



Acoustics Australia

Acoustics Australia

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Acoustics Australia

The papers and technical notes are available from the journal website www.springer.com/engineering/journal/40857.

All members of the Australian Acoustical Society have free access to the papers and technical notes but must log in via the member area of the AAS website and follow the link to the journal.

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June 2022

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TECHNICAL NOTE

Development of Australia-Wide Transportation Noise Maps: An Application in the Estimation of Population Exposure in Victoria

Ben Hinze, Janos Tsakiris & Wei Tang

Correction to: Development of Australia-Wide Transportation Noise Maps: An Application in the Estimation of Population Exposure in Victoria

Ben Hinze, Janos Tsakiris & Wei Tang

ACOUSTICS AUSTRALIA 50(2), 2022 ABSTRACTS

The full papers for these abstracts can be found in the online version of **Acoustics Australia**.
Members of the Australian Acoustical Society should access via the member login of the AAS website.
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GENERAL SUBMISSIONS - ORIGINAL PAPERS

A Feedforward Neural Network for Modeling of Average Pressure Frequency Response

Klas Pettersson¹, Andrei Karzhou² & Irina Pettersson^{1,3}

1. Chalmers University of Technology, Gothenburg, Sweden
2. University of Tromsø, Tromsø, Norway
3. Gothenburg University, Gothenburg, Sweden

The Helmholtz equation has been used for modeling the sound pressure field under a harmonic load. Computing harmonic sound pressure fields by means of solving Helmholtz equation can quickly become unfeasible if one wants to study many different geometries for ranges of frequencies. We propose a machine learning approach, namely a feedforward dense neural network, for computing the average sound pressure over a frequency range. The data are generated with finite elements, by numerically computing the response of the average sound pressure, by an eigenmode decomposition of the pressure. We analyze the accuracy of the approximation and determine how much training data is needed in order to reach a certain accuracy in the predictions of the average pressure response.

Low-Frequency Sound Absorption of an Inhomogeneous Micro-Perforated Panel with J-Shaped Cavities of Different Depths

Faisal Rafique¹, Jiu Hui Wu¹, Chong Rui Liu¹ & Fuyin Ma¹

1. State Key Laboratory for Strength and Vibration of Mechanical Structures and School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, 710049, China

In this paper, a micro-perforated panel (MPP) composite structure consisting of an inhomogeneous MPP (IMPP) backed with J-shaped cavities of different depths for low-frequency sound absorption is proposed. The goal is to increase the low-frequency (≤ 500 Hz) sound absorption performance of the IMPP. Sound absorption in a frequency range of 300–480 Hz was achieved with parallel-arranged IMPPs backed by J-shaped cavities, with average absorption of greater than 90%. A parametric analysis was used to optimize the structure's geometric parameters for the specified frequency range. The results show that when the length and volume of the back cavity depths increase, the low-frequency sound absorption peaks shift to a lower frequency. Similarly, the sound absorption curves are enhanced and move towards lower frequencies as the thickness of the IMPP increases. The structure was studied using an electro-acoustic equivalent circuit model (ECM) and finite element method (FEM) simulation. Model prototypes were then made using stereolithography (SLA) and verified by a square-shaped impedance tube-based experimental study to determine the normal absorption coefficient. The results revealed that the three types of curves, namely theoretical, FEM simulation, and experimental, were in good agreement.

Calculations of the Flow Noise from a Turbulent Boundary Layer for Acoustic Vector Hydrophones in the Flank Array

Hongyue Chen³, Zhongrui Zhu^{1,2,3} & Desen Yang^{1,2,3}

1. Acoustic Science and Technology Laboratory, Harbin Engineering University, Harbin, 150001, China
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3. College of Underwater Acoustic Engineering, Harbin Engineering University, Harbin, 150001, China

The flow noise for the acoustic vector hydrophone in the flank array is studied in this paper. The hydrophones are usually mounted above the baffle and are protected by a dome. This paper simplifies the flank array to be an infinite dome placed above an infinite baffle model, and the acoustic vector hydrophone is located in the fluid layer between the dome and the baffle. The spectral reflection coefficient of the multilayer baffle is obtained by the transfer matrix and matched boundary conditions. The cross-spectral density matrix is derived by the wavenumber–frequency spectrum analysis method. In addition, the spectral transfer functions are verified by the finite element method. Numerical results are presented to illustrate the influence of the free-stream velocity, the dome parameters, the location of the acoustic vector hydrophone and the baffle on the auto-power spectra of each hydrophone. Besides, the cross-power spectra of each hydrophone and the spatial correlation are discussed in this paper. The particle velocity channels are more sensitive than the pressure channel to the flow noise below 4000 Hz if the hydrophone is near the dome. The cross-power spectra between the pressure and particle velocity are lower than the particle velocity power spectra in the whole frequency band, and that are lower than the pressure power spectra in the higher frequency. The spatial correlation radius of the pressure and the particle velocity of all directions is small.

Efficient Computational Techniques for Evaluating Distance-Dependent Head-Related Transfer Functions

Ganesh Kailas¹ & Nachiketa Tiwari¹

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This work proposes and validates two computational tools for synthesizing distance-dependent head-related transfer function (HRTF), which is vital in spatial sound reproduction. HRTF is an anthropometric feature-dependent function that yields the direction-dependent gain of the auditory system. Even though it is subject to the distance of the auditory source, distance-dependent HRTF measurement is rare due to its high experimental cost. Numerical simulation tools can provide viable alternatives. The required computational resources and time increase exponentially with the frequencies and degree of freedom (DoF) of the simulations; still, it is faster than experimental procedures. This work proposes finite element computational solutions to measure distance-dependent HRTFs using domain truncation methods in association with frequency-dependent adaptive meshing. Two hybrid techniques to find HRTF in the entire region, employing infinite elements (IEs) and non-reflective boundary conditions (NRBCs) with near-field to far-field transformation techniques, have been implemented and analyzed. The proposed methods calculate distance-dependent HRTF in 0.2–20 kHz frequency band, with reduced computational cost and

time. Additionally, the spatial resolution of the HRTF measurement has increased a 100-fold. Since locally connected finite elements are used, the near-field effects of HRTF are well incorporated, and the obtained HRTF matches well with the experimental results. The proposed tools can also calculate sufficiently accurate HRTFs even when the surface meshes are of reduced quality. The tools also possess the versatility in effortlessly integrating appropriate bioacoustic attributes (e.g., internal reflection of the middle ear walls) into HRTF numerical models, which is noteworthy.

TECHNICAL NOTE

Development of Australia-Wide Transportation Noise Maps: An Application in the Estimation of Population Exposure in Victoria

Ben Hinze¹, Janos Tsakiris² & Wei Tang³

1. *Ambient Maps, Level 1, 38 Fisher Street, East Brisbane, QLD, 4169, Australia*

2. *Ambient Maps, East Brisbane, 4169, Australia*

3. *Virid IFC Pty Ltd, Level 1, 38 Fisher Street, East Brisbane, QLD, 4169, Australia*

In 2018, the World Health Organization (WHO) stated that transport noise is the second biggest environmental problem affecting people's health, after air pollution. The Australian Environmental Health Standing Committee (enHealth) also provides suggested health-based limits for transport noise exposure. To better understand the impact of transport noise in Australia, a strategic national transport noise model was developed, representative of the year 2018. The transport noise model presented included parameters for terrain, buildings, and noise barriers, with results verified against measured data. The model calculated the road, rail, and aircraft noise levels for the day, evening, and night-time periods, across all façades of all storeys for over 15 million buildings across Australia. The State of Victoria was chosen as a case study to document noise exposure

levels to the community. Australian Census of Population and Housing data and planning zones allowed a population within each dwelling to be calculated and paired to the modelled noise levels. Based on noise levels at the most exposed façade, it is estimated that 48% of the Victorian population are exposed to road traffic noise levels that exceed the 2018 WHO recommendations. Additionally, 10% are estimated to be exposed to aircraft noise levels, and 11% are estimated to be exposed to rail noise levels, that exceed the 2018 WHO recommendations. These percentages are commensurate with higher affected European Member states based on 2017 noise mapping completed as part of the European Noise Directive. When compared against environmental noise exposure recommendations from enHealth (2018), it is estimated that 11% of the Victorian population are exposed to combined road, rail, and aircraft noise levels above the recommended day/evening 60 dB LAeq 16 h health-based limit, and 10% above the health-based night-time limit of 55 dB LAeq 8 h. This national transport noise model provides a base for further research into the impacts of transport noise on the community, particularly regarding health and property values. The model can also support government planning, complaints handling, and asset management in the planning of future noise abatement in Australia.

Correction to: Development of Australia-Wide Transportation Noise Maps: An Application in the Estimation of Population Exposure in Victoria

Ben Hinze¹, Janos Tsakiris² & Wei Tang³

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The original article has been corrected. In section 3.1.4 and section 3.3.1 updates were required.



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FROM THE PRESIDENT



My last report was written in the final days before Acoustics 2021 Making Waves was held in Wollongong. These were quite stressful times as borders were still closed internationally and to WA, mask and social distancing measures still in place, and there was an understandable general hesitancy towards committing to anything. All of this made it very difficult to plan for an in-person conference. Essentially, we took a big gamble that you, the AAS members, wanted to get back to normal.

All my concerns started to evaporate on the Sunday night when we had around 80 delegates turn up for the early registration and stay for a drink (normally we expect about 30). The most noticeable thing was that nobody left because it was such a good catchup for everyone. It was obvious that it had dawned on everyone that they hadn't seen old colleagues or met up with new contacts in-person for years. Consequently, everyone was there for 2 hours longer than expected and the bar bill was 4 times the allocated budget, which really set the scene for what was to be a very social conference.

The venue was particularly well suited to our type of conference, with everything in very close proximity including the exhibitors. The catering was 1st class and the Conference dinner was amazing with dancing restrictions lifted just in time for everyone to enjoy a local surf band (a bunch of crusty old surfers that I grew up with) provide most of us with the first live music heard in years. Again no one went home early, and the venue was packed with over 160 guests. We also had a number of other activities such as the inaugural 7am Surfing with the Prez at the beach in front of the venue which was well attended including by two to the Keynote Speakers, Kristy Hansen and Ben Halkon.

It wasn't all about networking and socialising though, we had some 70 technical papers delivered that were extremely high quality. A good turn up by the Defence Science and Technology Group ensured the underwater acoustics sessions were very well attended, and the Rail Noise Session included some very interesting papers that hopefully will find their way into Acoustics Australia.

I think it was important that we took the opportunity to move back to in-person meetings again, and that was reinforced by the vibe experienced at the conference, and the kind words of thanks that I have received from attendees afterwards. We are a diverse Society, and it is such a meeting of minds that allows us to challenge each other. I'm sure that there will be new collaborations and innovations that occur as a result of conversations that happened at Acoustics 2021, that would not have occurred otherwise. This is what the AAS is about.

Having said all that, it I must flag to you that the planned joint conference with the Acoustical Society of New Zealand from 31 October – 2 November had to be de-scaled for logistical reasons and NZ border and quarantine requirements. This will now be essentially a ASNZ standalone conference. AAS members are most welcome to attend and conference paper submissions are welcome, but delegate numbers need to be capped. I encourage those of you who are able to attend, to do so, but recommend registering as soon as possible.

I hope you enjoy this issue of Acoustics Australia and look forward to seeing some of you at Tech Talks throughout the year.

Yours in acoustics.

Jeff Parnell

FROM THE CHIEF EDITOR



This June 2022 issue of Acoustics Australia features 6 technical papers on a diverse range of topics. One paper of interest is a technical note by Ben Hinze (Ambient Maps) and colleagues that details development of a transport noise model for Australia. As a test case, a noise map is calculated for Victoria (in the year 2018) incorporating road, rail and aircraft noise sources. The community exposure levels to transport noise, and in particular road traffic noise, are found to be

significant; when considering the most exposed façade scenario, up to half of the state's population is exposed to road traffic noise levels above WHO recommendations. The model is useful for a variety of purposes including informing government planning decisions and supporting complaints handling.

This issue also contains two Forum articles in this front matter section of the journal. The first Forum article by Walter Montano (ARQUICUST) presents an interesting historical account of pioneering efforts to measure sound levels in Australia. The second Forum contribution outlines a useful method to develop a low-cost dodecahedron loudspeaker to measure internal building acoustic parameters by Tristan Robertson (GHD).

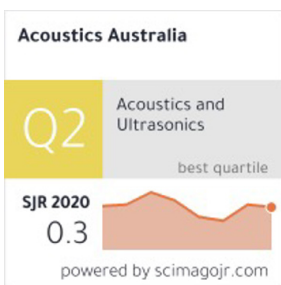
The Australian Acoustical Society supports an expansion of publications with Springer to the publication of books linked with AAS Publications. The first, which has just been released, is entitled 'Flow Noise: Theory' authored by Con Doolan (UNSW Sydney) and me. The second is a translation entitled 'Movement of Acoustic Energy in the Ocean' by Vladimir A. Shchurov and is soon to be released. Plans for an AAS Monograph Series via Springer are in process so if anyone is currently considering publishing a book on acoustics, we invite you to discuss this with Marion Burgess, AAS Publications at aaspublications@acoustics.asn.au.

Happy reading!

Danielle Moreau

Open Access Articles in Acoustics Australia for Australia and NZ

Springer Nature and the Council of Australian University Librarians have signed a Transformative Agreement to cover the article processing charges for articles published in participating hybrid journals. This means affiliated authors from many Australian and NZ institutions can publish their articles in Acoustics Australia open access with the fees covered in 2022. Please contact your university research librarian for more information. You can learn more about publishing open access under the agreement [here](#)



1.500 (2020)
Impact factor
1.267 (2020)
Five year impact factor

27 days
Submission to first decision

104 days
Submission to acceptance

24,877 (2020)
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Acoustics News

From the General Secretary

The AAS continues to move forward in line with industry movement. Membership numbers remain strong with the Society now comprising of 739 individual members. The industry has seen strong growth throughout the covid pandemic, with acousticians in high demand. The change in working arrangements for those who found themselves working from home led to an increase in desire for a more acoustically pleasing home office environment, which in turn increased demand for acoustic related services and products. The Society has also seen an increase in Sustaining members, currently at 25, as more manufacturers and suppliers enter the market supporting the AAS, acousticians and the science of acoustics.

As the membership base grows, new opportunities for members arise. A larger network of industry professionals, greater access to technical data, increased member resources and funding are just some of the benefits that members experience as the society grows. As we navigate our way back to some sense of normality, this in turn creates more opportunity for member events of the scale and size that members were formerly accustomed to such as large in person conferences and events.

Acoustics 2021 – Making Waves, which was held in February in Wollongong, was a successful, well attended and informative event with over 150 attendees. Delegates in attendance presented a multitude of papers on various topics, encouraging debate and provoking thought. It was great to see everyone in person and witness the meeting of minds, new collaborations form and ideas for new studies and projects arise. The 3-day event was thoroughly enjoyed by all and the Novotel North Beach was a magnificent venue that catered to all AAS and delegate requirements. The Gala Banquet, hosted at the Lagoon Restaurant, was an evening filled with fine dining, fantastic live music and much dancing. Delegates present witnessed the honour of Life Fellowship being bestowed upon the remaining founding member of the AAS, Peter Knowland, in recognition of his outstanding contribution to the formation and operation of the Society.

I genuinely enjoyed the opportunity to catch up with those of you in February that I am already familiar with, meeting those of you that I had not yet met in person and establishing new connections. It is imperative to establish and maintain these lines of communication so that I can continue to act effectively as the AAS General Secretary and continue to assist the Society to grow and achieve more for members.

As we move through the year, keep checking the website at www.acoustics.org.au for new features and resources. As always, if you have any questions, comments or concerns, please do not hesitate to contact me directly.

Julie Sobolewski

WA Division

The WA division have not been able to have technical meetings due to Covid restrictions, and with case numbers at the moment it is likely to be a little while before a face-to-face meeting will be held.

Benjamin Farrell



Visit the [AAS website](http://www.acoustics.org.au) to stay up to date with all the latest information.

Follow the AAS on [LinkedIn](#) and [Facebook](#) for industry updates.

QLD Division

Between the ongoing Covid pandemic, floods and everything else this year has thrown at us so far, the Queensland division has not held a meeting since the Federal AGM in January!

At the time of writing, we are planning a technical meeting for the end of May. Other AAS activities in Queensland have been relatively subdued.

The Queensland division committee recently welcomed Paul Schwarz as a new committee member.

Chris Grainger

SA Division

The SA Division has been busy planning our activities for the remainder of year, post an excellent Wollongong conference where several of our division members attended and presented papers. In terms of local news, a few recent policy related updates are relevant, namely the Department for Infrastructure and Transport's (DIT) Environmental and Heritage Technical Manual (EHTM) – Attachment 7D, Road Traffic Noise Guidelines and currently in final development, Attachment 7E, the Underwater Piling and Dredging Noise Guidelines. The University of Adelaide's Acoustics and Vibration Laboratory has also recently gone through a major refresh with final remaining works nearly complete, we can look forward to using this excellent facility in future. Also of note, our members, namely Darren Jurevicius (MAAS) and Jenna MacDonald (MAAS) were invited to speak at the Australian Institute of Building Surveyors (AIBS) SA Chapter conference, held March 2022 at Adelaide Oval, on the recently released Ministerial Building Standard 010, Construction requirements for the control of external sound (MBS 010). The presentation was well received by AIBS members, who appreciated the additional insights.



AAS CONFERENCE PROCEEDINGS
Available Online

AAS Conference proceedings spanning from 1968 through to 2021 are available online via the AAS website.

Digital copies of proceedings are available to view or download by AAS members by logging in at [AAS website](http://www.acoustics.org.au) and clicking on the 'Resources' menu.



TECH TALKS

A number of recorded Tech Talks are available for members to access on the [AAS website](#).

Log in and click on the 'Resources' menu to access 'Videos'.

Vic Division

In February 2022, James McIntosh attended the Acoustics 2021 Wollongong: Making Waves conference and presented on the progress of the Division's project to monitor noise levels during and after COVID-19 lockdown in Melbourne (the project was introduced in the News Item of Acoustics Australia Vol. 48, No. 3, December 2020). The extended abstract for this presentation is available via the resources section of the Society's website. While comparative data for only two sites could be presented, this was the occasion for a reminder to participants of the project to provide or gather data for the second round of the project.

The Division held its first technical meeting of 2022 on May 4th. Lee Group (formerly Lee Brothers; <https://leebrosfencing.com.au/>) organised a visit to their manufacturing partner Melbourne Rotomould (Melro, www.melro.com.au). Melro demonstrated the rotational moulding process, which involves casting products from plastic powder (generally polyethylene) in aluminium or sheet metal moulds that are rotated, to enable the distribution of the material in the mould, while heated in large ovens (much like the production of hollow Easter eggs). Melro also demonstrated how it is applied for the manufacture of noise wall panels which can be moulded from recycled material with various percentage, and allows for a wide range of shapes, colours or design features. More information can be found on the event page <https://www.acoustics.org.au/eventdetails/13659/melro-lee-group-manufacturing-partner>. Although attendance was modest, it was a pleasure to have a technical meeting in person. We would like to acknowledge Lee Group and Melro for this very interesting visit.

The Division Committee will meet shortly to discuss upcoming technical meetings, which are expected to be a mix of in-person and online events. If you have a project or matter you think could make an interesting presentation (about 30-45 minutes in length), or give rise to fruitful discussions with other members, please contact the Division Secretary at vic-secretary@acoustics.asn.au. We would be pleased to consider it for a future technical meeting.

Marc Buret

NSW Division

Finally the Acoustics 2021 conference was held in Wollongong between 21-23 February 2022. The conference was a great success with over 150 conference delegates and 20 sponsor/trade exhibitors. Thank you, Jeff Parnell the conference chair, the organising committee and keynote speakers for their efforts. I believe all the delegates enjoyed the social interaction after a couple of years of isolation!

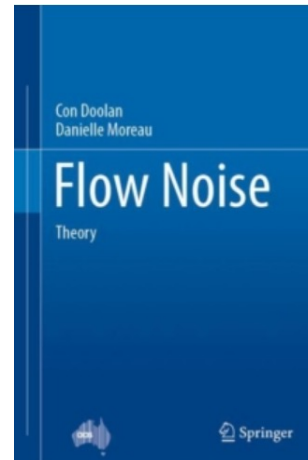
For the rest of the year the NSW Division will be continuing to organise technical meetings, so please keep a look out for emails informing you about these meetings or check the [AAS website](#).

John Wassermann



AAS PUBLICATIONS

Based on the experience with publication of the journal Acoustics Australia via Springer, the AAS has established an arrangement with Springer for AAS Publications and is working towards establishment of an AAS Monograph Series.



The first book has just been released and is entitled 'Flow Noise: Theory' by Con Doolan and Danielle Moreau from UNSW Sydney.

Flow noise is the sound created by fluid flow. There is a large list of modern technologies that produce flow-induced noise including aircraft, wind turbines, submarines, drones, high-speed rail, and cooling fans.

This book highlights the importance of this noise source and provides a comprehensive introduction to the theory underpinning flow noise. The authors were inspired to write this book to assist new postgraduate students joining their research group (Flow Noise Group at UNSW). However, there are also many practicing engineers and researchers who work in flow noise problems that will benefit from this resource.

ISBN/EAN 981192483X / 9789811924835

The second book, in the last stages of production, is the English translation from Russian of the book "Movement of Acoustic Energy in the Ocean" by Vladimir A. Shchurov. This would not have been achieved without the liaison and assistance of Alexander Gavrilov, from Curtin University, to first obtain a grant from the US Office of Naval Research to fund the translation from Russian to English.

If anyone is currently considering publishing a book on acoustics, we invite you to consider proposing that your book becomes one of the AAS series via Springer and discuss with Marion Burgess, AAS Publications at aaspublications@acoustics.asn.au

AAAC News



Hugh Vivian Taylor Award 2022

The Hugh Vivian Taylor Award 2022 has been awarded to Acoustic Directions and PKA Acoustic Consulting for their submission in which they prepared an acoustic design guide for the passive ventilation of apartments for the City of Sydney.

Hugh Vivian Taylor was a pioneering acoustic consultant who helped usher in motion pictures to Australia, acting as consultant for at least 434 theatres and public halls from 1930 to 1941. 'HVT' went on to become a Life Fellow of the Royal Australian Institute of Architects in 1971 and was elected the first Fellow of the Australian Acoustical Society in 1972.

Today, the Hugh Vivian Taylor Award recognises efforts in providing innovation, promoting consulting and advancing the field of acoustics.

Working in association, Glenn Leembruggen and Joel Parry-Jones describe below their submission which began as an acoustic design guide for the passive ventilation of apartments for the City of Sydney.

The aim of this project was to develop façade-based acoustic attenuation methods to achieve specified internal noise levels while providing natural ventilation. These measures include shielding by balcony balustrades, balcony soffit wintergardens, projections, open windows, set-back of facades, lined ducts using various innovative techniques.



Glenn Leembruggen

Joel Parry-Jones

Glenn:

"We were thrilled to receive the H Vivian Taylor award from the AAAC for a number of reasons. Firstly, it was the recognition of a lot of "deep-dive" research and modelling from first principles. Our modelling was unique; it combined high-resolution virtual acoustic models with finite element analysis to predict the acoustic behaviour of specific building elements. Secondly, the award acknowledged the huge benefits of fun and technical depth that our collaboration with PKA Acoustic Consulting brought."

Joel:

"PKA is honoured to share this prestigious award with Acoustic Directions. The collaboration of our firms has been a pleasure as we researched and developed the intersection of ventilation and acoustics. The guide combines the detail of science-based methods with the practicality of consulting, and we believe will further the understanding of this nuanced facet of our industry."



Richard Haydon, AAAC Chairperson presenting Glenn and Joel with their award

AAAC AGM

The AAAC had their AGM in Wollongong, prior to Acoustics 2022, held in February this year. This was the first time many people had been able to attend an in-person event, which was a cause for celebration in itself. There was plenty of time for information sharing and group discussion with the aim of raising standards throughout the industry.

Dr Katie Spearritt, CEO [Diversity Partners](#), was the keynote speaker, and gave some valuable insights into diversity initiatives and some helpful tips at the conference.

1. Think about the words you use in job descriptions and advertisements and express your commitment to diversity and inclusion. Consider also if the job can be done flexibly. (That's particularly important in this sector because 30 per cent of females with Engineering bachelor's degrees work part-time compared to 14 per cent of males, according to the 2021 Association of Professional Engineers Australia report on women in engineering)
2. Use diverse channels – do you advertise on LinkedIn and magazines that have a high female readership? Think laterally: can you recruit graduates from environmental engineering where there's a much higher percentage of women?
3. Train any hiring manager to recognise and challenge unconscious bias. (One unconscious bias is that the gender of the person doing the role will influence who is seen as most suitable. Just knowing that is a step forward to challenge bias.)
4. Have a look at your company's website and social media presence. Do the images represent cultural diversity, gender balance, age diversity? There's a saying that 'you can't be what you can't see', so it's important to reflect diversity so that people from differing backgrounds can see there's a potential path for them. "

It is great to see member firms embracing diversity, with Resonate recently receiving [National Association of Women in Construction \(NAWIC\) Crystal Vision 2021 Award](#), for their excellence in empowering and supporting women.



AAAC Guidelines

The AAAC Executive and friends have worked hard to ensure that all current guidelines are now up to date, with the latest guideline being released the [Guideline for Acoustic Assessment of Gymnasiums and Exercise Facilities](#).

The number of gymnasiums and exercise facilities has significantly increased over recent years, resulting in pressure to develop new facilities in a diverse range of urban settings.

The AAAC Guideline has been prepared by members of the Association of Australasian Acoustical Consultants (AAAC) to assist proponents and operators, architects, planners, Local Government or regulatory authority officers, or acoustical consultants to assess the noise and vibration impact resulting from the use and operation of both existing and proposed gymnasiums and exercise facilities consistently, accurately and fairly.

It is advisory in nature and is not a statutory document but provides guidance in relation to the assessment and management of noise associated with exercise facilities including gymnasiums. The AAAC recommends the use of this Guideline, to inform decision-making on the environmental regulation and management of noise and vibration from exercise facilities. It sets out noise mitigation and management measures which should be considered and a process for measuring and predicting noise levels and determining achievable noise limits for development consents.

This, and the other guidelines, can be downloaded at www.aaac.org.au. To join the conversation and get interesting industry information follow the AAAC LinkedIn Page, which now has over 1,200 members.

International News

Meetings in our region

The second half of 2022 will see two international meeting hosted in our part of the world.

The first is the 28th International Congress on Sound and Vibration (ICSV28) which is being held in Singapore from 24 to 28 July 2022 and will be held as hybrid conference although the ratio of in person to online attendees is still not clear

The second is the 24th International Congress on Acoustics (ICA 2022) which is being held in Gyeongju, Korea from 24 to 28 October 2022. The organizers of this conference hope to hold it as an in person conference but are also preparing to hold it as a hybrid conference if necessary.

John Davy



The Acoustical Society of New Zealand (ASNZ) Conference will be held at Te Papa Tongarewa Museum in Wellington New Zealand, from 31 Oct – 2 Nov 2022. Acoustics 2022 will provide engineers and scientists in all fields of acoustics the chance to share their work with colleagues. Six plenary/keynote lectures, a full and interesting programme covering a wide range of topics, and some excellent social functions, will give attendees the opportunity to exchange views and share experiences. Acoustics 2022 will provide a unique opportunity for manufacturers and suppliers to showcase the latest developments in acoustic instrumentation, software and noise and vibration control products. Surrounded by nature and fuelled by creative energy, Wellington is a compact city with a powerful mix of culture, history, nature and cuisine. Fuel your visit with strong coffee and world-class craft beer – Wellingtonians are masters of casual dining, with plenty of great restaurants, night markets and food trucks. On the waterfront itself you'll find Te Papa Tongarewa Museum, New Zealand's national museum. Te Papa, as it's colloquially known, means 'our place' and is one of the best interactive museums in the world. It is an iconic New Zealand building, right in the heart of the capital city. It is easily accessible by international and domestic flights into Wellington airport, which is only a short 15 min drive from the venue. The Acoustics 2022 Organising Committee looks forward to welcoming you to Wellington in November. We hope that the conference gives you an opportunity to strengthen your existing networks and that you leave with great memories, fresh ideas, and new friendships. Keep up to date with the latest conference information by visiting: www.acoustics2022.com



INTERNATIONAL YEAR OF SOUND

The International Year of Sound 2020-21 is now over and there will be sessions at the various conferences during 2022 to highlight the achievements of the IYS (despite the challenges of the pandemic).

The site www.sound2020.org is still available and has a large number of 'free to access' resources.

*Marion Burgess,
Co-organiser IYS*



AHH showcase – celebrating World Hearing Day

To celebrate Hearing Awareness Week and World Hearing Day, the Australian Hearing Hub hosted a showcase on 3 March 2022.

The event brought together more than 120 researchers, clinicians, educators, innovators, and students from the AHH community to connect, engage and be inspired by our world leading community.


For more information see [here](#)



NAL releases its Annual Impact Report

The National Acoustic Laboratories has released its 2021 Annual Impact Report. The report features impactful projects delivered with global collaborators and research experts, and it also explores future trends that are fuelling innovation in the field of hearing healthcare.

<https://www.nal.gov.au/nal-annual-impact-report-2021/>



The **Anita Lawrence PhD scholarship** is available within the UNSW School of Built Environment.

The scholarship can be used to support a student undertaking a project involving acoustics and the built environment. For more information see the website and/or contact m.burgess@unsw.edu.au


<https://www.unsw.edu.au/arts-design-architecture/study-with-us/scholarships-and-prizes>



Acoustics 23 Sydney
4-8 December 2023

This conference will be held at the International Convention Centre in Sydney. It will be a joint conference for the Australian Acoustical Society and The Acoustical Society of America, Wespac and the Pacific Rim Underwater Acoustics Group. Planning is in process for this unique event so make sure you register your interest via the website to receive all the updated information.

<https://acoustics23sydney.org/>



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General Items

We encourage any readers who find an item that may be of interest to other readers to send the item to acousticsaustralia@acoustics.asn.au

In addition, we greatly appreciate the contribution of Bob Fitzell who has brought some of the items in this section to our attention.

15 Bucket-List Concert Halls You Need to Experience Around the World

The COVID Pandemic has had a dramatic effect on the performing arts. However, as life returns to normal, we can all look forward to returning to live concerts and events. This article compiled by FODORS Travel looks at some of the amazing concert halls around the world. For more information see [here](#).

Scientists Can Now Turn Stem Cells Into Bone Using Nothing More Than Sound

Stem cells have the superpower of turning into any other kind of cell that gives the potential to help us repair parts of the human body that have been damaged by injury or disease. Carrying out those repairs requires the ability to manipulate stem cells on demand, and a new study outlines an innovative way of doing just that: by using high-frequency sound waves to turn stem cells into bone cells in as little as five days, with 10 minutes of stimulating treatment per day. See the full article written by David Nield on Science Alert [here](#).

Researchers Develop a Paper-Thin Loudspeaker

MIT researchers have developed an ultrathin loudspeaker that can turn any rigid surface into a high-quality, active audio source. The straightforward fabrication process they introduced can enable the thin-film devices to be produced at scale. The full article written by Adam Zewe and published by MIT News can be found [here](#).

Urban Design With Soundscape Benefits?

Around the world the impact of increased online shopping and Covid 19 has led to a decline in High St stores. One city in the UK, Stockton on Tees, has taken a dramatic approach to deal with the empty shops along the High St, to create an alternative modern shopping area for the remaining shops and demolish the former High St stores. In their place will be a city park and social hub including a library, leisure centre and theatre, that will encourage people to enjoy the visual and improved soundscape that will be created. While there is no specific part of the project addressing soundscape, the images show the central fountain and improved natural areas leading to the river. For more information see [here](#) and [here](#).

What do Black Holes Sound Like / These Eerie Wails are a Real Sound Wave from a Supermassive Black Hole

We might not be able to hear sound in space, but that doesn't mean there isn't any. In 2003, astronomers detected something truly astonishing: acoustic waves propagating through the gas surrounding a supermassive black hole, 250 million light-years away. New sonification has been used and it's the first time these sound waves have been extracted and made audible. NASA has recently released this amazing audio captured by one of its space telescopes. Two recently published articles discuss what was found. See the full article written by Michelle Starr and published by Science Alert [here](#) and the article written by Jon Kelvey and published in the Independent [here](#).

Tracking Earthquakes Deep Underground

September 2021 saw a magnitude 5.9 earthquake hit Victoria. Thankfully, Victoria has an incredibly sophisticated seismic network run by the University of Melbourne. This article looks at how a seismic network works, and why we need it? The full article written by Amalyah Hart and published in Cosmos magazine can be found [here](#).

Vanishing Birdsong: How Climate Change is Altering Canada's Soundscape

Boreal birds are vanishing, and with them, their songs. How can we conserve Canada's soundscape? This article written by Brandon Withrow and published in Canadian Geographic outlines how indigenous conservationists are listening in to track the impacts of climate change on the boreal forest. Read the full article [here](#).

Scientists Propose the Creation of a Global Aquatic Sound Library

To better understand the diversity, distribution and abundance of species in noisy underwater ecosystems, a group of 17 international scientists, are calling for a global audio collection of Earth's underwater biological sounds. See the full article published in the Smithsonian Magazine and written by Elizabeth Gamillo [here](#).

Reversing Hearing Loss With Regenerative Therapy

Biotechnology company, Frequency Therapeutics is seeking to reverse hearing loss with a new kind of regenerative therapy. The company uses small molecules to program progenitor cells, a descendant of stem cells, in the inner ear to create the tiny hair cells that allow us to hear. The new drug has undergone a number of clinical trials and has seen promising results, and is currently recruiting for another trial. For more information see [here](#) and [here](#).

New Products

Building acoustics tests on the move - HBK launches new sound level meter with Building Acoustics Partner

To help those involved in architectural and environmental acoustics, sound and vibration expert Hottinger Brüel & Kjær (HBK) has designed the HBK 2255 Sound Level Meter, which provides a complete measurement solution.

The HBK 2255 Sound Level Meter is ideal for any sound measurement task, from measuring the environmental noise emissions of a new roadway, to verifying sound insulation performance between apartments.

Weighing just 400 grams, the lightweight sound level meter has a rubberized body for a secure grip and places the measurement controls right under the user's thumb. It has Wi-Fi® and Bluetooth® built in and works with specially created mobile and PC apps, providing an entirely new level of efficiency and control. It can also operate as a stand-alone sound measurement device without an app.

HBK 2255 forms part of a new building acoustics measurement solution from HBK. The Building Acoustics Partner app provides full workflow support and wireless remote control for sound insulation measurements. The solution is completed with a HBK 2755 Smart Power Amplifier that enables wireless remote control of the sound source in a compact, robust and lightweight package.

For more information please contact HBK Australia on +61 2 9889 8888 or email auinfo@hbkworld.com.



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FIRST MEASUREMENTS OF STREET NOISE-1928 IN MELBOURNE, AUSTRALIA

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Introduction

The sound level meter 'ancestors' were modified audiometers, the earliest of which were electromechanical devices that were later replaced by electronic ones. The first portable full electronic commercial audiometer in 1919 was made in Germany (called the "Otaudion") [1], and the first US portable audiometer was made by Western Electric Co. (named the "2-A" model) introduced in 1922 [2]. Harvey Fletcher in 1923 improved the regular audiometer devices used for hearing testing to measure noise levels [3], and the first mentions of the use this kind of audiometers to measure the intensity of sound (in those days 'intensity' was used as a synonym of 'level') for noise surveys are: (a) January 1926, when Edward Elway Free (1883-1939) and other scientists were hired to measure the sound level of different US cities (New York, Chicago, Washington, etc.) [4], (b) June 1926 another company was commissioned to measure high-noise emitting sources in US cities including Niagara Falls [5].

It is intriguing and a mystery for the author how Prof. Laby was involved in acoustics or in measurement of street noise in Melbourne Australia in May 1928 because there is no background information at his official archive at the University of Melbourne.

In this article the author will try to draw together from various sources information about Prof Laby and collaborators and their ground-breaking contributions to the early development of acoustic measurements in Australia.

Three early researchers

The team at the University of Melbourne:

Thomas Howell Laby (1880-1946) is a renowned physicist. In 1911, together with G.W.C. Kaye he published the influential work "Tables of physical and chemical constants" [6]. It is relevant to note that Kaye was a prominent English acoustician. Laby became Head of the Physics Department of the University of Melbourne in 1915 and he "did much to advance physics research in Australia. He focused the department away from simply teaching in-service to one with true research culture" [7]. An interesting finding about his personality is written by Anduaga: "Almost everything that he knew was due to his self-taught background. Laby abhorred pretentious researchers, as well as slovenly work, whereas he adored accurate observation and a critical approach" [8].

Richard Ormond Cherry (1903-1996) began engineering but completed his B.Sc. in 1925 with the exhibition in Natural Philosophy (now Physics), he was involved in the first investigation on the propagation and absorption of radio waves for 3LO radio station [9].

R. Fallon (?) To date no information has been found on Fallon except that he was Laby's assistant and that he investigated the propagation and absorption of radio waves to 3LO station.

The research for the 3LO radio station

ABC Radio Melbourne (3LO) began transmission on 13 October 1924, and one of its owners was The Herald newspaper [10]. According to Anduaga: "In October 1926, Laby elicited from the Broadcasting Company of Australia (3LO Melbourne) a promise of a three-year research fellowship (£500 per year) for his department. In return Laby committed himself to investigate physical problems arising in broadcasting" [8]. It is then that Prof. Laby and his collaborators (R. O. Cherry and R. Fallon) came into contact with the physics of wave behaviour, since part of their research consisted of studying the propagation of radio transmissions. It is assumed that they also had to analyse the audio signal (because it modulates in amplitude the wave that carries it).

Technical magazines, journals and media

While it is not possible to access the 'scattered' hard copy documents that are kept in the University of Melbourne archives (they are closed as a result of COVID-19), we are only in a position to research for evidence among the technical publications of that time. It has to be kept in mind that by the 1920's the study of the behaviour of sound waves was focused on telephone transmission, recording, and the incipient broadcasting invention.

Speaking specifically about the measurement of street noises, in the Australian Wireless Weekly and Australasian Wireless Review magazines (all of them are freely available from [11]), it is possible to find many articles in 1924 mentioning Fletcher's work on audibility curves, others describing the audiometer for the study of hearing (with schematics of valve circuits to manufacture it), and some from 1926 discussing the use of the modified audiometers to measure street noises in US cities.

An editorial published by Otago Daily Times (from New Zealand) on January 5th, 1928, on "Noise and nuisance" transcribes one article from The Engineer magazine (of England) published in 1927, which comments on a campaign for recording the London street noises.

One could presume that given the contacts Prof. Laby had with research centres in England, he may have had access to the Bell System Technical Journal, in which all the technological advances relating to sound measurement were published.

This information could have provided for Prof. Laby and his assistants the basis for developing their own devices to measure and record sound levels in streets.

Publicity on noise problems

On March 28th, 1928, the Melbourne's Noise Abatement League (MNAL) was created by prominent people of that city, and they started an anti-noise campaign through the media (history of this league is in Acoustics Australia August 2020 [12]), and The Herald newspaper began to publish many articles, not only about MNAL public actions, but also medical reports referring to mental problems because of city noises. The Herald advocated for initiatives to reduce tram noise and motor noise (the most important sources of annoyance at that time) around schools and hospitals. Perhaps because Laby and his team were already hired by 3LO (the radio station which belongs to this newspaper), they were asked to conduct a campaign to measure the Melbourne street noises.

Street noise measurements

On April 30th, 1928, under the title of "Science to investigate electric tram din," The Herald asked the Natural Physics Laboratory "acting under Prof. Laby, to co-operate with 3LO and this newspaper to ascertain the cause of preventable noises, and to aid in suggesting a remedy." With the consent of the University authorities Laby started a project to measure the 'noise evil' of Melbourne: Tram noise.

On May 5th, under the title "City noise growing" The Weekly Times (also owned by The Herald), published some of Laby's statements about how science could be useful "There is no doubt that a physicist can suggest means for minimising these," and ended with an interesting thought "The trouble with the Tramways Board seems to be that they do not realize that before the remedy can be suggested, trained physicists are necessary to ascertain the real cause of the distressing din."

At this point the author has to make a distinction about the two parts of Laby's work, which from media reports were: (a) measurements of street noises, promoted by The Herald; and (b) measurements of tram cars promoted by the Tramway Board.

Due to the 'contract' with Prof. Laby and his team to measure the Melbourne street noises, The Herald published the 'breaking news' first, and after that many Australasian newspapers replicated its articles.

In contrast, The Argus newspaper published the noise measurements that Laby's team obtained inside the tram cars but never mentioned his name (or the other members of his team) and this paper covered the investigation asked by the Tramway Board "with a view of discovering its exact source and so working out a diminution."

First measurements in Melbourne streets

On May 7th, The Herald announced the two week's experiment will start on May 9th, where Prof. Laby "will measure the volume of the city's noises, and prepare graphs, which will indicate the crescendo and diminuendo of the varied sounds of our workaday Melbourne." The sarcasm used by the writer indicating the 'crescendo and diminuendo' of the noise levels using a musical language instead of technical terms, possibly is intended to help the readers to understand the concept.

The newspapers headlines marked the beginning of the street

noises measurement with big letters: "Tram noises hideous; intolerable. Tracking city's noises. Science makes a start. Recorder hears tram a mile away."

A long article was published by The Age morning issue of May 9th, which explained the experiment conducted during the measurements inside a tram car the day before, it explains "The instrument... consists of a wireless valve amplifier connected with a recording machine, which shows the speed of the tram, and the noises heard by a special microphone," and it describes everything that happened along the way, mentioning the streets of the route it took and the state of the rail where it travelled; unfortunately, the names of Laby and his collaborators are not mentioned.

The Argus evening issue of May 9th published four pictures that were taken during the measuring conducted the day before, showing a tram car in which the noise measurements were done (see Figure 1), but unfortunately, the images have poor quality.



Fig. 1: R.O. Cherry measuring the tram car noise. The Argus May 9, 1928.

Perhaps because of the 'contract' that Prof. Laby had with The Herald, neither his name nor the team are mentioned. For the May 10th issue, the Argus published one chart showing the noise level recorded and the tram car speed.

Laby's sound level meter

As it was mentioned before, it is not possible to get access to the professor's archives, so all information concerning the instruments described here has been found from media reports.

On May 9th, The Argus evening issue described the instrumentation used for the noise measurements inside a tram car: "The apparatus consists of a microphone for picking up noises and a valve amplifier similar to a wireless amplifier, by which the microphone currents are 'boosted up' to sufficient strength to work a delicate stylus tracing a graph on a sheet of squared paper, which is drawn beneath the stylus by clockwork (SIC)"; adding that "The instrument is valuable in that it enables an exact record, useful for comparative purposes, to be made, the amplitude of motion of the recording stylus when a noise is being registered being directly proportional to the volume of the noise."

The only photo found to date showing Laby with his instruments was published by The Herald on May 12th, under the text “Recording Melbourne’s noises. Professor Laby, with this set of instruments, recorded the noises of the city, including those made by the trams” (see Figure 2).



Fig. 2: T.H. Laby (center), R.O. Cherry (left), R. Fallon (right). The Herald May 12, 1928.

First measurement report

On May 14th the first report was published by The Herald with some interesting statements by Laby. Considering that the article was written for a newspaper and not for a technical journal, Laby wrote about the “difficulty of gauging sound” and “Preliminary observations on the noises of the city of Melbourne indicate that information of value can be obtained if the noises are observed by means of apparatus which is suitable for the measurement of sound.” It has to keep in mind in 1928, sound pressure measurement was not yet standardized. Laby asked the rhetorical question: “Do such physical measurements place a number of noises in the same order of intensity as they are placed by the ear?” answering that “Preliminary observations on traffic noises placed them in the same order of intensity when measured by a microphone as by the ear.”

To summarize, what has been found from different articles, these are the characteristics of the instruments (the microphone and amplifier had been lent by 3LO) that Prof. Laby and his team used for the measurements:

Microphone: “Noises in the city have been observed by means of a very sensitive condenser microphone, which was first described by Wente in the Physical Review in 1917. This microphone has a tightly-stretched diaphragm and the effect of noise upon it is likely to be similar to the effect of noise upon the ear.” This microphone was designed and patented in 1917 by Edward Christopher Wente (1889–1972), and it was the first truly condenser microphone. It had a 15 kHz bandwidth, undistorted and flat response, with real

possibilities of calibration, electric circuit stability [13].

Amplifier: There is no description of this device; the media just explained that “the microphone currents are ‘boosted up’ to sufficient strength to work a dedicated stylus”.

Recorder: “Traced a graph on a sheet of squared paper, which is drawn beneath the stylus by clockwork”.

Voltmeter: They used a Moullin valve voltmeter to measure the electric signal delivered by the amplifier output; information on this instrument is found at the Physics Museum of the University of Queensland [14].

Scale: It is important to note the efforts that Laby and his team did to have a precise way to report the information on sound levels: “The readings of noises given below are the readings of this voltmeter in tenths of a volt. The readings are not to be taken as giving the ‘intensity’ of the noises, but as their approximate order or gradation of ‘intensity’”. This means that they used a ‘linear’ scale to report the sound levels.

System calibration: In 1928 modified audiometers to measure street noises had to be ‘calibrated’ each time a measurement was to be made and for this purpose the apparatus had a built-in sound generator that supplied a tone as a reference, and a trained person had to adjust the instrument in a quiet place as follows: The tone had to be heard through an earphone placed in one ear, and with the free ear he had to listen to the ambient sound, then he had to turn ‘up or down’ the knob until the level of the tone “balanced” with the level that was in the ambient. But Laby elaborated a different and clever method to calibrate his system: “The microphone and amplifier are being calibrated by means of a small organ pipe, which is blown with air at constant pressure. To calibrate the microphone, it is placed in the open air at various known distances from the organ pipe,” and this task was not so easy for them, because “lack of silent places in the University grounds, wind and rain have so far interfered with the calibration.”

At the end of his report, Laby concludes “As stated, the magnitude of the readings given by the meter (indirectly) connected to the microphone, correspond to the effect of the noises on the ear.”

First Melbourne street noises measurement: Wednesday, May 16th, 1928

On Saturday, May 12th, The Herald announced “City din to be broadcast. 3LO test on Wednesday”. This headline is apparently confusing, because instead of announcing the street noises measurement, it says that the station will broadcast the noise: “Another move in the campaign to minimize the noises of the city will be made next Wednesday at 5 p.m. when a microphone will receive the roar of peak traffic at Melbourne’s business corner and 3LO will broadcast it to listeners throughout the state”. The rest of the article does not say anything about Laby or his team.

On Wednesday, May, 16th, The Herald following the same idea, its headline was “Country to hear city noises. Peak traffic on radio. Microphone listens at Cathedral steps”. Perhaps the media authorities were worried, because the Tramway Board were against the street noises campaign supported by The Herald, and with the ‘evil noise’ live broadcast had the opportunity to raise awareness among people: “Today at 5 o’clock, when the traffic at the Cathedral Corner is at its peak, and the first “wave” of homeward bound citizens is breaking on Flinders street Station,

3LO is transmitting to the country the conglomerate noises of the city at their worst." Finally, the microphone was mounted on the steps of St. Paul's Cathedral and "a running description of the scene at the busy corner will be given as an accompaniment to the din". This means that there was a narration of what was happening in the street at the same time as the sound picked up by the measurement microphone was broadcasting by 3LO.

In a subheading "Din of the trams" an important clue is given: "University experiments were carried on today, and copious notes taken. The apparatus, valued at £300, is mounted in the back seat of a closed car. Messers. R. Cherry and R. Fallon are conducting the street tests for Professor Laby". Finally the names of Laby's collaborators were mentioned as responsible for the internal tram noises measurement. An explanation of their work included: "The car stood for some time by the side of the Melbourne Hospital". This is noteworthy because the measurements that they undertook on May 8th, were conducted inside of a moving car; "On arrival, the experimenters "tuned in." The "ear," a square box, was placed at the open window of the car, the indicator of the voltmeter, which records the presentation of the sounds, standing at zero below it". This was a significant improvement of their job has to note because they had many problems with the stylus writing pen when they tried to record the sound level when the tram car was in movement.

On May 19th, The Herald under this headline "Listeners hear city's din. Peak traffic evils brought home by radio," comments: "The effect caused by the broadcasting of the "peak" traffic at the Cathedral Corner yesterday was indescribable. At the studio 3LO officials were kept busy answering telephone calls from subscribers who were amazed at the volume of the noise to which they had become accustomed in their daily comings and goings". It must have impressed the listeners to hear the street noises in the quiet of their homes. The setup is described as "The apparatus was erected at the top of the cathedral steps" and "the microphone was raised ten feet above street level."

As far as the author has investigated there are no references in the press of the rest of the world that something similar to measuring and broadcasting street noise has been done. The media congratulated themselves in initiating these measurements in the open areas; "The Herald is to be congratulated on opening up a new field of scientific investigation, which will have a great effect if resolution is shown in following it up". A proposal was made to record the noise on a gramophone; "Professor Laby, with whom Dr. Ostermeyer was in consultation, expressed the view that the test had shown the necessity for preserving in permanent form by means of phonographic records, the sounds of the city, for the purpose of study, of comparison, and research."

An interesting technical article on Laby's measurement and the problems from the tram noise was written by Rupert V. Markham B.E. from Sydney, in Builder magazine, with title "Tram noises affecting health. Some Melbourne experiments" [15].

Graphs showing the street noises levels

The Herald published, in three editions, some graphs which show the noise levels recorded by Laby.

On May 22nd, on the first page in a long article describing the measurements conducted by Laby, are two graphs showing the noise levels recorded on William Street and Collins Street, with a full description of each noise event (Fig. 3).

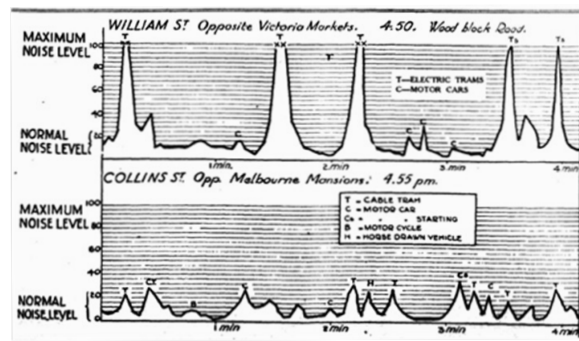


Fig. 3: Noise level chart published in The Herald May 22, 1928, page 1.

On May 23rd, two graphs show the noise level at another location in Collins Street and on High Street (Fig. 4), and the article has some interesting comments from Laby: "It has been conducted with the very latest appliances, and under rigid scientific conditions. Personally I am astounded at the immense field covered in the time. Much still remains to be done, and it is in the stimulating suggestions of its omissions, no less than in its findings, that the report is valuable." Laby was aware about the work that he and his collaborator had done in this novel branch of technical acoustics: "It has opened a window into the entire subject of noise study and its ramifications. It has had the splendid effect too, of releasing the repressed feelings of citizens and causing evidence to flow in, through many channels, of the harmful effects of noise, thereby directing public attention to a source of nervous ills."

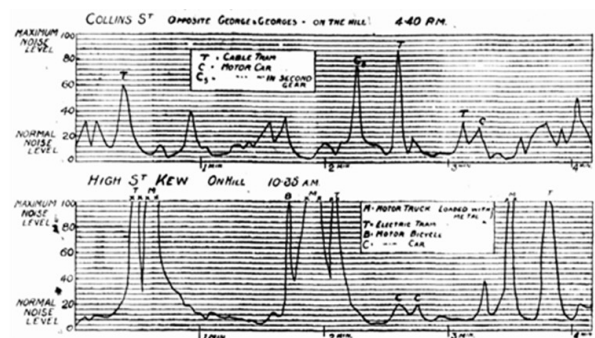


Fig. 4: Noise level chart published in The Herald May 23, 1928, page 4.

On May 24th, two graphs show the noise level on Glenferrie Road hill 1/4 mile from Kooyong Street and on St. Kilda Road, with a full description of each noise event (Fig. 5).

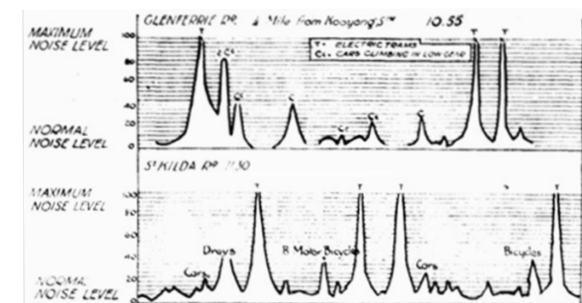


Fig. 5: Noise level chart published in The Herald May 24, 1928, page 12.

The street background sound measured during a tram strike in 1934

On October 16th, 1934, a strike was held by the tram Workers union, and R.O. Cherry took the advantage of the absence of trams, to conduct noise measurements at several locations. To date the findings of these measurements have yet to be found.

Proposal for centenary

May 2028 will be the centenary of those remarkable first attempts internationally to measure environmental noise by Laby and his team. So the author proposes the Australian Acoustical Society (AAS) and Australian Institute of Physics (AIP) consider collaborating in May 2028 in a centenary celebration of the innovative work by Laby and colleagues. In May 1928 there was the involvement both of the society and technology with the assistance of the media. It would be a grand recognition of this achievement if in 2028 the two organisations can promote this achievement.

Conclusions

It is intriguing that the work by Laby was the first to be published in the media showing charts and technical explanations and one and a half years before similar actions in New York City. In 1928 the modified audiometers for measuring street noise were not commercial devices, and were owned by the companies that manufactured them for their own researchers, so Laby undertook a 'Herculean' task to devise his own instruments and to undertake measurements 'in the field'.

The author, from Argentina, has provided information on what he has found using freely available material on the Internet. So while there is evidence in newspapers, it is intriguing that there is no information about their work on street noise measurement in the obituaries of Prof. Laby, R. Cherry or R. Fallon. There are many unanswered questions about their work, for example how could they record these measurements in the street on a gramophone that may only be answered by careful research in the University of Melbourne archives.

As a summary of Laby, Cherry and Fallon's pioneering work, four statements can be made:

- They did not use the audiometer for their noise measurements.
- They recorded the sound time-history on paper (not by means of mechanical mirrors/photos).
- They broadcast the sound picked up by the microphone simultaneously.
- They published their complete work in a newspaper.

This article is a contribution to the Australian Acoustical Society, showing the pioneering technological efforts to gauge the sound levels scientifically in Australasia, and to encourage acousticians and physicists to search for more records of the work by Prof. Laby and his team to fully recognise their pioneering work in this field.

Acknowledgements

The author wants to thank and acknowledge Marion Burgess for encouraging and for inviting him to write this article and for

the proofreading, and to thank Sophie Garrett, the Reference Archivist at the University of Melbourne Archives, for her help seeking information into the archive box for Laby.

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Footnote: As the weblink for each newspapers reference weblink is very long, please use a web search engine on the title.

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DEVELOPMENT OF A LOW-COST DODECAHEDRON LOUDSPEAKER TO MEASURE INTERNAL BUILDING ACOUSTIC PARAMETERS

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Abstract:

One of the major challenges associated with internal building acoustic measurements is acquiring a signal source that is omnidirectional and meets the requirements of international testing standards. A dodecahedron loudspeaker is a type of signal source that can meet these requirements. However, due to the high costs associated with purchasing such a loudspeaker, it is often overlooked for alternative signal sources. This paper investigates the construction of a low-cost dodecahedron loudspeaker that can achieve compliance with the specifications outlined in ISO 16283-3:2016 Acoustic – Field measurement of sound insulation in buildings and of building elements – Part 3: Façade sound insulation (ISO 16283) and ISO 3382-1:2009 Acoustics — Measurement of room acoustic parameters — Part 1: Performance spaces (ISO 3382).

Introduction

It was my privilege to be first introduced to the wonderful world of loudspeaker design during my time at university by one of the leaders in the industry, Albert Neville Thiele. Since that time, my fascination for loudspeaker design and acoustics in general has grown exponentially. 13 years of acoustic consulting later I still consider myself to be just a baby in the industry. However, over that time I have regularly undertaken acoustic testing for commercial office spaces, residential apartments, recording studios, performance halls and countless other types of spaces.

Generally, the testing procedure requires that an omnidirectional signal source be used. As the reader could imagine, common off the shelf loudspeakers do not produce an omnidirectional signal source. To meet this requirement, manufacturers of acoustic equipment have developed acoustically certified, twelve-sided speakers known as dodecahedron loudspeakers that emulate a relatively uniform omnidirectional signal source. The cost to purchase one of these dodecahedron loudspeakers can range from approximately \$12,000 to \$15,000. Due to the high cost, this piece of testing equipment can be very hard for a business or individual to justify purchasing. Having considered the cost of entry issue for a considerable amount time and not finding any alternatives I decided that I would use

my loudspeaker design knowledge and woodworking skills to build my own dodecahedron loudspeaker.

This paper provides a brief overview of the omnidirectional signal source requirements contained within International Standard ISO 16283-3:2016 Acoustic – Field measurement of sound insulation in buildings and of building elements – Part 3: Façade sound insulation (ISO 16283) [1] and ISO 3382-1:2009 Acoustics — Measurement of room acoustic parameters — Part 1: Performance spaces (ISO 3382) [2] and focuses specifically on the construction and cost to build your own dodecahedron loudspeaker that meets these requirements. Is it worth the time and effort? This will be explored in the following sections.

There are many videos and guides available on the internet for DIY dodecahedron loudspeaker design, I have included several useful links within the reference section located at the end of this paper.

2. Design requirements for omnidirectional sources

2.1.1 Overview

The investigation started with a thorough review of the omnidirectional source design requirements as defined in ISO 16832 [1] and ISO 3382 [2]. Below is a summary of the key design requirements of an omnidirectional loudspeaker:

- A loudspeaker shall be a closed cabinet containing one or more individual speaker units.
- All speaker units in the same cabinet shall radiate in phase.
- The directivity of the loudspeakers shall have approximately uniform, omnidirectional radiation.
- Loudspeakers mounted on the surfaces of a polyhedron, preferably a dodecahedron, will give uniform, omnidirectional radiation.

The qualification procedure for loudspeaker directivity that is described in C.2 (refer to ISO 16283-3:2016) and section 4.2.1 (refer to ISO 3382) shall be used to confirm that the loudspeaker is suitable for measurements. This is described in more detail further on in this paper.

3. Dodecahedron loudspeaker construction

3.1 Required materials

Table 3.1 is a list of materials and approximate cost breakdown for each item you will need to build your own dodecahedron loudspeaker.

Table 3.1 Estimated material costing (2021)

Item No.	Description	Cost AUD (incl. GST)
1	Sheet of 16 mm MDF (1800 mm x 900 mm x 16 mm)	\$31.50
2	12 x Jaycar 4" speakers	\$299.40
3	60 x Screw-in locking nuts (10mm)	\$46.00
4	48 x Screw Button head Hex M4 x 28 mm	\$39.75
5	60 x Screw Button head Hex M4 x 10 mm	\$107.40
6	48 x Tee nut 4 prong M4 (4 mm)	\$32.00
7	Duratex loudspeaker paint + roller	\$85.00
8	Gorilla wood glue (532 ml)	\$19.35
9	Heavy Duty Speaker cable – 30 m roll	\$35.95
10	PCB blank board	\$5.95
11	12 x speaker terminal clips	\$26.80
12	Large PA speaker stand	\$49.95
13	Gravity SF 3616m reducer flange 32 mm to 16 mm	\$78.35
14	12 x Speaker grill mesh	\$70.34
15	12 x speaker surrounds (anodised aluminium)	\$587.00
16	12 x speaker rings (3D printed)	\$60.00
17	10 m 2 core Speakon audio cable	\$54.95
18	NobSound G2 Pro 300W mono channel power amplifier	\$112.75
19	Speakon mount connector	\$12.95
20	Speaker enclosure centre support rod (anodised aluminium)	\$884.00
21	Speaker handle and (anodised aluminium)	\$121.00
22	Solder wire	\$5.50
23	Self-adhesive sound absorbing foam	\$29.90
24	3D printed speaker heart housing	\$60.00
25	Directivity certification testing (two yearly requirement for ongoing calibration)	\$3,740.00
26	Insulation material impedance tube testing (option)	\$1,054.00
Total		\$7,649.59
28	Labour time	Love is priceless

3.2 Loudspeaker enclosure

Loudspeaker enclosures can be made from a range of different materials such as medium density fibreboard (MDF), plywood, concrete, plastic, glass, and carbon fibre. Each material has pros and cons depending on the design requirements, functionality, and aesthetics. I decided to build the dodecahedron loudspeaker out of 16 mm MDF due to its versatility, availability, cost, low weight, high stiffness, uniform construction, and it is not subject to warping. It is not recommended to use any thickness of MDF less than 16 mm due to the strength and stiffness required to make an enclosure to house twelve speakers. An enclosure with twelve speakers will generate a lot of sound pressure and vibration, and if not controlled will result in catastrophic failure of the enclosure.

As any avid woodworker would tell you, jigs are your best friend when replicating multiple parts, this process was no different when constructing the dodecahedron loudspeaker enclosure. Setting up multiple jigs during the manufacturing process was the easiest way to maintain a high-quality build while maintaining uniformity.

There are many different tools that can be utilised to cut out the twelve pentagon shaped sides of a dodecahedron loudspeaker enclosure. These include: a table saw, radial arm drop saw, bandsaw, router table or computer numerical control (CNC) machine. A CNC machine is the ideal tool as it can produce the highest quality parts as it removes the human element and avoids using multiple machines but not everyone has a CNC machine in their garage.

I used the radial-arm drop saw since I could cut both the pentagon sides and the bevelled angle joints at the same time. The key components for each side of the dodecahedron enclosure are listed below and shown in Figure 3.1:

- Twelve pentagons side.
- 16 mm MDF.
- Pentagon side angles of 1080.
- Pentagon side bevel angle of 31.71750.
- Angle of intersection of 2 adjacent faces 116.56510.
- 92 mm diameter loudspeaker driver housing cut out.
- 4 mm grill screws and speaker driver mounting screws holes.

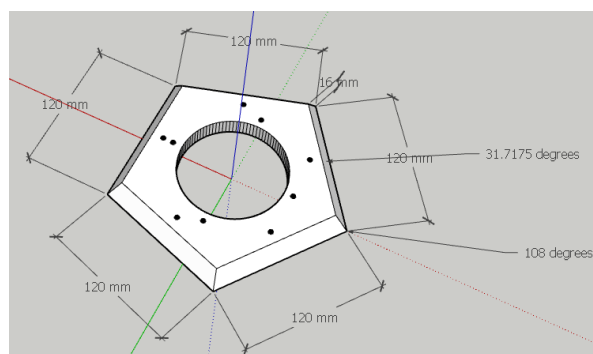


Figure 3.1 Dodecahedron pentagon side cut-out

3.2.1 Manufacturing procedure guide

Outlined below is a step-by-step guide to building your own dodecahedron loudspeaker enclosure.

Step 1: Cut the 16 mm MDF sheet into twelve equal squares of 200 mm (L) x 200 mm (W).

Step 2: Figure 3.2 presents the jig that was built to cut out the twelve pentagon shapes. Remove the small triangular piece on the jig and cut one of the sides on each of the twelve squares in Step 1. Similar jigs could easily be setup for a saw table, router table or band saw.

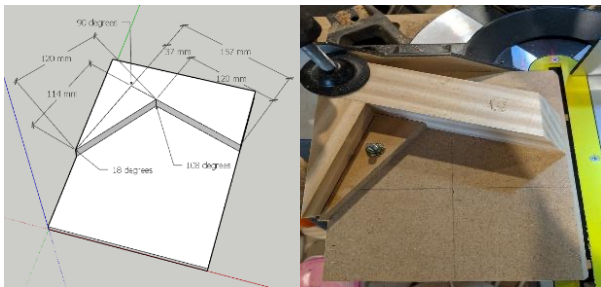


Figure 3.2 Pentagon cutting jig

Step 3: Insert the small triangular piece back into the jig and cut the remaining four sides of the pentagon on all twelve pieces.

Step 4: Once the twelve pentagons have been cut out, you can use a drill press with a hole cutting bit to drill out the speaker driver housing hole. Figure 3.3 presents the hole drilling jig that was built to cut out the speaker driver housing holes (92 mm). The size of the hole may vary depending on the speaker drivers you select.

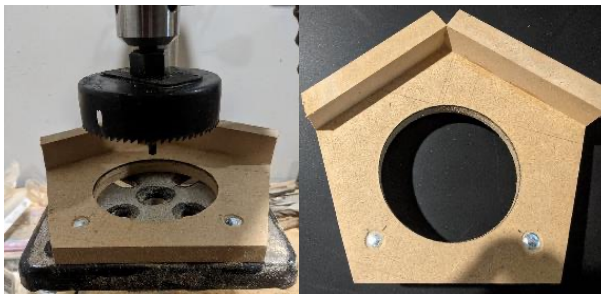


Figure 3.3 Speaker housing hole cutting jig

Step 5: Glue each of the twelve pentagons together to form the dodecahedron enclosure shell. One of the strongest woodworking glues is Gorilla Glue, especially for MDF. To hold/clamp the pentagons into shape while the glue sets, I recommend you either 3D print or make a clamping jig (this will save you a lot of hassle and will stop you pulling your hair out in frustration).



Figure 3.4 Gluing the dodecahedron sides

Step 6: Drill the holes for the speaker protection grill screws and speaker driver mounting screws (4 mm holes). If you have access to a 3D printer, you can print out a jig (refer to Figure 3.5). You could probably do this step before gluing in Step 5.

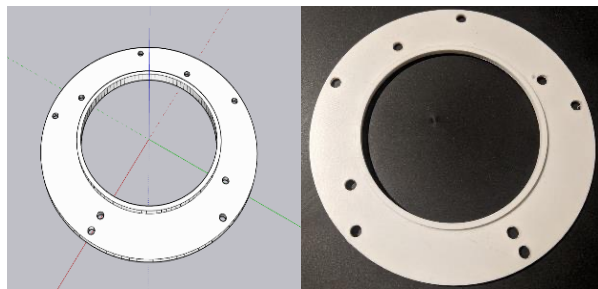


Figure 3.5 3D printed hole jig

Step 7: Paint the enclosure with Duratex paint using the textured roller as per the manufacturer instructions. This is a widely used paint specifically designed for speaker enclosures and protects it from damage from the elements and general uses. I sprayed the whole enclosure with an undercoat of quick dry black spray paint before applying the Duratex paint (refer to Figure 3.6).

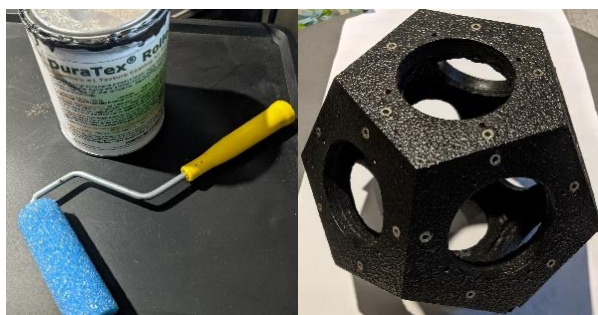


Figure 3.6 Duratex loudspeaker enclosure protective paint

Step 8: Once painted, you can start to attach the speaker hardware such as adding the tee nuts for the speaker mounting screws (located on the inside of the enclosure) and the threaded screw-in flange nuts for speaker protection grills (located on the outside of the enclosure).

Step 9: Line the inside of the enclosure and the back of the speaker drivers with sound absorption material (Jaycar Response AX-3662 Sound Insulator 5mm) (refer to Figure 3.7). Sound absorption coefficient test data was not available

from the supplier. However, I sent a sample to the University of Technology Sydney Tech Lab and they performed impedance tube testing on the insulation material. The absorption test results are presented in Figure 3.8.



Figure 3.7 Dodecahedron enclosure lined with sound absorption material

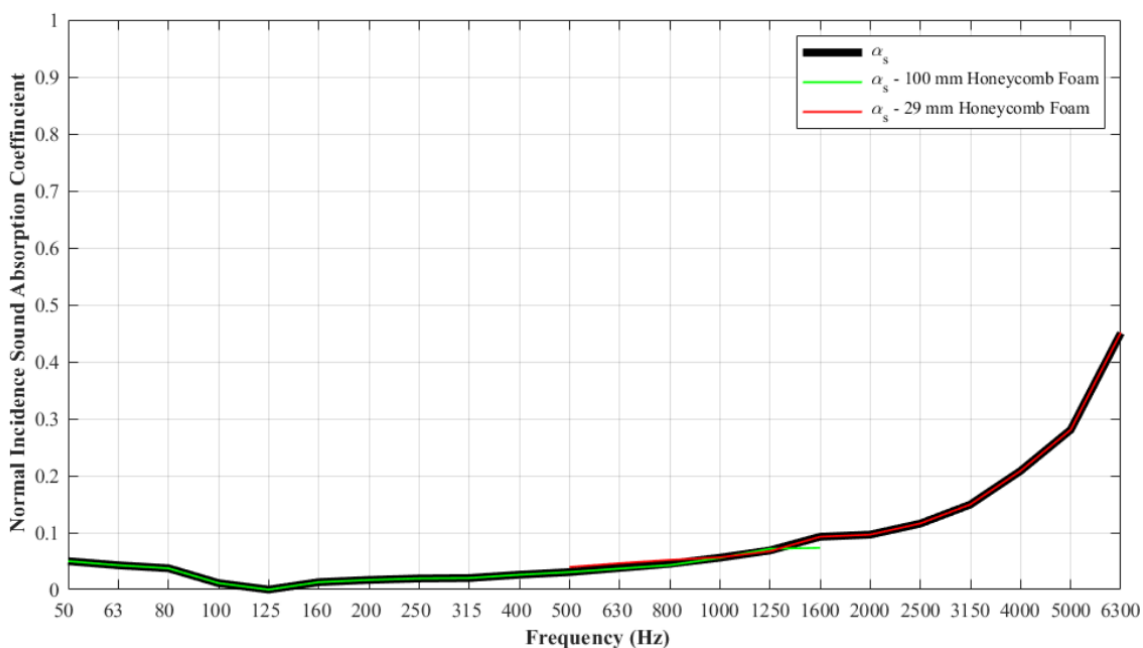


Figure 3.8 Jaycar Response AX-3662 Sound Insulator 5mm – Absorption coefficient test data from impedance tube testing

3.3 Speaker drivers

Keeping with the low-cost theme, I decide to try my luck with an off the shelf 4” speaker driver from Jaycar.

Speaker driver specifications:

- Size of speaker: Response (CW2190) 4 inch shielded woofer

- Rated impedance: 8 ohm
- RMS power: 27W
- Max power: 55W
- Frequency response: 70Hz to 7 KHz
- Sensitivity: 86 dB

3.3.1 Protection grille

Unfortunately, most off the shelf speaker drivers do not come with protection grilles. I developed a custom-made press mould to manufacture the protection grilles from perforated speaker grille mesh. I also designed and manufactured the outer aluminium housing (see Figure 3.9).

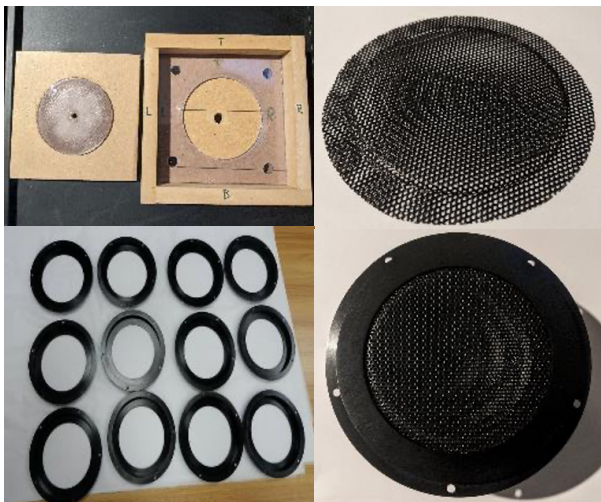


Figure 3.9 Speaker driver protection grille

3.3.2 Speaker rings

Speaker mounting rings were 3D printed to decouple the speaker drivers from the enclosure to help reduce vibrations and to fully seal the speaker drivers to the enclosure to avoid sound leakage (refer to Figure 3.10).



Figure 3.10 3D printed speaker ring

3.4 Wiring

As the reader can imagine, space within the enclosure was very limited. I designed a small dodecahedron heart that wired all speakers together and gave the ability to remove any speaker driver without affecting the speaker wiring and the need to resolder any cabling if a speaker driver needed to be replaced in future (refer to Figure 3.11).

The wiring itself is in a series/parallel formation so a 300 Watt amplifier can supply 25 Watts @ 8 ohm to each speaker. The wiring diagram is shown in Figure 3.12. I used a CNC machine to manufacture the pcb internal wiring boards.

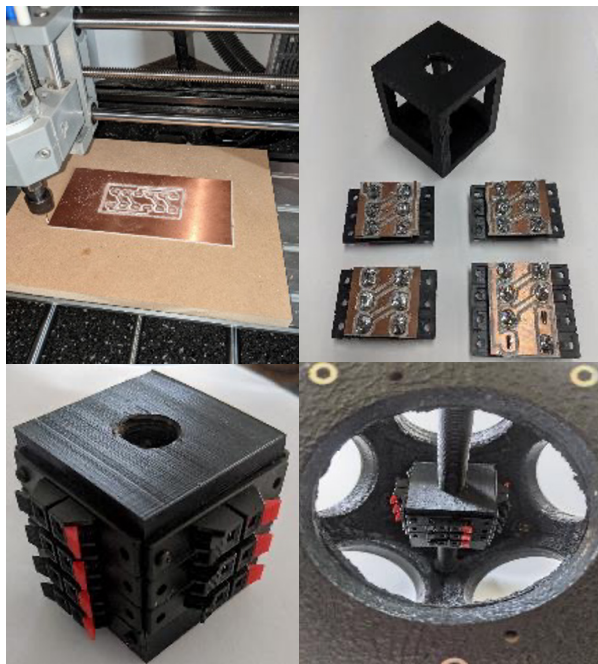


Figure 3.11 Speaker wiring heart

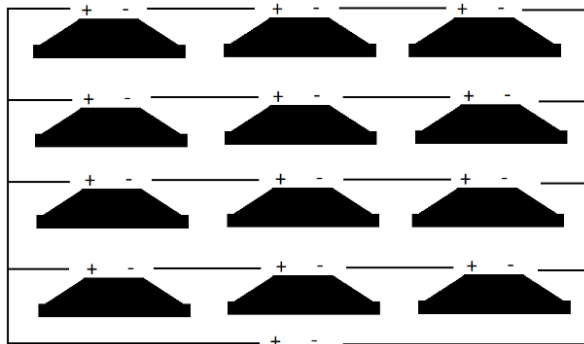


Figure 3.12 Dodecahedron speaker wiring diagram

3.5 Internal support structure

Due to the significant weight of the 12 speakers (approximately 13 kg), an internal support rod runs straight through the middle of the enclosure. This rod enables the weight to be lifted from the bottom of the enclosure and not the top. Without the weight inversion of the supporting rod, the handle would have torn right out of the enclosure. This also enabled the speaker wiring heart to be mounted in the centre of the enclosure (refer to Figure 3.13 and Figure 3.14).



Figure 3.13 Internal support structure and handle

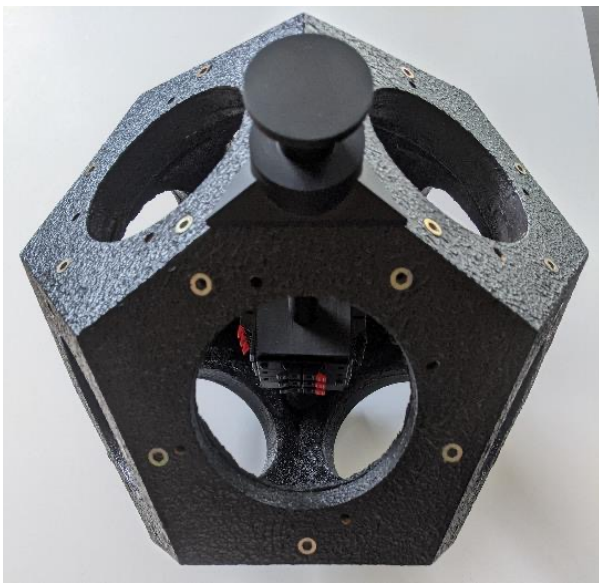


Figure 3.14 Internal support structure

3.6 Power amplifier

I took a gamble and purchased a very small sized power amplifier (Nobsound G2 Pro mono amplifier) from Ebay that was said to be rated at 300W. I had my suspicions, so I asked for confirmation from the manufacturer who provided the test results. The amplifier's maximum power rating with the current power supply of 32 volts and 5 amps is 170 watts as presented in Figure 3.15. I was advised however that the maximum 300 Watt output could be achieved with a 32 Volt 10 amp power supply.



Figure 3.15 NobSound G2 Pro maximum power output

3.7 Audio cabling

The dodecahedron is powered by a 2-pole Speakon audio cable via connection point at the base of the enclosure (see Figure 3.16).



Figure 3.16 Speakon input cable connection

3.8 Final design

Figure 3.17 provides the final dodecahedron loudspeaker design.



Figure 3.17 Final dodecahedron loudspeaker during testing in the UTS Tech Lab anechoic chamber

4. Directivity certification

In order to certify that the directionality of the dodecahedron loudspeaker met the requirements specified in ISO 16283 and ISO 3382. The Dodecahedron underwent certification at the University of Technology (UTS) Tech Lab anechoic test facility

4.1 Criteria

The relevant sections of ISO 16283 and ISO 3382 relating to directivity testing has been reproduced below:

ISO 16283

- To test the directional radiation of a loudspeaker, measure the sound pressure levels around the source at a distance of 1.5m from the centre of the loudspeaker in a free-field environment. The loudspeaker should be rotated using a turntable or by taking discrete measurements at 5° intervals. The loudspeaker shall be driven with a broadband noise signal, and measurements made in one-third octave bands.
- Measure L_{360° which is the energy-average level for the complete arc of 360°. Measure $L_{30,i}$ values for each angle step i (typically chosen as 1° or 5° intervals) which corresponds to the energy-average value over the arc of 30° that is centred around the angle step (i.e. +/- 15°). The directivity indices shall be calculated using Formula (C.1).
- $DI_i = L_{360^\circ} - L_{30,i}$ (C.1)
- For one-third octave bands, the loudspeaker(s) can be considered to have uniform omnidirectional radiation if the DI values are within +/- 2 dB for the frequency range from 100 Hz to 630 Hz, +/- 5 dB for the frequency range from 800 Hz and +/- 8 dB for the frequency range from 1000 Hz to 5000 Hz.
- Carry out the test in different planes to ensure inclusion of the “worst case” conditions. For a polyhedron source, testing in one plane is sufficient.
- This qualification procedure shall be carried out at intervals not exceeding two years to ensure conformance.

ISO 3382

4.2.1 Sound source

The sound source shall be as close to omnidirectional as possible (see Table 1). It shall produce a sound pressure level sufficient to provide decay curves with the required minimum dynamic range, without contamination by background noise. In the case of measurements of Impulse responses using pseudo-random sequences, the required sound pressure level might be quite low because a strong improvement of the signal-to-noise ratio by means of synchronous averaging is possible. In the case of measurements which do not use a synchronous averaging (or other) technique to augment the decay range, a source level will be required that gives at least 45 dB above the background level in the corresponding frequency band. If only $T20$ is to be measured, it is sufficient to create a level at least 35 dB above the background level.

Table 1 lists the maximum acceptable deviations from omnidirectionality when averages over “gliding” 300 arcs in a free sound field. In Case a turntable cannot be used, measurements per 50 should be performed, followed by “gliding” averages, each covering six neighbouring points. The reference value shall be determined from a 3600 energetic average in the measurement plane. The minimum distance between source and microphone shall be 1.5m during these measurements.

Table 1 Maximum deviation of directivity of source in decibels for excitation with octave bands pink noise and measured in free field

Frequency, hertz	125	250	500	1000	2000	4000
Maximum deviation, decibels	±1	±1	±1	±3	±5	±6

Please note that ISO 3382-1:2009 also requires investigation into the dynamic range of the loudspeaker. However, this was not undertaken as part of the directivity testing presented in this paper.

4.2 Measurement methodology

The loudspeaker was mounted on a turntable, as shown in Figure 4.1 and measurements were taken at 5 degree increments at a distance of 1.5m from the dodecahedron loudspeaker.

4.3 Compliance testing results

Figure 4.2 and Figure 4.3 provides the directivity testing results in accordance with ISO16283 and ISO 3382 testing methodologies. The measured directivity for the dodecahedron complies with both ranges required by ISO16283 and ISO 3382 and therefore is considered to have uniform omnidirectional radiation.

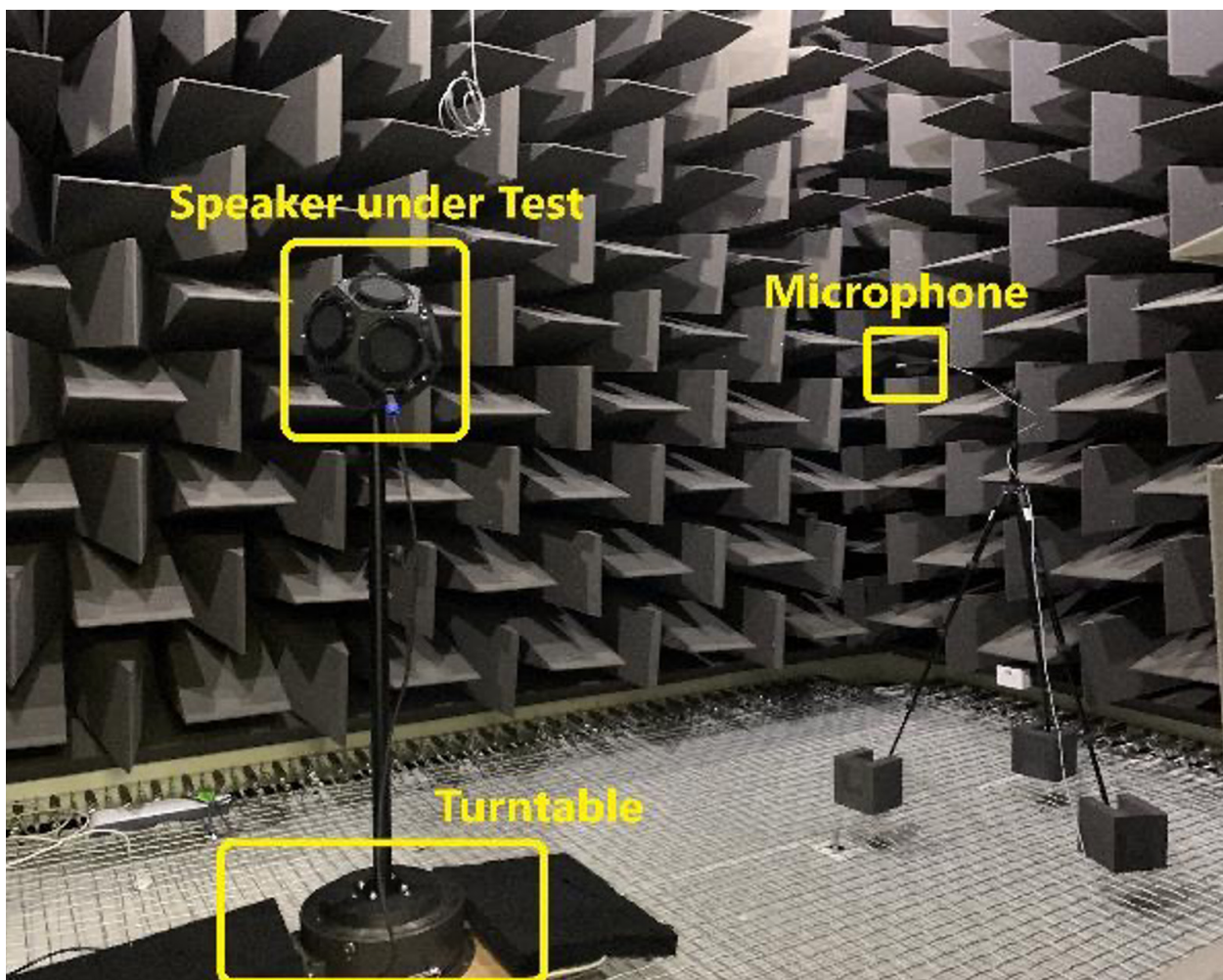


Figure 4.1 Dodecahedron loudspeaker directivity testing – UTS Tech Lab anechoic chamber

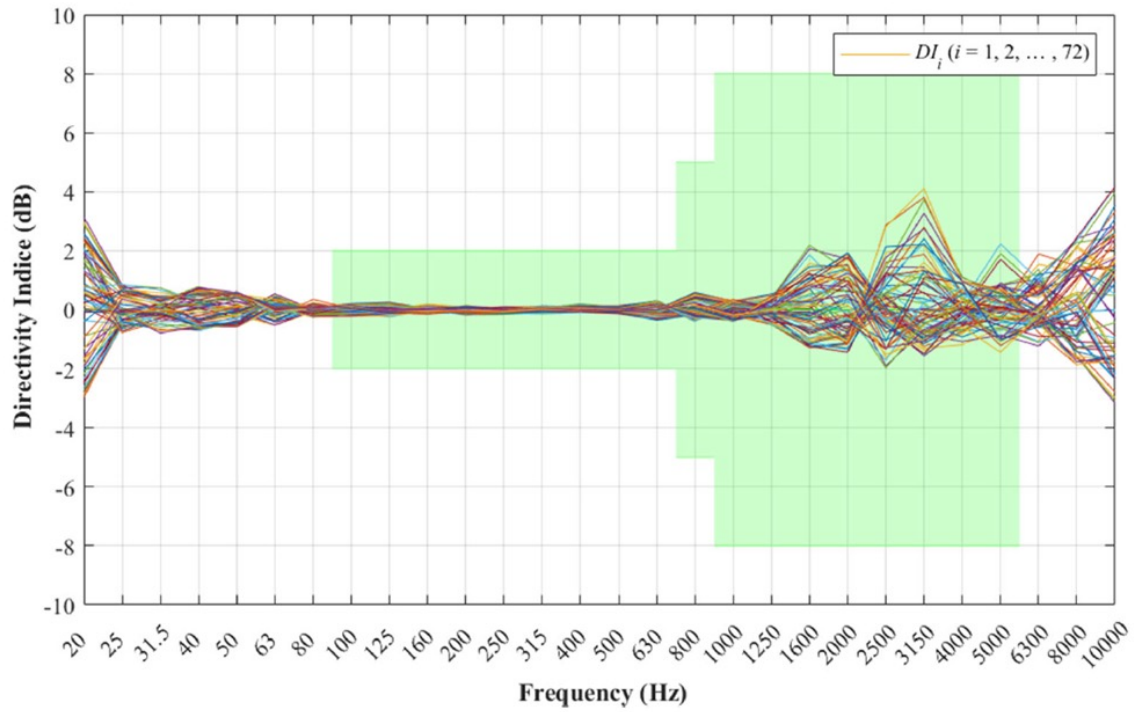


Figure 4.2 The directivity indices at each angle step (50 intervals) and the range required by ISO 16283

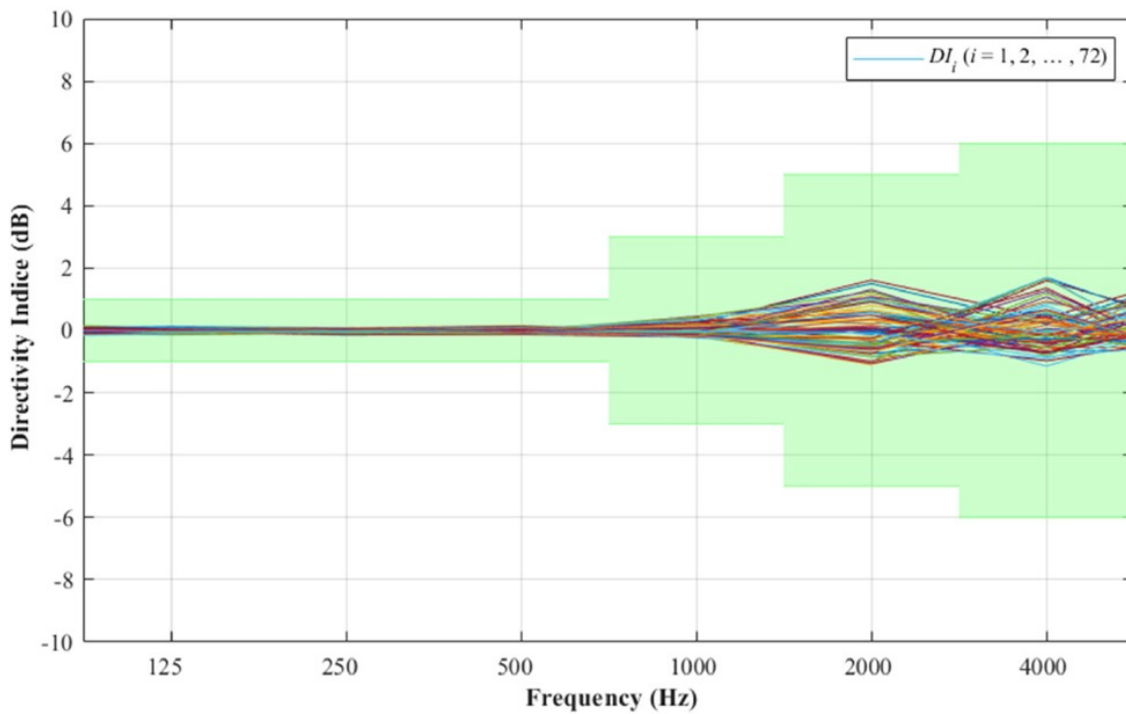


Figure 4.3 The directivity indices at each angle step (50 intervals) and the range required by ISO 3382

5. Future improvements

There were many aspects of the build that could be improved by streamlining the manufacturing process. However, the approach taken was the best available given limited access to other tools whilst trying to reduce costs. If I were to go through this process again, I would improve the following elements:

- CNC machine the pentagon speaker enclosure sides.
- Use better quality speaker drivers with a flatter and larger frequency response.
- Purchase a better-quality power amplifier that is actually rated at 300 Watts.
- Provide 32 volts 10 amp power supply to achieve the full 300 Watts from the amplifier.
- Potentially rebate the speaker drivers on the enclosure to avoid the use of speaker rings.
- There were a lot of unknowns in relation to the performance of the off the shelf materials/equipment. Extra time and testing were undertaken on these elements. You would save on these extra costs by using material/equipment that have approved/trusted performance test reports.
- Use better insulation internal sound absorption material.
- Undertake maximum sound pressure level testing.

6. Conclusion

The question one must ask themselves at the end of this process though is:

“Does the end justify the means?”

Yes, this dodecahedron loudspeaker meets the directivity design requirements of ISO 16283 and ISO 3382 and the cost of materials was significantly less than a commercially available dodecahedron loudspeaker. However, if you include labour time, the costs would be around the same or potentially even more. If you have a lot of free time, patience, and access to the right tools then yes, this dodecahedron loudspeaker is a potential option for you.

It was fulfilling to see the final product after months of hard work dedicated to overcoming those various challenges. Since its completion, the dodecahedron loudspeaker has been successfully utilised on recent projects as an alternative to those available to purchase on the market.

7. Acknowledgements

I'd like to thank the University of Technology Sydney Tech Lab. In particular, Qiaoxi Zhu and Monica Brockmyre for undertaking the directivity and absorption coefficient certification within their acoustic anechoic chamber facility. If you require similar testing, please visit <https://techlab.uts.edu.au/> for further details on capabilities. For all enquiries and tour requests please email techlab@uts.edu.au

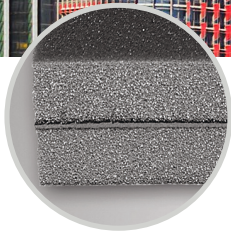
I would also like to thank Bill Elder, Evelyn Potoczny, Andy Cheung and Craig McVie for your support.

8. References

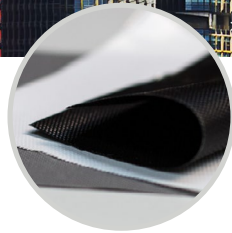
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Future Conferences

With the ongoing COVID-19 pandemic uncertainty remains regarding future meetings nationally and internationally. While all care is taken to present the most up to date information, Acoustics Australia cannot guarantee the accuracy of the listings below and recommends that you seek the latest details from the respective conference website, in particular if the meeting is to be held only in person or allow some form of remote participation.

Additional meetings may be listed on the ICA calendar at: - <https://www.icacommission.org/events/>

Quiet Drones 2022 – Paris, France

27-30 June 2022



The second international symposium on Noise from UAV and UAS will be held in virtual mode from Paris over the period 27-30 June 2022. The scheduling of sessions will take into consideration the participation from different time zones. The Programme covers all themes related to noise and acoustics of UASs and UAVs (both referred as Drones). The symposium will also discuss evolutions from Urban Air Mobility to Advanced Aerial Mobility and present activities of collaborative projects, exchange working groups, standardization committees, first experimentations of air taxis in European cities as well as drone delivery which are in operation in Australia.

To see the program and to register, visit the website:

<https://www.quietdrones.org>

ICSV 28 – Singapore

24-28 July 2022



International Congress on Sound and Vibration (ICSV) is an annual premier event led by International Institute of Acoustics and Vibration (IIAV). This congress combines all aspects of acoustics, noise and vibration. The Society of Acoustics (Singapore), or SAS, is proud to join hands with IIAV in organising the ICSV 28 in Singapore. There will be presentations by researchers across many different fields of acoustics and vibration, special sessions on emerging research and technologies organized by experts in those areas, along with sessions and topics focused on local needs and scenarios. The conference will be held at the iconic Sands Expo and Convention Centre and is expected to attract many international delegates and exhibitors from related industries.

In the light of ongoing COVID-19 pandemic, we are proposing ICSV 28 to be a hybrid congress; a mix of in-person and virtual participation. As the vaccination against COVID-19 progresses in many countries we are hoping that a good number of participants

will be able to travel and participate in-person. The virtual component of the conference would help delegates who are unable to travel to engage with the conference and present their research contributions as pre-recorded videos.

One of the safest countries in the world, Singapore is also the best illustration of how people of different religious faiths can co-exist in peace and harmony. A Garden City state littered with lush green vegetation in an urban setting, a world-class airport, efficient transportation system, mouth-watering international cuisines, and ease of communication in English makes it a very special place for all visitors. So, besides participating in the conference, it is also important for delegates who do participate in person to take the opportunity to explore, understand and experience the unique cultures of Singapore.

<https://www.icsv28.org/>

Internoise 2022 – Glasgow, Scotland

21-24 August 2022



The 51st International Congress and Exposition on Noise Control Engineering is to be held at the Scottish Event Campus (SEC) in Glasgow on the 21-24 August 2022. This is the major international conference on noise control engineering and attracts scientists, engineers and consultants from around the world. The Congress is organised by the Institute of Acoustics (IOA) and the United Kingdom Acoustics Network (UKAN) on behalf of the International Institute of Noise Control Engineering (I-INCE).

The Congress theme is Noise Control in a more Sustainable Future. This theme is particularly timely and the congress venue is the same as that for the recent conference on climate change COP 26. The Technical Program will have sessions in Main Topics ranging from Aircraft Noise to Underwater, Ship and Offshore Acoustics. Included is the Topic: Profession, Training and Outreach, which will be of special interest to young researchers, engineers and consultants who are at the early stage of their careers.

Whilst we are looking forward to people attending in person, we are also offering a virtual option, primarily for intercontinental travellers. The majority of presenters and attendees of a technical session will still be in the room, with a minority of presenters and attendees on-line. The full program of social and networking events will still take place.

<https://internoise2022.org/>

ISMA/USD conferences - Leuven

12-14 September 2022



The ISMA/USD conferences are organized by the KU Leuven LMSD (Mechatronic System Dynamics) division and will be held in Leuven (Belgium) from 12 to 14 September 2022 as a live in-person event.

The 30th edition of the international ISMA Noise and Vibration Engineering Conference - ISMA2022 is next year's edition of a sequence of biennial international conferences on noise and vibration engineering, structural dynamics and modal testing.

Since 2012 this event is organized in conjunction with the USD conference on Uncertainty in Structural Dynamics – USD2022, which will be organized for the 9th time. Intended as a forum for engineers, researchers and other professionals in the different conference fields, the meetings focus on both academic research excellence and top-notch industrial innovations and applications and strive to cultivate interaction between them.

This will be an in-person-only event with technical presentations, time for discussions, conference exhibition and networking opportunities. We aim to pick up again from the last physical edition in 2018, where the technical programme included 420 technical papers in 8 parallel tracks and 4 plenary poster sessions and where we had the pleasure to welcome 700 participants in Leuven.

Full conference proceedings will be published digitally and submitted for reference in the ISI Web of Science.

The annual ISMA course on Modal Analysis and the annual ISAAC seminar on Applied Acoustics. will be held on September 15-16, 2022.

Information on the conference can be found on our website.

<http://www.isma-isaac.be>



ICA 2022 – Gyeongju, Korea

24-28 October, 2022

ICA2022, to be held on behalf of the International Commission for Acoustics will be held in Gyeongju, Korea, October 24 to 28, 2022 and will offer the unique opportunity to learn about the study and latest research as well as to exchange ideas and information on acoustics through plenary lectures, technical sessions, and poster presentations. In addition, various social programs have been planned for participants to enjoy the fascinating Korean culture and share our warm spirit of friendship.

Koreans have a well-known love of music, from K-pop to Western classical music to reinterpretations of traditional Korean music. It follows then that Koreans are highly sensitive to the quality of sound, not only in musical instruments but also in everyday products and spaces. Thus, our technical advancement in acoustics is tied to centuries of musical appreciation.

As the cradle of the country's religion, philosophy, arts and of course, music, Gyeongju can offer visitors an insight into the development of acoustics in Korea. Furthermore, the entire city is an open-air museum full of ancient sites and treasures which include three UNESCO World Heritage Sites. In short, the unique and authentic glimpse of Korean culture through Gyeongju City into Korean culture makes it the ideal backdrop for ICA2022.

We look forward to seeing you in Gyeongju, Korea.

<http://ica2022korea.org>



Acoustics 2022 – Wellington

31 October-2 November 2022

The Acoustical Society of New Zealand (ASNZ) Conference will be held at Te Papa Tongarewa Museum in Wellington New Zealand, from 31 October-2 November 2022.

Acoustics 2022 will provide a unique opportunity for manufacturers and suppliers to showcase the latest developments in acoustic instrumentation, software and noise and vibration control products.

Surrounded by nature and fuelled by creative energy, Wellington is a compact city with a powerful mix of culture, history, nature and cuisine. Fuel your visit with strong coffee and world-class craft beer – Wellingtonians are masters of casual dining, with plenty of great restaurants, night markets and food trucks.

On the waterfront itself you'll find Te Papa Tongarewa Museum, New Zealand's national museum. Te Papa, as it's colloquially known, means 'our place' and is one of the best interactive museums in the world.

It is an iconic New Zealand building, right in the heart of the capital city. It is easily accessible by international and domestic flights into Wellington airport, which is only a short 15 min drive from the venue.

On behalf of the Acoustics 2022 Organising Committee, we look forward to welcoming you to Wellington in November and hope that the conference gives you an opportunity to strengthen your existing networks and that you leave with great memories, fresh ideas, and new friendships.

We encourage you to save the dates in your calendar and register your expression of interest today to be kept up to date with the latest information and program news.

<https://www.acoustics2022.com/>



NOVEM 2023 – Auckland

10 – 12 January 2023.

The conference will be a major gathering of researchers, from research establishments and from industry, working in the areas of noise and vibration.

The emphasis of the conference is on new and emerging methods, techniques and technologies in acoustics and vibration.


We are pleased to announce an exciting and informative line-up of Keynote Forums for the conference.

Topics covered and speakers will be:


- Big data and machine learning in vibration and acoustics
- Kyle B. Gustafson, Naval Surface Warfare Center, Carderock
- Keith Worden, University of Sheffield
- Wenjing Ye, Hong Kong University of Science and Technology
- Engineered materials for noise and vibration control
- Kon-Well Wang, University of Michigan
- François Gautier, Université du Maine
- Sound field control
- Efrén Fernandez-Grande, Technical University of Denmark
- Filippo Fazi, University of Southampton
- Suichi Sakamoto, Tohoku University, Japan

<https://www.novem.ac.nz/>

Currently, passport holders of visa-waiver countries do not have to apply for a visa before they travel to NZ but must hold an NZeTA (New Zealand Electronic Travel Authority). Details on visa-waiver countries and NZeTA's can be found [here](#). For other information on how to enter Aotearoa New Zealand, you can visit [Immigration NZ](#) and the [Covid-19 website](#).




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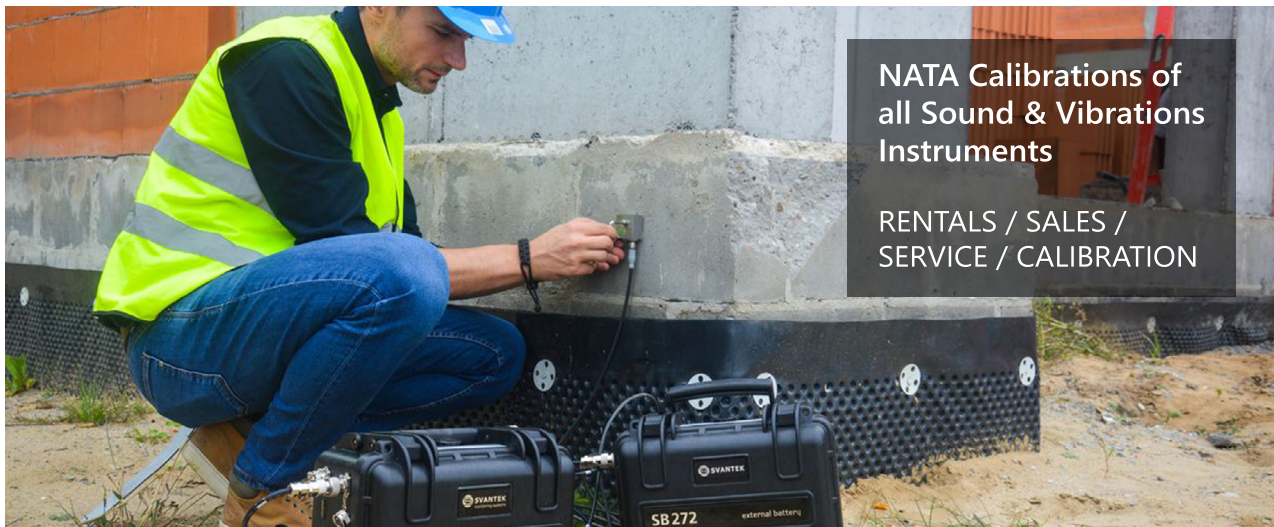
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2022

20 - 23 June, Southampton, UK

International Conference on Underwater Acoustics (ICUA 2022)
icua2022.org/

27 - 30 June 2022, Paris, France

Quiet Drones 2022
<https://www.quietdrones.org/go.php?id=129>

24 - 28 July, Singapore, Singapore

28th International Congress on Sound and Vibration (ICSV28)
www.iav.org/

21 - 24 August, Glasgow, UK

51st International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2022)
internoise2022.org/

12 - 14 September, Leuven, Belgium

ISMA/USD conferences
<http://www.isma-isaac.be>

2022 continued

24 - 28 October, Gyeongju, Korea

24th International Congress on Acoustics (ICA 2022)
<http://ica2022korea.org/>

31 October - 2 November, Wellington, New Zealand

Acoustics 2022
<https://www.acoustics2022.com/>

2023

10 - 12 January, Auckland, New Zealand

NOVEM 2023 Noise and Vibration Emerging Methods
<https://www.novem.ac.nz/>

20 - 23 August, Chiba, Japan

52nd International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2023)
<https://i-ince.org/>

4 - 8 December, Sydney, Australia

Acoustics 2023, Sydney
Joint meeting AAS, ASA, Wespac and PRUAC

ACOUSTICS 23

Sydney



Acoustics 23 Sydney 4-8 December 2023

This conference will be held at the International Convention Centre in Sydney. It will be a joint conference for the Australian Acoustical Society and The Acoustical Society of America, Wespac and the Pacific Rim Underwater Acoustics Group. Planning is in process for this unique event so make sure you register your interest via the website to receive all the updated information.

<https://acoustics23sydney.org/>