Technical Note

Note: Technical notes are aimed at promoting discussion. The views expressed are not necessarily those of the editors or the Australian Acoustical Society. Contributions are not formally peer-reviewed.

IRIS – THE SOUND OF SCIENCE

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Recently developed equipment provides unprecedented access to 3D room acoustic analysis.

Source loudspeaker

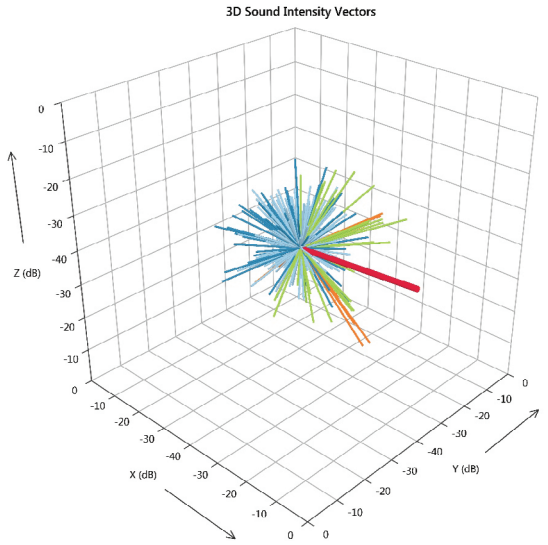
HISTORICAL BACKGROUND

Although many great concert halls were built prior to 1900, by the middle of the 20th century the science behind auditorium design had not progressed much beyond the estimation of reverberation time. However, the craft of understanding and analysing the acoustics of performance spaces has greatly developed in more recent times.

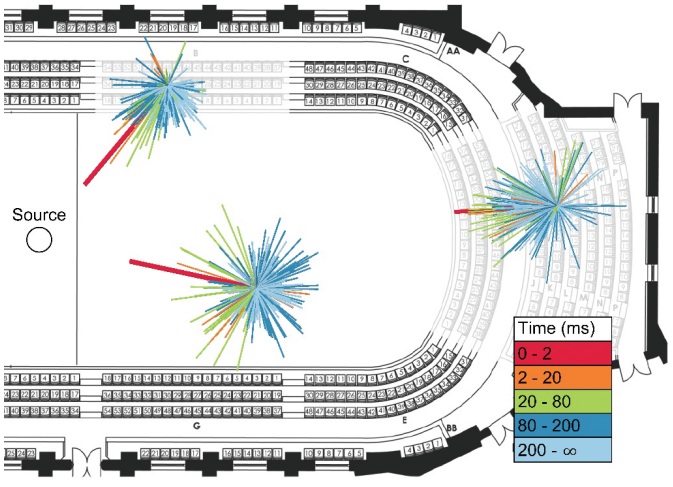
The sound in any concert hall comprises the direct sound generated by the performers, and reflections of this sound as it travels throughout the interior of the auditorium. It is now widely accepted that it is not just the timing and strength of these reflections, but also the direction of their arrival that influence the extent that a listener feels immersed in the sound of a performance.

In 1952, Rolf Thiele, a researcher in Germany, realised that reverberation time did not explain all the qualities of how a room sounds. He proposed a technique for measuring and visualising the directional distribution of reflections as "hedgehog patterns". The length and angle of each line corresponds to the strength and direction of each reflection compared to the direct sound.

In the late 1960s, while reviewing various designs for the Christchurch Town Hall, Harold Marshall investigated the effect of room shape on acoustical quality. He discovered that early lateral reflections, associated with narrow rectangular halls, were important in providing a sense of space. This effect was further investigated and quantified by Marshall in collaboration with Michael Barron in 1981. This work developed the concept of "spatial impression" in acoustics. This is now recognised as an important characteristic of good sounding concert halls, and is now considered to be a key factor in auditorium design and analysis.



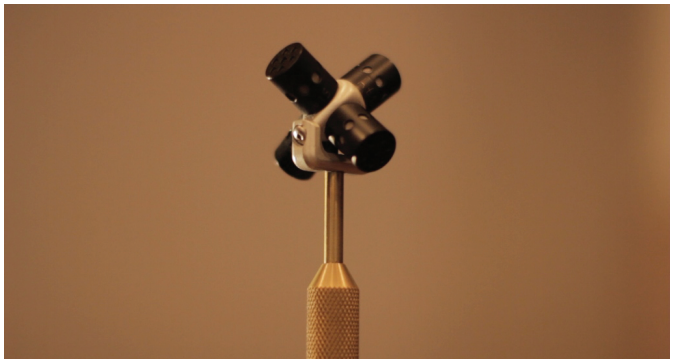
The IRIS Plot



Auckland Town Hall with IRIS measurement plots

ADVANCED MEASUREMENT

The acoustical characteristics of a room are traditionally determined using single channel impulse response measurements. These yield information about sound reflections in terms of time and strength, but not direction. Researchers have developed 3D impulse response measurement systems in the past, but these use custom, expensive or impractical equipment.



Tetrahedral microphone array

The IRIS measurement system developed by Marshall Day Acoustics enables 3D impulse responses to be captured and analysed through a commercially available tetrahedral microphone array and a four channel USB audio interface. The signals are calibrated to the measured responses from each of the 4 microphones in the array, and then correlated to derive the strength and direction of each reflection.

The IRIS plot is at the heart of the system. Sound reflections arriving at the microphone array are represented as a series of coloured spikes. The length and direction of each spike correspond to the reflection strength and direction. Spikes are coloured according to the time interval that reflections arrive after the direct sound.

The plot can be used to relate sound reflections to physical features of the room, observe the directional distribution of early and late sound energy, or identify surfaces causing problematic reflections. The graphical nature of the IRIS plot enables easy comparison between the acoustic conditions at different locations in a room.

Numerical magnitude, time and direction information can be obtained for a comprehensive analysis of individual reflections. This can indicate which reflections may be heard as late echoes, which reflections can produce a perceived image shift, and which can blend with other reflections to enrich the aural experience.

A standard impulse response waveform is also provided, and this allows the calculation of room acoustic parameters according to ISO 3382.

IRIS is considered to be a breakthrough in real-world acoustics. It puts spatial analysis into the hands of acousticians around the world.

AAS CODE OF ETHICS

INCLUDED ON A REGULAR BASIS FOR THE ATTENTION OF ALL AAS MEMBERS

1. **Responsibility**
   The welfare, health and safety of the community shall at all times take precedence over sectional, professional and private interests.
2. **Advance the Objects of the Society**
   Members shall act in such a way as to promote the objects of the Society.
3. **Work within Areas of Competence**
   Members shall perform work only in their areas of competence.
4. **Application of Knowledge**
   Members shall apply their skill and knowledge in the interest of their employer or client, for whom they shall act in professional matters as faithful agents or trustees.
5. **Reputation**
   Members shall develop their professional reputation on merit and shall act at all times in a fair and honest manner.
6. **Professional Development**
   Members shall continue their professional development throughout their careers and shall assist and encourage others to do so.

EXPLANATORY NOTES

1. RESPONSIBILITY

In fulfilment of this requirement members of the Society shall:

- avoid assignments that may create conflict between the interests of their clients, employers, or employees and the public interest.
- conform to acceptable professional standard and procedures, and not act in any manner that may knowingly jeopardise the public welfare, health, or safety.
- endeavour to promote the well-being of the community, and, if over-ruled in their judgement on this, inform their clients or employers of the possible consequences.
- contribute to public discussion on matters within their competence when by so doing the well-being of the community can be advanced.

2. ADVANCE THE OBJECTS OF THE SOCIETY

Appropriate objects of the Society as listed in the Memorandum of Association are:

Object (a)

To promote and advance acoustics in all its branches and to facilitate the exchange of information and ideas in relation thereto.

Object (e)

To encourage the study of acoustics, highlight excellence in acoustics and to improve and elevate the general and technical knowledge in any manner considered appropriate by the Society.

Object (g)

To encourage research and the publication of new developments relating to acoustics.

3. WORK WITHIN AREAS OF COMPETENCE

In all circumstances members shall:

- inform their employers or clients if any assignment requires qualifications and/or experience outside their fields of competence, and where possible make appropriate recommendations in regard to the need for further advice.
- report, make statements, give evidence or advice in an objective and truthful manner and only on the basis of adequate knowledge.
- reveal the existence of any interest, pecuniary or otherwise, that could be taken to affect their judgement in technical matters.

4. APPLICATION OF KNOWLEDGE

Members shall at all times act equitably and fairly in dealing with others. Specifically they shall:

- Strive to avoid all known or potential conflicts of interest, and keep employers or clients fully informed on all matters, financial or technical, that could lead to such conflicts.
- refuse compensation, financial or otherwise, from more than one party for services on the same project, unless the circumstances are fully disclosed and agreed to by all interested parties.
- neither solicit nor accept financial or other valuable considerations from material or equipment suppliers in return for specification or recommendation of their products, or from contractors or other parties dealing with their employer or client.

5. REPUTATION

No member shall act improperly to gain a benefit and, accordingly, shall not:

- pay nor offer inducements, either directly or indirectly, to secure employment or engagement.
- falsify or misrepresent their qualifications, or experience, or prior responsibilities nor maliciously or carelessly do anything to injure the reputation, prospects, or business of others.
- use the advantages of privileged positions to compete unfairly.
- fail to give proper credit for work of others to whom credit is due nor to acknowledge the contribution of others.

6. PROFESSIONAL DEVELOPMENT

Members shall:

- strive to extend their knowledge and skills in order to achieve continuous improvement in the science and practice of acoustics.
- actively assist and encourage those under their direction or with whom they are associated to advance their knowledge and skills.