attention in both research and industry. This paper will briefly investigate the origins, working principles and evolution of LDVs, focusing on industrially relevant, practical applications. Particular focus will be on overcoming specific challenges associated with making successful measurement campaigns in challenging scenarios, including directly from rotating equipment and from vibrating platforms, a UTS topic of interest.

Keynote III

Acoustic metamaterials for maritime applications

Alex Skvortsov (1), Gyani Shankar Sharma (2), Ian MacGillivray (1), Nicole Kessissoglou (2)

(1) Defence Science and Technology (2) UNSW Sydney

Abstract
Acoustic metamaterials are rationally designed composites for which the effective material properties go beyond those of their bulk ingredients. A simple design of an acoustic metamaterial for underwater applications comprises a lattice of resonant scatterers embedded in a host elastic matrix. This composite design facilitates multiple scattering of waves and strong acoustic coupling between scatterers. Due to their extraordinary wave manipulation capabilities and the tremendous progress in fabrication technology, acoustic metamaterials are becoming immensely popular for noise control. However, the analytical and numerical treatment of acoustic metamaterials is still a challenging undertaking. The Maritime Division of the Defence Science and Technology and the School of Mechanical and Manufacturing Engineering at UNSW have developed a range of analytical and numerical tools to determine the acoustic performance of metamaterials for underwater applications. We have translated some well-known analytical results from electrostatics, fluid dynamics, diffusion kinetics, and solid-state physics to develop homogenisation and effective boundary approximation approaches to modelling acoustic metamaterials. This paper provides an overview on how the proposed frameworks can be applied for the tailored design of acoustic metamaterials.

Keynote IV

Long-term investigation into wind farm amplitude modulation and annoyance

Kristy Hansen
Flinders University

Abstract
Despite widespread community acceptance of renewable power generation to reduce CO2 emissions and natural resource impacts, large-scale expansion of wind farms has prompted significant community debate regarding adverse health impacts of wind farm noise (WFN). Our research has aimed to investigate this issue by identifying, quantifying, and characterising the components of WFN that are responsible for annoyance and sleep disturbance. In this study, we carried out 1-year-long acoustic and meteorological measurements at three residences located near different wind farms, allowing detailed characterisation of WFN and its relationship with meteorological conditions. At two of these residences, participants recorded their subjective annoyance, providing insight into the relationship between specific noise features and human response. To detect amplitude modulation (AM), which is a particularly annoying component of WFN, we used a novel detection algorithm which significantly outperformed previous methods. Application of this algorithm revealed that AM prevalence was 2 to 5 times higher during the nighttime compared to the daytime. Annoyance due to WFN was reported most often during the nighttime and early morning, consistent with the measured AM prevalence. Participants most often described the noise as a “swish” or “swoosh” and the presence of these signal components was confirmed via spectral analysis.

Keynote V

Are the trains getting quieter?

Dave Hanson, Dave Anderson, Sav Shimada, Larry Clark
Acoustic Studio

Abstract
The Australian rail industry has made remarkable progress over the last fifteen years to better understand rail noise and devise mitigation strategies. There have been significant developments in curve noise, locomotive noise, and general rolling noise, both in understanding their root causes in Australia and in how to reduce these types of noise. But the industry has been slow to implement these developments and risks losing its reputation as an environmentally friendly mode of transport. This paper explores the successes, failures, and untapped opportunities in regards to implementing noise mitigation. We emphasise understanding the broader rail system and the drivers of rolling stock and network operators, and how acousticians can leverage this broader context. We then examine rail noise mitigation through the lens of opportunity cost. With reference to recent examples, and the current rail infrastructure boom, we pose a challenge to regulators, planners, operators and proponents to be open to different ways of implementing mitigation.

Aeroacoustics I

1. Sound radiated by two and three-dimensional supercritical airfoils operating in low Mach number flows

Manuj Awasthi (1), Tingyi Zhang (1), Jiawei Tan (1), Danielle Moreau (1), Rio Baidya (2), Charitha de Silva (1)
(1) University of New South Wales Sydney
(2) Bundeswehr University Munich

Abstract
Measurements of the far-field sound radiated by two and three-dimensional supercritical airfoils operating in a low Mach number flow were performed in an anechoic open-jet facility. For the three-dimensional case, two aspect ratios (AR = span/chord) of 1.0 and 1.5 were considered. The far-field sound was measured using a 64 microphone phased array placed outside the flow region and the array output was beamformed to reveal the acoustic sources. The results show that the trailing-edge noise from the 2D airfoil is larger than the 3D cases up to a frequency of 5 kHz, while above 7 kHz, the 3D airfoils generate more noise. Further, for the 3D airfoils, trailing-edge is the dominant noise source at 4 kHz, whereas at 8 kHz the source is concentrated near the free-end of the trailing-edge. Qualitatively, the source behaviour is the same for both ARs, but the airfoil with lower AR generates less broadband noise.

2. Estimating propeller trailing-edge pressure using the BPM method

Richard Howell (1,2), Paul Croaker (1), Christopher Gargan-Shingles (1), Paul Dylejko (1), Alex Skvortsov (1)
(1) Defence Science and Technology Group (2) YTEK Pty Ltd

Abstract
Vehicles moving through a fluid all suffer from unwanted noise and vibration from turbulent boundary layer excitation. Industries involved with designing planes, trains and automobiles have consequently invested heavily in its control. Large levels of noise and vibration can negatively impact on passenger and crew comfort as well as contributing to environmental noise. This paper details a novel approach for estimating the unsteady pressure at the trailing edge (TE) resulting from the turbulent boundary layer of a rotating propeller blade. This methodology is based on the semi-empirical method of Brooks, Pope and Marcolini known as the BPM method. Using a spanwise-strip implementation, the far-field TE noise is calculated for multiple points along the TE of the propeller surface of interest and at different positions of the propeller rotation. To provide quantitative validation of the numerical model, we present a comparison of estimated noise and trailing edge pressure characteristics with results obtained via experiment in the open literature. The noise estimates shown provide varying agreement using predictions of the flow field from the original empirical relationships and with those calculated using Reynolds Averaged Navier Stokes (RANS) CFD and the potential flow panel code XFOIL. The derived surface pressure characteristics are useful when evaluating the unsteady loading from the blade boundary layer flow.

3. Experimental investigation of airfoil-turbulence interaction noise

Roman Kisler, Chaoyang Jiang, Con Doolan, Danielle Moreau, Charitha de Silva
UNSW Sydney

Abstract
Airfoil-turbulence-interaction noise, which is created whenever turbulent flow encounters an airfoil, is a major contributor of unwanted noise emitted by aircraft, turbomachinery and alike. The experimental study presented here is the precursor to a larger investigation of the impact of complex turbulence on noise generation at the airfoil's leading-edge and airfoil-wall junction. In the current study, we examine links between the experimentally acquired properties of isotropic turbulence and the sound radiation of the immersed airfoil. This is achieved by varying the in-flow turbulence intensity using two different turbulence grids. A NACA0012 airfoil was analysed at a range of geometric angles of attack up to 16 degrees and Reynolds numbers of 1.10^5 up to 3.10^5. Stereoscopic Particle Image Velocimetry (SPIV) was conducted beforehand to capture the turbulence characteristics of the free flow. Additionally, acoustic beamforming with a phased microphone array provides insight into the sound generation at the leading-edge. Pressure taps along the centre chord-line were used to measure the mean static pressure, thereby allowing for an open-jet deflection correction of the angle of attack.

4.* Application of wall-modelled LES to the prediction of turbulent flow noise

Graeme Lane (1,2), William Sidebottom (2,3), Paul Croaker (2)
(1) RMIT University (2) Defence Science and Technology Group
(3) UNSW Sydney
* Peer reviewed

Abstract
Large eddy simulation (LES) has the potential to be a high-fidelity approach for predicting broadband noise from turbulent boundary layer flow, with the predicted surface pressure fluctuations providing an input to acoustics analogies. However, the practical application of conventional wall-resolved LES is limited by high computational cost. Therefore, wall-modelled LES (WMLES) has been investigated as a means to reduce this cost. Simulations were carried out using OpenFOAM, with channel flow as a test case. Predictions from both wall-resolved and wall-modelled approaches were compared against data from direct numerical simulation (DNS). The accuracy of WMLES was found to be comparable to that of wall-resolved LES over most of the channel, while incurring less than a tenth of the cost. However, near-wall accuracy of the boundary layer statistics from WMLES was reduced, resulting in a reduction in accuracy for the estimated wall pressure fluctuations. As an alternative approach, a semi-analytical method has been tested, which does not rely on the pressure fluctuations. Instead, a model derived from a Fourier transform solution of the pressure Poisson equation was implemented, with the boundary layer parameters supplied by LES. The accuracy of the resulting spectra for each LES method is discussed.

5. Aeroacoustics of flow over a forward-backward facing step

Chung-Hao Ma, Manuj Awasthi, Danielle Moreau, Con Doolan
UNSW Sydney

Abstract
An experimental study on aeroacoustics of low Mach number flow over a forward-backward facing step (FBS) with aspect ratio of 8 is presented. The height of the step being considered was 50% of the incoming boundary layer thickness (h/d = 0.5) and the Reynolds number based on the step height Reh ranged from 1.4 x 10^5 to 2.8 x 10^5. The acoustic measurement was conducted using a 64-microphone-phased array in the UNSW Anechoic Wind Tunnel (UAT). The beamforming results show that the noise source locates at the leading edge of the step. The sound spectra obtained from the centre microphone of the array show that noise produced by the step is generally broadband without any distinct tonal noise. The data at different flow speeds collapse well using the scaling law proposed by Doolan and Moreau (2014).

Aeroacoustics II

6.* Wavepacket coupling in screeching twin-jets

Petronio Nogueira, Michael Stavropoulos, Daniel Edgington-Mitchell
Monash University
* Peer reviewed

Abstract
An analysis of the symmetry-locking mechanism in screeching twin-jet systems dominated by axisymmetric modes is performed in this work. The different waves supported by the flow in a

range of jet conditions are obtained by means of a twin-jet vortex sheet model, which considers the shear layer as an infinitesimal region. Analysis of the bands of existence of upstream waves in the flow suggest that the jet separation greatly affects the ability of the flow to support anti-symmetric screech modes, while symmetric modes remain relatively unaffected by this parameter. Comparison with acoustic data shows that most tones lie in the frequency bands of existence of guided jet modes, supporting the hypothesis that resonance is closed by these waves. The dominant symmetry for each condition is obtained by means of a symmetry-imposed spectral proper orthogonal decomposition of schlieren data, which provides both mode shapes and energies of the most amplified coherent structures in the flow. Overall, it is shown that symmetric modes are more energetic for very low spacings, and no clear dominance is found for large spacings.

7.* Prediction of vortex-shedding noise from flow over a high aspect ratio cylinder using an acoustic analogy

William Sidebottom (1,2), Paul Croaker (1), David Jones (1), Mattias Liefvendahl (3)
(1) Defence Science and Technology Group
(2) UNSW Sydney
(3) Swedish Defence Research Agency
* Peer reviewed

Abstract

Noise generated by turbulent flow over high-aspect ratio bluff bodies is of interest in many engineering applications including the design wind turbines, aircraft and marine vessels. This study investigates the noise produced by a large span circular cylinder in cross-flow at a Reynolds number based on diameter (ReD) of 22,000. Large eddy simulations and the Ffowcs Williams and Hawkings acoustic analogy were used to simulate the aerodynamic and aeroacoustic fields around both full- and reduced-span cylinders, with aspect ratios of 18.75 and 4.0 respectively. At ReD=22,000, there is well-documented evidence of a low-frequency modulation of the fluctuating lift force, which is evident in the present results. The modulation means that very long runtimes are required to reach statistical convergence for the full-span cylinder. The modulation is not observed in the reduced-span simulation results, which significantly reduces the time taken to reach statistical convergence. The sound pressure levels (SPL) predicted from the full-span simulation are consistently 3-6 dB below experimental values. The SPLs predicted by scaling the reduced span simulation were in better agreement with the measured values, particularly around the vortex shedding frequency. These results show that more accurate far-field acoustic predictions can be obtained by scaling the results from the reduced-span simulation, when compared to the full-span predictions.

8.* An experimental investigation of the flow field and noise generation at a NACA 0012 wingtip

Tingyi Zhang, Yuchen Ding, Jeoffrey Fischer, Yendrew Yauwenas, Charitha de Silva, Con Doolan, Danielle Moreau
UNSW Sydney
* Peer reviewed

Abstract

This paper presents an experimental investigation of the tip vortex formation noise produced by a wall-mounted finite airfoil. To characterise the noise at the wingtip, acoustic measurements taken in the UNSW open jet anechoic wind tunnel with a planar microphone array are presented for a NACA 0012 airfoil with varying aspect ratios at different geometric angles of attack and chord-based Reynolds numbers. Measurements of the mean streamwise total pressure field at the wingtip using a single pitot probe for selected test cases are included to link the flow dynamics with noise production. Furthermore, the flow interaction between the wingtip and the wing-wall junction region and its effect on tip noise generation for a low aspect ratio (AR = 0.2) NACA 0012 airfoil will also be examined.

Aeroacoustics III

9. Aeroacoustic source contributions to sound power

Esmaeel Eftekharian (1), Paul Croaker (2), Steffen Marburg (3), Nicole Kessissoglou (1)
(1) UNSW Sydney
(2) Defence Science and Technology Group
(3) Technical University of Munich

Abstract

A technique to investigate the contributions of aeroacoustic sources to the sound power is presented. The method combines the Lighthill source distribution with an acoustic impedance matrix constructed from radiation kernels of the free-field Green's function. By calculating the contributions of aeroacoustic sources to sound power, the location and nature of the dominant flow noise sources are identified. To demonstrate the technique, the flow noise produced by a pair of co-rotating vortices is examined. The aeroacoustic contribution of each component of the Lighthill tensor is determined for a range of wavenumbers, with key findings discussed.

10. Surface contribution of a stochastically excited panel to the radiated sound power

Mahmoud Karimi
University of Technology Sydney

Abstract

In many engineering applcations it is important to identifiy the regions on a vibrating structure which radiate energy to the far field. This work analytically formulates a surface contribution technique based on non-negative intensity in the wavenumber domain to investigate the surface areas on a vibrating planar structure that are contributing to the radiated sound power in the far field. The non-negative intensity is derived in terms of the cross spectrum density function of the stochastic field and the sensitivity functions of either the acoustic pressure or normal fluid particle velocity. A simply-supported baffled panel excited by a turbulent boundary layer or an acoustic diffuse field is considered to illustrate the technique. The region of the panel contributing to the radiated sound power are identified. The non-negative intensity distribution is shown to be dependent on stochastic excitation. It is also observed that the more the non-negative intensity distribution is localised within the panel surface, the more effective the panel radiates sound to the far field.

11. Acoustic technique for building envelope air permeability test

Andreas Havenstein (1), Karel Ruber (2), Matthew Harrison (2), Con Doolan (3)
(1) Consultant (2) Pulse White Noise Acoustics
(3) University of New South Wales Sydney

Abstract

Buildings are an enormous consumer of energy, due to air leaks alone buildings waste up to 5% of all energy worldwide. Building envelope airtightness is therefore of paramount importance to minimise energy consumption and to meet cut carbon emissions by 2050, as set out by the Australian Government. Air permeability rate testing is also becoming a requirement for various building rating systems such as WELL and Green Star and must be performed to obtain the relevant credit points. The commonly used current standard measuring technique for air permeability is the blower door test, while thermography and smoke pens are widely used for air leak detection. All these methods have in common, that a difference of either pressure or temperature between inside and outside of the building must be established. Moreover, the blower door test is labour and time intensive. To meet the demand for increased building airtightness and testing, more efficient methods are needed. Following the principle that sound travels the same path as leaking air, acoustic basedtechniques are proposed. Among

those techniques the acoustic imaging shows best potential benefits. This paper provides a short summary of the research published in this area and the plan for further research.

Architectural and Building Acoustics

1. A case study on the new transmission loss suite built in University of Technology Sydney

Qiaoxi Zhu
University of Technology Sydney

Abstract
This paper introduces the newly built sound transmission loss suite at the Centre for Audio, Acoustics and Vibration (CAAV) at the University of Technology Sydney. This report covers vital parameters of the transmission loss suite when testing a typical heavyweight masonry wall, including the background noise, the spatial variations of the sound pressure level, the reverberation time, the absorption coefficients and the transmission loss. The averaged overall background noise level inside the receiving room is 21.3 dB or 15.5 dBA, approaching the test system/equipment's range. The standard deviation of the sound pressure levels in each test room is less than 1.6 dB in one-third-octave bands with centre frequencies between 100 Hz and 5000 Hz. The weighted sound reduction index (Rw) of the test wall is 66 dB with spectrum adaptation terms (C and Ctr) being -1 dB and -6 dB for the A-weighted pink noise spectrum and urban traffic noise spectrum, respectively.

2. Using lab-based and non-lab-based audio-visual virtual reality experiments for auditorium seat preference studies

Yuxiao Chen, Densil Cabrera
The University of Sydney

Abstract
Seat preference in a concert hall is affected by both auditory and visual conditions. While traditional concert hall preference studies have mainly focused on auditory preference, visual preference has drawn more recent attention, as the importance of audio-visual interaction has been emphasized. For combined audio-visual studies, using virtual reality simulation with head-tracked audio provides more flexibility and control compared to in-situ studies, while maintaining most spatial information that would be lost in experiments merely using photos and/or binaural recordings. Furthermore, with the popularization of head-mounted virtual reality devices and the ease of online file transfer, the experiments need not be limited to laboratories. This paper provides an overview of techniques used for such experiments and briefly discusses relevant findings.

3. Predicting patron noise levels in restaurants and bars - An extension to Rindel's Method

Glenn Leembruggen
Acoustic Directions and ICE Design Australia

Abstract
The simple method that J. H. Rindel recently published to predict patron noise in eating establishments is based on a model of the Lombard Effect. This method provides a substantial increase in accuracy over the commonly-used prediction method which assumes raised voices and 10*log(number of talkers). A key outcome of the Lombard model is that noise levels increase by approximately 20*log(number of talkers). Although Rindel's method is not yet widely used in Australia, it is now documented in the Patron Noise Guideline prepared by the Association of Australasian Acoustical Consultants. Rindel's statistical method has several simplifications, which can potentially result in over or under predictions. The proposed extension to this statistical method includes the use of octave-band room constants and the contribution of the direct field of talkers, which allow it to be used in situations with low reverberation such as outdoor terraces. The extended method is illustrated with a comparison of predicted and measured noise levels in two situations; the first is a busy Sydney bistro with patron numbers varying from 40 to 160 over an afternoon; the second is a restaurant, before and after sound absorption was installed. The effects on the predictions of the key parameters of Lombard ratio and Speaking Group Size are also explored.

4.* Acoustics in gesamtkunstwerk; design of Phoenix Central Park

Matthew Ottley
Marshall Day Acoustics
* Peer reviewed

Abstract
The recently opened Phoenix Central Park is a building space dedicated to art, performance, nature and culture. The result of an open architectural brief based around the German concept of gesamtkunstwerk, that is, a total work of art. At the heart of the building is an intimate performance space, with a folded bell shaped internal form. The space does not have a stage or traditional seating, but instead invites artists to perform from anywhere in the space and audiences to likewise find their own place to experience the performance. The first acoustic challenge was to determine what the space should sound like, given an open brief and few boundaries of how the space would be used. The design challenges increased as the form of the space evolved with complex geometries and the need for a coherent singular expression and not with acoustics as an add-on. The finishes presented unique challenges, including gilded/gold leaf acoustic panels and ultimately a singular bell shaped room constructed with stepped and contoured free-formed cross laminated (CLT) components incorporating tuned acoustic resonators. The Phoenix opened in 2020 and has been well received by audiences and critics alike.

Building Vibration

1. Gym noise reduction: Two case studies

Michael Hayne
SoundBASE Consulting Engineers

Abstract
Two case studies involving the reduction of structure borne noise due to use of boxing bags and the dropping of heavy barbells during deadlifts are presented. The boxing bag isolation varied from the usual installation method as the client wanted to suspend the boxing bags via framework suspended from the underside of the suspended concrete slab above. The deadlift isolation involved testing different rubber tiles on an on-ground concrete slab to reduce the structure borne noise moving laterally into the adjoining commercial tenancy. The results of in-situ testing are presented along with lessons learnt during the studies.

2. Structural dynamics, noise and vibration: Buildings adjacent to train lines

Pablo Reboredo Gasalla
ACOR Consultants Vic Pty Ltd

Abstract
In architecture and civil engineering there is a growing interest in the study of the dynamics of structures. The dynamic effects are due to various actions, but their influence is widened or reduced according to the design of the structure. Structures can be highly susceptible to the action of dynamic loads produced by the action of wind, earthquake, industrial activities, blasting activities, construction sites, road vehicles, trains, building services and human activities. Noise and vibration can have significant environmental impact on buildings and structures and can damage track components, crack roadways, unsettle foundations,affect sensitive equipment, impact human comfort and damage structures. Structure-borne noise and vibration can be a major and often overlooked consideration in the planning, design and operation of existing or new developments.

A reliable, considered approach to assessing noise and vibration is needed to achieve outcomes that meet client expectations while maintaining on-going compliance with relevant standards and regulatory and planning requirements. The proposed paper will focus on a general overview of the structure-borne noise and vibration risks, associated with new developments that are adjacent to existing rail lines during the early design stages, from commercial and residential buildings to sensitive research facilities. It will further explain the general description of the design process, including problem descriptions, measurements of ground and structural vibration levels at the proposed site, vibration criteria, finite element analysis and provisions of the isolation system required to be considered at the building to achieve the relevant criteria. The procedures proposed are mainly aimed at structural and civil engineers who are working in construction and environmental engineers who are not specialists in vibro-acoustics.

3. Gymnasium vibration isolation within a sensitive medical research building

Andrew Parker
Resonate Consultants Pty Ltd

Abstract
This paper presents the design, installation and outcomes of a bespoke weightlifting platform within a university-based Exercise Physiology Laboratory. The Exercise Physiology laboratory is located within a medical research building which houses vibration sensitive research functions including microscopes. The Exercise Physiology Laboratory has a requirement for elite level athletes to conduct heavy weightlifting movements including deadlifts and overhead presses. Weight placement on the floor without appropriate treatment demonstrated that adjacent spaces would be adversely impacted by these activities. A targeted vibration isolation platform was designed to mitigate these potential impacts.

Environmental Acoustics

1. Predicting outdoor sound propagation in the presence of wind and temperature inversions

Ray Kirby
University of Technology Sydney

Abstract
It is common in Australia to encounter complex meteorological conditions such as temperature inversions, especially at night. These climatic conditions can have a significant effect on the propagation of sound, and this can influence the noise levels experienced by local communities from activities such as mining. It is, therefore, desirable to understand how the propagation of sound is influenced by climatic conditions, especially in the planning and monitoring of noise generating activities. A new approach to modelling outdoor sound propagation is presented here, which uses the semi analytic finite element method to generate solutions to the exact governing wave equation for a two dimensional problem. This approach allows arbitrary wind and temperature profiles to be included, so that exact solutions can be generated for temperature inversions in the presence of wind. Sound transmission loss predictions will be presented for range independent problems in the presence of different temperature inversions, as well as ground conditions. It will be shown that the semi analytic finite element method enables solutions to be generated for large ranges, and predictions will be presented here for ranges of over 5 km. This method is, however, currently limited to range independent problems, and so the extension of the approach to range dependent problems, such as the inclusion of noise barriers, hills and other terrains will also be discussed.

2.* Sound directivity from a 250kW gas turbine exhaust system

Ben Cazzolato, Orddom Leav, Carl Howard
University of Adelaide
* Peer reviewed

Abstract
Experiments and numerical simulations have shown that sound radiated from vertically orientated hot exhaust stacks is strongly refracted away from the exhaust plume. In gentle cooler horizontal cross-flow, the plume bends downwards, which subsequently leads to increased refraction of the sound towards the horizontal plane downwind from the stack outlet. This paper builds upon previous research and reports on field trials of the sound directivity measured from a 250kW gas turbine (Turbine Technologies Minilab SR-30 Gas Turbine). The turbine was operated at two turbine shaft speeds, approximately 45,000RPM and 75,000RPM delivering exhaust jet flow speeds and temperatures of Mach Mj = 0.06-0.12 and Tj = 400 oC-560oC, respectively, and with wind conditions ranging from calm to 8m/s. It was found that previous research could be reproduced in the field, with SPLs downwind of the exhaust stack 10-12 dB higher than spherical spreading predicts. The paper concludes with guidelines for acousticians to assist in far-field predictions of sound pressure levels arising from hot exhausts such as those found in gas turbine power plants.

3. Comparison of five general noise prediction models and their performance in estimating low frequency noise propagation.

Lance Jenkin (1), Jeffrey Peng (2), Jeffrey Parnell (3)
(1) Global Acoustics
(2) Dept of Planning, Industry and Environment NSW
(3) Sydney Metro

Abstract
Predicting noise impact is a valuable tool for acoustic consultants. In Australia, five common models are used to determine the propagation loss from a source to a receiver; being ISO-9613-2, CONCAWE, ENM, CNOSSOSEU, and NORD2000. Emissions data for common construction equipment is used to compare the predicted A and C-weighted levels from these models to show there are large differences in predictions, even for simple scenarios.

4. A GIS-based heavy vehicle noise emission model

Daipei Liu, Jeffrey Peng, Jeffrey Parnell, Nicole Kessissoglou
UNSW Sydney

Abstract
Prediction of road traffic noise is important for environmental impact assessments. In this work, a GIS-based heavy vehicle noise emission model is presented. The GIS-based model accounts for the influence of translational vehicle dynamics for a heavy vehicle on grade to enable accurate prediction of vehicle speed as well as operating conditions such as acceleration and deceleration. These kinematic variables in turn assist with accurate estimation of engine noise and rolling noise. To illustrate the model, a case study based on a freight route of the Great Western Highway in New South Wales is presented.

Environmental Noise Policy and Regulation I

1. Managing construction noise and vibration on major infrastructure projects in NSW

Tracy Gowen, Mattia Tabacchi, Peter Karantonis
Renzo Tonin & Associates

Abstract
Over the last decade Metropolitan Sydney has been changing as a multitude of major infrastructure projects are constructed, including South West Rail Link (Glenfield to Leppington),

Sydney Metro NorthWest, Sydney Metro City and South West, WestConnex, Parramatta Light Rail, Northern Beaches Hospital road upgrade and Western Sydney Airport. Projects in the pipeline include Sydney Metro West and Sydney Metro Western Sydney Airport, Western Harbour Tunnel, Warringah Freeway Upgrade, Beaches Link to name a few in Sydney. Minimising construction noise and vibration impacts has been a significant consideration in the planning and management of these projects. This paper looks at how construction noise and vibration has been managed on some large infrastructure projects over the last decade. It looks at what some of the key learnings have been and how we might take this forward into a 'golden century of infrastructure investment'.

2. Acoustics, amenity and the vicissitudes of impact

Robert Fitzell
Robert Fitzell Acoustics

Abstract
Land-use planning and assessment is envisaged by many to involve orderly and uncontentious procedures contributing constructively to how we protect community assets and the environment more generally. However most decisions are made in a local or parochial context with an underlying assumption that impacts and outcomes are considered in close proximities to the land boundaries. These local decisions can lead to cumulative outcomes that, progressively and sometimes instantly, entirely change the nature of nearby lands. This insular perspective is allowed perpetuate by the absence of legislative definitions for fundamentally important terms - impact, amenity and reasonableness – leading to assessment reports that do not consider the potential impact from a proposed land use in an appropriate way. This has aggravated public misunderstanding of the assessment process such that expectations and outcomes are commonly disarticulated. Acoustical assessment reports frequently refer to amenity loosely and encourage an emphasis on sound level criteria referencing sometimes inappropriate regulatory authorities. This paper examines the issues involved in these circumstances and attempts to establish more rigorous procedural foundations that may help ameliorate the risk of unsatisfactory unforeseen outcomes.

3.* Application of the Objective Impulse Assessment method in AS1055:2018

Colin Tickell
Recognition Research Pty Ltd
* Peer reviewed

Abstract
The 2018 revision of 'AS1055 Acoustics - Description and measurement of environmental noise' included an informative Appendix E, which provided an objective method for assessment of impulsive noise. The intent of the Appendix was to provide a standard method for impulse assessment in Australia, as at present there is no other objective method to assess such impulsive characteristics. Assessment in those States requiring 'I' (or Impulse) time response can't be implemented as there is no current international standard for the 'I' time constant in sound level meters and many sound level meters do not include it because of that. The paper describes how to apply the Standard method, which uses 'F' (or Fast) time weighting and compares results of analyses of three different and common types of impulsive industrial noise sources using 30ms, 20ms and 10ms time intervals allowed in the standard to identify if there was any difference between their calculated impulse adjustment. The 100ms and 50ms intervals were also used for comparison and 100ms was found to provide a relatively simple screening method. Because of the potential for variation in adjustment value identified using different sample intervals, jurisdictions using Appendix E of AS1055:2018 should clearly state the sample interval to be used; if one value is to be used, 10ms is recommended.

4. Development of South Australian Building Standard for aircraft noise intrusion - Ministerial Building Standard - 010 (MBS 010)

Darren Jurevicius, Jenna MacDonald, Lachlan Newitt, Jingyuan Tan
Resonate Consultants

Abstract
For the first time in South Australia, a newly implemented building standard provides a deemed-to-satisfy protocol for the mitigation of aircraft noise for affected constructions in general accordance with AS2021:2015. With the implementation of the Planning and Design Code in South Australia, residential developments are required to adhere to building requirements outlined in the Ministerial Building Standard - 010 (MBS 010), in which aircraft noise intrusion has been introduced. Implementation of these updated methods in MBS 010 is aimed to simplify the assessment of aircraft noise intrusion and reduce the costs associated with the development application process for residential homeowners. This paper details the methodologies, aircraft noise modelling and general development of the deem-to-satisfy and performance solution protocols outlined in MBS 010. This includes development of the Aircraft Noise Reduction (ANR) contour which describes the predicted maximum noise level from aircraft movements surrounding the subject aerodrome, deemed-to-satisfy construction assumptions and the constraints of this new assessment methodology.

Environmental Noise Policy and Regulation II

5. Noise impact of the COVID 19 lockdown in Melbourne

James McIntosh, Marc Buret, Norm Broner, Phil West
Victoria Division, Australian Acoustical Society

Abstract
In response to the COVID 19 pandemic in 2020, the government of the Australian state of Victoria implemented short term travel restrictions in the city of Melbourne that resulted in an approximate halving of road traffic volume. The Victorian Division of the Australian Acoustical Society took the opportunity to monitor traffic noise at twenty-six sites during this time. Due to a prohibition on unnecessary travel, the sites were at individuals' home addresses. Monitoring was repeated at several of the sites following a return to near-normal traffic volumes. This paper presents the results of this monitoring work and compares the noise levels during "lockdown" versus "normal".

6. Exploration of aircraft noise model validation with noise measurements

Mark Latimore, Daniel Wanasili, Clyton Moyo
Airservices

Abstract
Aircraft noise pollution continues to be a major part of adverse community reaction towards airports and air navigation service providers. With the ease of access to noise and flight operations data, community opposition to airport growth is increasing and is originating from areas further away from airports. Recent studies of airports in Hobart, Sunshine Coast and Brisbane have shown that adverse public reaction to aircraft noise can be high at distances of 30km to 50km along a flight path where predicted noise levels are low. This highlights the need for accurate noise modelling and the importance of noise modelling results to inform major community engagement activities. Noise modelling accuracy can be improved through validation with real world measured data. The key goal is to continually improve the practice of noise modelling to better predict noise levels in community areas both close to and far from airports so mitigation actions or noise improvements can be implemented.

7. Protecting the hearing of divers from underwater noise

Douglas Cato (1,2), Neil Tavener (1)
(1) Defence Science and Technology Group
(2) University of Sydney

Abstract
Workplace health and safety regulations for the protection of hearing are well established but there appear to be no similar regulations for divers working underwater. Apart from the noise of machinery used by divers, they will also be subject to noise from many other sources because sound travels with much less absorption attenuation than in air. Regulations developed for airborne noise cannot be applied directly to underwater noise because the human auditory system functions differently in water compared with air. This difference is due to the large impedance difference in the two media. Hearing evolved in water so the terrestrial ear has evolved substantial adaptations (mainly the ossicular chain in the middle ear) to ensure that most of the energy incident on the external ear is transmitted to the cochlea or inner ear where the sound is sensed. The fluid in the cochlea has a similar acoustic impedance to that of water so that without the impedance matching of these adaptations, more than 99.9% of the energy would be reflected and less than 0.1% would reach the cochlea. In water, there is no need for the impedance matching. How then does the sound travel from water to the cochlear and how does this affect sensitivity? There have been a small number of measurements of hearing sensitivity underwater and although the results show significant variation between studies, they provide a basis for establishing a benchmark sensitivity when assessed with the theoretical considerations discussed above. This paper will compare the mechanism of transmission of sound from air to the cochlea with possible mechanisms for transmission from water to the cochlear and consider what can be inferred about hearing sensitivity underwater. It will compare this with the underwater hearing sensitivity measurements and suggest how criteria developed for hearing protection in air can be adjusted to establish criteria for underwater noise exposure.

Noise Control Materials

1. Sound absorption of a soft medium embedded with hard spheres

Gyani Shankar Sharma (1), Alex Skvortsov (2), Ian MacGillivray (2), Nicole Kessissoglou (1)
(1) UNSW Sydney (2) Defence Science and Technology Group

Abstract
Sound absorption by an acoustic coating comprising a hexagonal lattice of hard spherical inclusions embedded in a soft elastic medium is analytically and numerically investigated. The analytical approach approximates each layer of inclusions in the direction of sound propagation as a homogenised layer incorporating local resonance of the inclusions and multiple scattering of waves between the inclusions in the lattice. The analytical results for sound absorption are in excellent agreement with finite element simulations that exactly model the geometric and material properties of the coating.

2. Acoustic performance of a voided soft medium under hydrostatic pressure

Christopher Levin (1), Gyani Shankar Sharma (1), Alex Skvortsov (2), Ian MacGillivray (2), Nicole Kessissoglou (1)
(1) UNSW Sydney (2) Defence Science and Technology Group

Abstract
The effect of hydrostatic pressure on the acoustic performance of a metamaterial attached to a rigid backing and submerged in water is presented. The metamaterial design consists of a polydimethylsiloxane (PDMS) matrix embedded with an array of spherical voids. A nonlinear finite element model is developed that considers deformation of the voided inclusions caused by hydrostatic pressure as well as the rheology of the viscoelastic material. An increase in the hydrostatic pressure is shown to significantly affect the volume of the voids which in turn affects the sound reflection from the coating. Results from the numerical model developed here are compared with results from the literature, showing good agreement.

3.* Novel resonator geometry for easily manufactured tunable locally resonant metamaterial

Can Nerse, Richard Schadeberg, Sebastian Oberst
University of Technology Sydney
* Peer reviewed

Abstract
Mechanical waves and sound waves have complex propagation characteristics that are manipulated by periodic structures such as elastic metamaterials and phononic crystals for the purposes of wave guiding, vibration isolation and sound absorption. System parameters are tuned to induce auxetic physical properties such as negative effective mass density and negative Poisson's ratio. Locally resonant metamaterial (LRM) uses Fano-type interference to manipulate elastic wave propagation from the host structure by formation of a band gap due to local resonance. Not restricted by the Bragg interference limit, such sub-wavelength structures are particularly effective in attenuation of the low frequency oscillations. Tunability of the lower and upper bounds of the band gap through simple geometrical and material variations has made the LRMs a strong candidate for the noise and vibration control of automotive and industrial applications. In this study, we demonstrate a tunable LRM design that can be fabricated by injection moulding and vacuum casting. The mould for the fabrication of the resonator features a cylindrical hollow section. Pins of different diameter can be inserted into the mould to vary the material distribution in the cavity, thereby changing the resonance. A numerical model using COMSOL Multiphysics has been developed to investigate the dispersion mechanism. A parametric study of the pin diameter with respect to target band gap frequency demonstrates the capability of broadband vibration attenuation while keeping the overall size of the resonator small and constant. These results are promising for practical implementation of LRMs.

4. An experimental study on the effect of diffusers on the sound absorption measurement

Qiaoxi Zhu
University of Technology Sydney

Abstract
Limited reproducibility of absorption coefficients measured in different laboratories has been observed in the recent inter-laboratory test. This measurement uncertainty can result from the room acoustic design variance amongst laboratories and the material selection for qualification tests. Sound absorption measurements were performed in the reverberation room at the University of Technology Sydney, with test sample sizes and materials under different room acoustic conditions by installing different numbers of diffusers. With the measured data, initial work was made to decompose the sound absorption components based on the geometric feature of the test specimen, which is potential to assist the assessment of the diffuseness of the test facility and the optimization of diffuser installation.

Railway Noise and Vibration I

1. Insights from long-term wayside monitoring of rail vibration

Dave Hanson (1), Briony Croft (2), Dave Anderson (1)
(1) Acoustic Studio
(2) Revelstoke, Canada

Abstract
Over a year's vibration data was collected from a monitor located adjacent to the rail corridor in Sydney. The results allow detailed

analysis of long-term vibration trends by train type and track. The results also provide insight into the repeatability of short-term vibration monitoring, such as the common approach of attended measurements of around 20 trains.

2. Examining the use of eVDVs to determine VDVs from rail vibration in NSW

Aaron Miller, Jordan McMahon, Dominik Duschlbauer
SLR Consulting Australia

Abstract

In NSW, vibrations from train passbys that result in human comfort concerns are assessed in terms of Vibration Dose Values (VDVs). Measuring VDVs requires the use of instrumentation that can either measure VDVs directly or record waveforms that enable VDVs to be calculated through post-processing. However, when rail vibration is measured within buildings, ground-borne noise is often of primary concern with human comfort vibration relegated to being a secondary concern or an afterthought. Ground-borne noise is often measured in terms of one-third octave band vibration spectra and VDVs or waveforms are not recorded in many cases; in these instances, VDVs can only be calculated using the eVDV method detailed within BS 6472. It is not clear how much error/conservatism may be introduced with this approach with respect to rail vibration. This paper compares the estimated VDVs (eVDVs) calculated from one-third octave band acceleration spectra, from total root-mean-square (RMS) acceleration and from Peak Particle Velocities (PPVs) with the VDVs calculated from velocity waveforms recorded on the same device simultaneously. The comparison considers results collected from two locations in the Sydney metropolitan rail network. Different methods for calculating eVDVs are examined as well as the influence of different weighting functions.

3. Implementation of NSW rail and road traffic noise guidelines on light rail projects

Samaneh Fard, Megan Haberley, Poppy Coleman
Transport for NSW

Abstract

The mode of public transport known as light rail has been prioritised by the NSW Government, funding three (3) infrastructure projects since 2010 to serve and revitalise the growing Sydney and Newcastle communities. Light rail connects communities and helps both locals and visitors move around more freely and explore what regions have to offer. Transport for NSW's light rail portfolio includes Newcastle Light Rail, Sydney Light Rail (Inner West Light Rail, and CBD & South East Light Rail) and Parramatta Light Rail. This paper demonstrates how these three case studies have implemented the Rail Infrastructure Noise Guideline (RING) and Road Noise Policy (RNP) criteria to comply with the planning approval requirements, while outlining the challenges encountered that are not addressed in these guidelines. The impact of noise and community response to at-property treatments due to light rail operations is also discussed.

4. Engine exhaust silencers for older locomotives - A case study

Dave Hanson (1), Bradley Wolfgang (2), Paul Williams (3), Ray Kirby (3), Michael Neville (2)
(1) Acoustic Studio
(2) Hushpak Engineering
(3) University of Technology Sydney

Abstract

Mitigating engine exhaust noise from older locomotives is a substantial challenge. The engine noise is broadband, but also includes prominent low-frequency tones that vary with engine speed. There is very little space inside the locomotive, so while a silencer would ideally be as large as possible, it must fit within tight constraints around other locomotive equipment. Many older locomotives have two-stroke engines that are highly sensitive to back pressure and were designed to run with direct ventilation to atmosphere. This imposes tight constraints on the flow resistance that a silencer can introduce, thereby constraining the design options.

Railway Noise and Vibration II

5.* Maintenance effects on rolling noise - metro and light rail

Briony Croft (1), Aaron Miller (2), Arthur Kupper (1)
(1) SLR Consulting Canada
(2) SLR Consulting Australia
* Peer reviewed

Abstract

The combined roughness of the wheel/rail interface is an important factor in railway rolling noise emissions. Although it is widely acknowledged that track condition influences noise levels, the potential changes over time due to wear and maintenance cycles are rarely addressed in impact assessments for proposed new systems in NSW. Instead, it is commonly assumed that track will be maintained in good condition with noise emissions that are stable. This assumption may be disconnected from the reality of light rail and metro transit maintenance practices. A series of case studies and measured data is provided to illustrate the range of different rail roughness conditions and corresponding noise levels that can be observed over time on real-world operating systems. On some systems, there is relatively little variation in rail roughness over time and train noise emissions are very similar at comparable locations. Others can see see dramatic increases in noise soon after rail grinding. A case study is provided where measurements at different tangent track locations on the same network with the same rolling stock indicate a difference of 26 dBA in passby noise levels, attributable to rail condition and maintenance state.

6.* Freight rail noise in NSW: Comparisons of recent measurements against the rail noise database

Pri Pandey
GHD Pty Ltd
* Peer reviewed

Abstract

The Transport for NSW Rail Noise Database (RNDB) has served as an invaluable source of reference data for railway noise assessments in NSW. However, for freight trains, the data is limited to tangent track only and arguably by its relatively small sample size. This paper presents a methodology to obtain passby data from a single channel microphone located close to track, with linkages to databases containing relevant operational details including speed and train consists. The paper also presents a comparison of the RNDB against selected measurement campaigns undertaken since the last revision of the RNDB, offers some insights into curve gain in NSW and observations pertinent to refining currently adopted noise modelling methods.

7. An analytical and experimental study of railway noise emissions from Sydney Harbour Bridge

Graham Brown (1), David Timms (1), Peter Lark (2), Ross Emslie (2)
(1) Mott Macdonald
(2) Jacobs

Abstract

An analysis of noise generated from railway operations on Sydney Harbour Bridge is presented based on a hybrid analytical and experimental method. The approach includes vibro-acoustic testing of the rails, rail deck and supporting structures. The mobility of the rails and rail supports is determined along with the rail vibration decay rate. Measurements of operational vibration on the rails and at a matrix of locations on the bridge structure are used to quantify the energyaveraged vibration velocity for each bridge component. The data gathered from

testing is used to validate Finite Element and Statistical Energy Analysis models and to calculate the sound power contributions of the train wheels, rails and bridge components. The validated models are used to predict the change in component and overall sound power levels due to the replacement of the existing timber transom rail deck and timber walkways with a low maintenance continuous concrete rail deck.

Signal Processing

1. Data verification for ambient vibration tests

Valeri Lenchine
GHD Pty Ltd

Abstract
Ambient vibration tests for large structures have become more popular as a tool to identify fundamental or lowest natural frequencies. Ambient vibration analysis is pertained to "response only" methods where the characteristics of excitation are not known. Different techniques are utilised to post-process data. The quality of the ambient monitoring data used for subsequent post-process is critical for further analysis, independently of the method used for structural dynamics analysis. A data pre-processing procedure was suggested for the rectification of data collected during ambient vibration tests. It is suggested to make the decision on the validity of data acquired during particular time periods based on the comparison of descriptive statistics such as skewness and kurtosis with reference magnitudes. A high deviation of the skewness and kurtosis from the reference magnitudes can be used as an indication that the data may be invalid. An example in the paper utilised the Jarque-Bera test for normal distribution to rectify data for subsequent fundamental frequency identification. The method was successfully implemented for the analysis of a large amount of data collected during an ambient vibration test of a dam structure.

2. Dynamic auralisations of two simultaneous sound sources using ambisonics IR convolutions

Daniel Castro (1), Henry Andrew (2)
(1) Stantec, Australia
(2) Stantec, UK

Abstract
This paper presents a software that allows users to experience a high quality auralisation in a virtual reality scenario. The novelty of this new software iteration relies on the ability to simultaneously auralise two different noise sources while continuously and dynamically update the acoustic output at the user position within VR scenario. We use convolutions with pre-computed ambisonics impulse responses as the basis for our method.

3. Acoustic based classification of transfer modes in gas metal arc welding

Mitchell Cullen, Sipei Zhao, JC Ji
University of Technology Sydney

Abstract
Gas Metal Arc Welding (GMAW) is a welding process which involves forming an electric arc between a consumable wire electrode and a metal work piece while protecting the arc from contaminants using a shielding gas. In this form of welding, there are several varying ways in which the molten droplets can be transferred from the end of the welding wire into the weld pool known as transfer modes. Identifying these transfer modes is crucial in monitoring and controlling the welding process, especially in automated applications such as industry 4.0 manufacturing lines. Currently in industry, these transfer modes can be identified by expert welders by using the sound signal that is generated throughout the welding process. However, there has been limited research on using the acoustic signal to detect these transfer modes in automated welding applications. This paper explores a new method of automatic GMAW transfer mode detection using machine learning techniques to analyse the acoustic signal generated during the welding process. Several time and frequency domain features are extracted from the acoustic signal and used to train a support vector machine classifier to accurately classify the transfer modes. In addition to this, a new feature selection algorithm is proposed to improve the prediction accuracy of the support vector machine classifier and a final prediction rate of 96% was achieved. This high prediction rate demonstrates the feasibility and promising accuracy of using the acoustic signal as a basis for transfer mode classification in future smart welding technology with real-time adaptive feedback control.

4.* Application of improved sliding DFT algorithm for non-integer k

Carl Howard
The University of Adelaide
* Peer reviewed

Abstract
An algorithm and network is described in this paper that implements a sliding Discrete Fourier Transform, such that it outputs an estimate of the DFT value for every input sample. Regular DFT algorithms calculate a complex value that is proportional to the amplitude and phase of an equivalent sine wave at the selected analysis frequency. The analysis frequency that can be select is typically an integer multiple of the frequency increment of the DFT algorithm, and this might not necessarily correspond to the desired analysis frequency. The sliding DFT algorithm proposed here overcomes this limitation, and permits the analysis frequency to be any value up to half the sampling frequency. The proposed sliding DFT algorithm is demonstrated by analysing a synthetic sine wave, and the exhaust noise from a V8 diesel engine.

Soundscapes

1. Evolution of noise pollution reports during COVID-19

Marc Buret, Elaine Just
Environment Protection Authority Victoria

Abstract
In response to the COVID-19 pandemic, the State Government of Victoria implemented strict measures, including several periods of "lockdown" that involved strict constraints on travel, and required people to work from home where possible. For most Victorians, these restrictions led to reduced noise from road traffic and from aircraft, however they appear to have resulted in increased exposure to other sources of noise. The number of pollution reports received by Environment Protection Authority (EPA) in relation to noise more than doubled in the period from January to July 2020 (which covered several episodes of lockdown) compared with the same period in the previous year (with no lockdowns). This paper investigates the evolution of noise reports during 2020 and 2021, giving regard to the alleged noise source categories used in their triage.

2. Preliminary exploration of noise and student learning in modern flexible education spaces

Greg Barry (2), Lisa O'Keeffe (2), Bruce White (2), Jill Colton (2), Leanne Farmer (1)

(1) WSP Australia
(2) University of South Australia

Abstract
Contemporary learning environments are typically designed to be large areas with fluid boundaries and can facilitate cohorts well in excess of 50 students in one space; indeed the terms "open plan" and "flexible" are synonymous when describing modern learning areas. In these scenarios it is common for high amplitude, random and modulating noise levels to be generated during teaching and learning activities. It is well

documented that random modulating noise environments can disadvantage some learners. Research has shown that the inclusion of additional environmental auditory stimuli (such as music or white noise) can improve task orientated outcomes through triggering stochastical resonance. However stochastical resonance is highly dependent on both the character of the added stimulus and the individuals neuronal signalling. The use of music or white noise is a common tool utilised by educators although it is likely that the approach tends to be haphazard with the sources played at "low" or "background" level. This research attempts to bridge the current gap by analysing a response (distraction or concentration) of students to predetermined levels of white noise, a natural environmental soundscape or low bpm instrumental music. The study was carried out in a modern teaching and learning environment in South Australia with two separate cohorts of students. This study also takes the opportunity to investigate the response of students to a typical open plan classroom soundscape.

3.* Noise measurements in an acute Australian hospital

Jesse Coombs, Md Ayub, Tim Shultz, Rick Weichula, Anthony Zander, Lynette Cusack, Joanne Dollard
University of Adelaide
* Peer reviewed

Abstract
Many studies have shown that hospital staff and patients are subject to noise levels in excess of those specified in the World Health Organization (WHO) guidelines. This article presents the results of a single-centre study of noise in four wards in an acute hospital in Adelaide, Australia The study measured noise in multi-bed bays, as well as nurse stations, and involved continuous noise monitoring between one and three days. For 4-bed and 6-bed patient bays, as well as nurse stations, the maximum, minimum and average equivalent 1-minute A-weighted sound levels were relatively constant from 22:00 until 06:00, increase from 06:00 until 09:00, remain raised until 18:00, and then decrease from 18:00 until 22:00. Measured average equivalent A-weighted noise levels for nurse stations and patient rooms were 56.6 dB(A) and 54.8 dB(A) respectively. Noise levels were higher in the 6-bed bays compared to the 4-bed bays with average equivalent A-weighted noise levels of 55.7 and 54.3 dB(A) respectively. The results were consistent with similar hospital studies, with noise levels exceeding WHO guidelines for patient comfort.

Structure Borne Noise

1.* Radiation efficiency of planar structures - A case study on its application for estimation of radiated sound power

Vahid Alamshah, Valeri Lenchine, Craig McVie
GHD Pty Ltd
* Peer reviewed

Abstract
Identification of the contribution from multiple noise sources is critical for suggesting potential noise mitigation measures. Structural noise radiation of planar structures located on industrial sites frequently provides significant contribution to noise levels measured at affected receivers. One of the methods to estimate sound power (SPW) radiated from walls, enclosure roofs, or industrial buildings is the measurement of vibration over the radiating surface. Theoretically the SPW emitted by a planar structure is proportional to product of the squared vibrovelocity averaged over the radiating surface, area of the surface, the radiation efficiency, and a few other ancillary parameters. Radiation efficiency of simple plates has its peak at a critical frequency and tends to be unity at higher frequencies. Industrial enclosures and building are frequently built from reinforced concrete, brick, and mortar. They represent inhomogeneous structures, and the radiation efficiency of these structures is more complex than it is for metal plates. Sound intensity measurements of planar structures installed in an electrical substation site were undertaken using a sound intensity probe. Vibrovelocity estimates were also obtained to compute indirect estimates of the radiated sound power. Radiation efficiency was analysed in third octave frequency bands using the SPW and vibrovelocity estimates. It was shown that radiation efficiency has a more complex character in comparison with metal plates, showing that vibration measurements of these types of structures and materials for estimation of radiated sound power may not always provide good representation of such complex structures.

2. Parametric study of circular duct breakout transmission loss

Paul Williams, Ray Kirby
University of Technology Sydney

Abstract
Breakout from ducts can be a major source of noise on industrial sites. The emitted noise is harmful at sufficient levels and must be reduced. Reducing noise levels using appropriate methods after the fact can be both costly and time consuming. This can be avoided by correctly predicting duct transmission loss before the duct is installed and choosing a suitable construction. In this paper the breakout from circular ducts will be presented as part of a parametric study. Parameters such as duct radius and wall thickness will be used to allow for a suitable choice of duct construction. In practical systems duct radii can be several metres in diameter and this is reflected by the range of the study. The breakout noise is calculated using a semi analytic finite element method. The first step in this method requires determination of the duct's modal properties which is calculated using a numerical eigenvalue analysis. The waves are then propagated along the duct using an analytic expression. A monopole sound source is used to excite the system, simulating the complex acoustic field within HVAC ducts with the transmission loss calculated from the difference between radially propagating sound power to axially propagating sound power.

3. Low frequency noise from vibrating screens

Dominik Duschlbauer (1), Steven Walker (2)
(1) SLR Consulting Australia
(2) WSP Australia

Abstract
Vibrating screens are commonly used to separate and classify material across a variety of processing industries. The operation of the screens can be a source of noise (unwanted sound) within communities and environments near to processing plants and industrial premises. The emissions can include prominent low frequency sound which has the potential to impact public health and wellbeing. The nature of potential impacts associated with low frequency noise can be contentious, particularly where the low frequency sound is not always audible (often referred to as infrasound). Decisions to rectify low frequency noise problems require a detailed understanding of the mechanisms which generate the low frequency sound during the operation of the vibrating screens. This paper considers vibrating screens as sources of low frequency noise and discusses techniques to diagnose and quantify the low frequency sound emissions.

Tribute

* Anita Lawrence - Contributions to acoustics in Australia

Marion Burgess
UNSW Canberra
* Peer reviewed

Abstract
Anita Lawrence was a pioneer in acoustics in Australia and a pivotal contributor to the formation and development of the Australian Acoustical Society (AAS). She was involved at the outset and continued throughout the decades. She contributed greatly to the international reputation for AAS via her role in the hosting of international meetings in Australia. In addition to initiating courses to provide acoustic education,

her contributions were broad and included important research findings relevant to the Australian context and the development of Australian Standards. Her passion for acoustics, especially for quality of acoustics inside and outside buildings, has led to a legacy in her generous donations to the University of New South Wales. Her bequest is to be used solely to provide scholarships for PhD students studying acoustics within the School of the Built Environment. This paper will outline some of the achievements of Anita Lawrence.

Underwater Acoustics and Noise I

1. Issues and opportunities for inverting a simple seafloor description for shallow oceans

Adrian Jones, Md Ayub, Paul Clarke
Defence Science and Technology Group

Abstract
With suitable processing, a broadband acoustic signal received at a short range in a shallow ocean may be used to invert the Weston alpha parameter (Weston, D. E., J. Sound Vib. 18, 271-287, 1971) appropriate for the local seabed. Based on this, adequate simulations of sound transmission to much longer range may be obtained. The broadband signal may be an impulse, or continuous random emission, across the frequency band of interest. As no sensor calibration is required for the technique, there is considerable opportunity for legacy time series data to be re-processed to carry out the inversion. Application of the inversion technique is demonstrated using previously unpublished legacy impulse data, and simulations of transmission to longer range are obtained. These simulations are then compared with legacy at-sea measurements of transmission. Both the inversion technique itself and the application of the inverted data are not without a number of issues. These are considered with reference to practical cases.

2. Underwater vector sensor flow noise reduction

John Barnes, Garry Harris
Defence Science and Technology Group

Abstract
Defence Science and Technology Group (DSTG) undertook measurements of flow noise on a Geospectrum M20 acoustic velocity sensor from 15-17 June 2020 as part of a joint AUS/US program to reduce flow noise on acoustic vector sensors. The aim of the trial was to measure the flow noise associated with the sensor both with and without a flow shield, at a variety of angles to the flow, to determine if the flow shield reduced the noise. The measurements were undertaken in a water supply canal on the outskirts of Sydney which provided a quiet environment without the noise from pumps associated with conventional flow tanks. The measurements suggested a simple flow shield could greatly reduce the flow noise and confirmed the suitability of the canal for future trials. While most measurements were conducted with a fixed flow, towards the end of the trial the canal was "turned off", leading initially to a period of increased flow velocity followed by reduced flow velocity. A sharp increase in flow noise with increased flow velocity was noted. Some suggestions are made for refinement of techniques to assist in future trials.

3. Characterisation of an underwater acoustic seal deterrent system in the Tamar River

Craig McPherson (1), Mary Anne Lea (2), Steven Connell (1), Dana Cusano (1), Belinda Yaxley (3), Sam Welch (4)
(1) JASCO Applied Sciences (Australia)
(2) University of Tasmania
(3) Nautilus Collaboration
(4) JASCO Applied Sciences (UK)

Abstract
Underwater acoustic seal deterrent systems are increasingly used internationally to mitigate interactions between seals and marine fish farming operations, however none have been utilised in Australian waters or with Australian fur seals. The OTAQ SealFenceTM system was examined at a site on the Tamar River, Tasmania via a detailed modelling and field characterisation study. The modelling study considered a source spectra derived from measurements, along with different sea states and applied a statistically justifiable representation of multiple operational devices. The measurement study was conducted using fixed and mobile recorders during different sea states, and re-modelling was undertaken to allow comparison between similar scenarios. Understanding the propagation of signals from individual and multiple devices in a specific location is essential when estimating effects. Confidence in the predicted ranges to effect thresholds for seals and other marine fauna (e.g., cetaceans and fish), is an important part of an impact assessment required prior to further system use. The characterisation results have provided the basis for understanding potential effects of the SealFenceTM on marine fauna, and the representation will be used to underpin the feasibility of the next project phase; a long-term behavioural response study to examine the system efficacy on Australian fur seals.

Underwater Acoustics and Noise II

4. Effect of sound speed profiles on wind-generated ocean noise

Zhi Yong Zhang (1), Alexander Gavrilov (2), Robert McCauley (2)
(1) Defence Science and Technology Group
(2) Curtin University

Abstract
The power spectrum densities of underwater noise recorded on the seafloor at a site northwest of Australia were compared for the same wind speeds in summer and winter, when the predominant sound speed profiles were distinctly different for underwater sound propagation, with the primary difference being the presence/absence of the surface acoustic duct in the top mixed layer in the colder/warmer seasons respectively. For the same wind speeds in different seasons, little differences were found between the noise levels at frequencies where wind-generated noise dominates, indicating that the sound speed profiles had little effects on wind-generated underwater noise. Acoustic modelling showed that the surface acoustic duct trapped only an insignificant amount of noise energy propagated within a narrow range of shallow grazing angles from distant sources and most of the noise was contributed from a local surface area with relatively steep propagation angles to the receiver.

5. Estimates of the influence of seafloor type on vertical directionality of surface-generated ambient noise in shallow oceans

Adrian Jones, Md Ayub, Zhi Yong Zhang
Defence Science and Technology Group

Abstract
The level and vertical directionality of ambient noise in shallow oceans may each be influenced by the acoustic reflectivity properties of the seafloor. Components of ambient noise interacting with the seafloor at small grazing angles may be either strongly reflected or absorbed, depending on seafloor density, sound speed and attenuation, and the speed of shear waves in the seafloor. The nature of the seafloor reflectivity near normal incidence is almost entirely determined by the product of the sound speed and density for the seafloor material. In a brief study, estimates are made of the vertical directivity of the ambient noise generated by dipole surface sources, with consideration to the influence from reflections from several, quite different, seafloor types. This work includes the derivation of several simple expressions for resultant noise intensity and their comparison with numerical integrations. As these expressions are in terms of the geoacoustic properties of the seafloor, it suggests that prediction of ambient noise characteristics may be viable.

6.* Reduced order modelling of vibroelastic response of a hydrofoil in homogeneous isotropic turbulence

Konstantinos Tsigklifis (1,2), Marcus Wong (1), Steven De Candia (1), Paul Dylejko (1), Paul Croaker (1), Alex Skvortsov (1)
(1) Defence Science and Technology Group
(2) YTEK Pty Ltd
* Peer reviewed

Abstract
The paper deals with a reduced order analytical model of the vibration response of a NACA0015 cantilevered hydrofoil excited by honeycomb-generated turbulence. The statistical stochastic excitation model employs strip theory with the intensity and the integral length-scale of the turbulence being the input parameters. The structural response is calculated as the product of the total hydrodynamic response function with the frequency spectrum of the space-time velocity correlation function. The total hydrodynamic response is represented by the combination of Sears' model of unsteady hydrodynamic gust combined with Theodorsen's theory for the lift and moment due to the heaving and pitching motion of the strip coupled with Euler-Bernoulli and torsional equations of the cantilevered hydrofoil motion. The comparison of the predicted structural velocity spectra with available experimental results shows good agreement for the first bending mode but overpredicts the amplitude at higher frequencies. Finally, a finite/boundary element model developed using COMSOL Multiphysics, provides further cross-verification with the aim of understanding some of the limitations of the simplified analytical model.

Underwater Acoustics and Noise III

7.* Exploring the effect of underwater burial on the resonant behaviour of simplified shell geometries

Joseph Milton (1), Marshall Hall (1), Yan Kei Chiang (2), Ben Halkon (1), Sebastian Oberst (1) David Powell (2)
(1) University of Technology Sydney
(2) UNSW Canberra
* Peer reviewed

Abstract
Globally, naval mines and unexploded ordinance litter large areas of the ocean floor, resulting in many coastlines being abandoned due to their deadly and indiscriminate threat. Recent developments in state of the art Mine Like Object (MLO) countermeasure have seen the use of Unmanned Underwater Vehicles (UUV), equipped with advanced active sonar systems, becoming more effective at identifying, classifying, and clearing these threats. Such systems rely heavily on large databases of known MLO acoustic signatures, which are typically characterised by their resonant behaviour. Whether originally designed to sit on the seabed or not, many MLOs have ended up buried under the seabed, becoming less visible, but no less of a threat. In order to accurately identify MLOs as they become "lost" in the seabed, it is necessary to track how their acoustic signatures change when their boundary conditions move from water to saturated sand. In this paper, the change in resonant behaviour of several simplified shell geometries has been estimated when sat proud on the seabed vs. when in shallow burial beneath it. These scenarios have been modelled numerically, as is typical for the creation of the MLO reference database, and analytically for validation. The results show how embedding the objects within saturated sand results in a decrease in the resonant frequencies for all geometries.

8.* Effect of local masses on radiated sound pressure from an underwater enclosure due to machine noise

Xia Pan, James Forrest, Ian MacGillivray, Stephen Moore
Defence Science and Technology Group
* Peer reviewed

Abstract
This paper presents the modelling and analysis of local masses and their effect on the radiated sound pressures from an underwater enclosure. The underwater enclosure is modelled as a submerged cylindrical enclosure with ring stiffeners. To simulate the structure-borne and airborne noise transmission, machine noise is characterised by forces applied along the enclosure in three directions and by acoustic sources located inside of the enclosure. An analytical approach is presented where the inertial force of an added mass is modelled by including a mass-induced pressure in the cylindrical shell equations of motion of the enclosure. Thus, an analytical model implementing the approach can have a number of local masses attached to the surface of the enclosure, which gives insight into how the local masses affect the inherent modal amplitudes for given modal forces. These modal amplitudes determine the radiation characteristics of the underwater structure. The influence of mass sizes and locations on the structure is discussed. For benchmark example cases, the analytical results are compared with those from numerical finite element / boundary element models with good agreement.

9. Sound radiation from a cylindrical shell with an acoustic coating

Cikai Lin (1), Gyani Shankar Sharma (1), Alex Skvortsov (2), Ian MacGillivray (2), Nicole Kessissoglou (1)
(1) UNSW Sydney
(2) Defence Science and Technology Group

Abstract
Sound radiation from a submerged, structurally excited, cylindrical shell with an acoustic coating applied to the external shell surface is presented. The coating is composed of a soft elastic medium embedded with a circumferential array of periodic resonant inclusions. The layer of soft material encompassing the resonant inclusions is approximated as a homogeneous medium with effective material and geometric properties. Results show that local resonance of inclusions leads to sound reduction in a broad frequency range. The effects of variation in the size and number of resonant inclusions on the radiated pressure of the submerged cylindrical shell are observed.

10. Sound radiation from a plate immersed in water near the free surface

Jamie Kha (1), Mahmoud Karimi (1), Laurent Maxit (2), Alex Skvortsov (3), Ray Kirby (1)
(1) University of Technology Sydney
(2) INSA Lyon
(3) Defence Science and Technology Group

Abstract
The results on the acoustic response of a heavy fluid-loaded baffled plate excited by a harmonic point force are presented. The displacements of the fluid-loaded plate are decomposed on the basis of the in-vacuo plate modes and the radiated acoustic waves are determined solving the Helmholtz equation in a fluid. The Green's function for the acoustic waveguide domain formed by the baffled plate and the free surface is modelled by the source-image method. Predictions for the radiated sound power from the plate and pressure spectra are calculated for varying depths of the free surface and compared against results from an unbounded domain to infer the effect of the free surface on the acoustic response of the plate. The proposed analytical model is verified by comparison with finite element simulations.

Author Index

Australian Acoustical Society

The Australian Acoustical Society (AAS) is a Learned Society, being the prominent technical society for individuals working in acoustics. The AAS aims to promote and advance the science and practice of acoustics in all its branches to the wider community and provide support to acousticians.

The Society was formed in 1964 when meetings were held by like-minded people interested in acoustics and vibration. The Society was later incorporated on 1 April 1971 as a public company. Divisions are active in all Australian States.

The Australian Acoustical Society provides a source of expertise in acoustics to the public, private corporations, small business, the legal system, standards organisations, regulatory bodies and government.

The AAS encourages interaction between practitioners of the various branches of acoustics including:

- Architectural Acoustics
- Environmental Noise
- Marine Acoustics
- Noise and Vibration Control
- Occupational Noise Management
- Physiology of Hearing
- Audiology Studies
- Musical Acoustics

The AAS hosts a variety of activities including annual conferences, divisional meetings, technical meetings, on-site visits, seminars, equipment demonstrations and social functions. A key role of the AAS is to organise and facilitate international conferences held within Australia, to encourage internationally recognised experts in various fields to visit Australia to provide the Society with the benefits of their knowledge.

The Federal Council, made up from representatives of the State Division sets the direction of the Society, as well as representing the Australian acoustical community Standards and international committees such as WESPAC (Western Pacific Commission for Acoustics). It also supports the publication of its journal, Acoustics Australia.

State Divisions are established in NSW (including ACT), VIC (including TAS), QLD, SA and WA. The national annual conference is organised and held by these five State Divisions on a rotation basis. The Acoustical Society of New Zealand (ASNZ) also forms part of this rotation. Annual AAS conferences are typically held over 2.5 days with international meetings sometimes stretching up to 5 days. The AAS hosts a library of previous conference proceedings on its website.

The hosting of technical meetings principal activities of the Society are held regularly by State Divisions according to the availability of speakers and places of interest. These meetings normally consist of a lecture given by an invited guest speaker on some subject related to acoustics. Other technical meetings consist of workshops, visits to laboratories, auditoria or other places of interest to the members of the Society.

Acoustics Australia Journal

Acoustics Australia is published by the AAS, is Australia's only technical journal devoted entirely to issues related to sound, noise and vibration. It is published three times a year and includes technical articles and general information regarding the Society and acoustics. The journal has been in continuous publication since 1985 and is recognised by international acoustics organisations, educational facilities, industry and a variety of publishing houses/distributors. International authors have been regular contributors to the journal since its inception and the journal is cited regularly.

The *Acoustics Australia* journal is distributed by the AAS to all members tri-annually, and is distributed commercially and internationally online via Springer.

Previous Conferences

Year	Title	Location
2022	Acoustics 2021 Wollongong: Making Waves	NSW
2019	Acoustics 2019 Cape Schanck: Moving Forward with Acoustics	VIC
2018	Acoustics 2018 Adelaide: Hear to Listen	SA
2017	Acoustics 2017 Perth: Sound, Science and Society	WA
2016	Acoustics 2016 The Second Australasian Acoustical Societies Conference	QLD
2015	Acoustics 2015 Hunter Valley	NSW
2014	**InterNoise 2014**	VIC
2013	AAS 2013 Victor Harbor - Science, Technology and Amenity	SA
2012	Acoustics 2012 Fremantle: Acoustics, Development and the Environment	WA
2011	Acoustics 2011 - Breaking New Ground	QLD
2010	**International Congress on Acoustics**	NSW
2009	Acoustics 2009: Research to Consulting	SA
2008	Acoustics 2008: Acoustics and Sustainability	VIC
2007	**Fourteenth International Congress on Sound and Vibration**	QLD
2006	Noise of Progress	NZ
2005	Acoustics 2005: Acoustics in a Changing Environment	WA
2004	Transportation Noise & Vibration The New Millennium	QLD
2003	**Wespac VIII - Acoustics on the move**	VIC
2002	Acoustics 2002: Innovation in Acoustics and Vibration	SA
2001	Acoustics 2001: Noise and Vibration Policy the way forward	ACT
2000	Acoustics 2000: Putting the Science and Technology to Work	WA
1999	Acoustics Today	VIC
1998	**ICBEN Congress. Noise Effects '98**	NSW
1997	**Fifth International Congress on Sound and Vibration**	SA
1996	Making Ends Meet: Innovation and Legislation	QLD
1995	Acoustics Applied: Putting the Science and Technology to work	WA
1994	Noise and Sound: Nuisance and Amenity	NSW
1994	**International Conference on Underwater Acoustics**	NSW
1993	Progress in Acoustics and Vibration Control	SA
1992	Practical Acoustical Solutions	VIC
1991	**InterNoise - The Cost of Noise**	NSW
1991	**Western Pacific Regional Acoustics Conference IV**	QLD
1990	Interior Noise Climates	WA
1988	Noise in the Nineties	SA
1987	Acoustics in the Eighties	TAS
1986	Community Noise	QLD
1985	Motor Vehicle and Traffic Noise	NSW
1984	**Developments in Marine Acoustics**	NSW
1984	Noise and Vibration Legislation in Australia	WA
1983	The Economics of Noise Control	SA
1982	Aircraft Noise to the Year 2000	NSW
1981	Acoustics and Society	VIC
1980	**10th International Congress on Acoustics - Engineering for Noise Control**	SA
1979	Building Acoustics Design Criteria	VIC
1978	Occupational Hearing Loss - Conservation and Compensation	NSW
1976	Progress in Acoustics	VIC
1975	Planning for Noise	NSW
1974	Noise, Shock and Vibration	VIC
1972	Noise Legislation and Regulations	NSW
1971	Noise Zoning Conference	VIC
1969	Noise reduction of floors, walls and ceilings	NSW
1968	**International Acoustics Symposium**	VIC

Bold = International meeting

Sustaining Members of the Australian Acoustical Society

Acoustics 2021
WOLLONGONG
making waves