A SCREENWOOD INDUSTRY GUIDE

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The Interior Designer's Guide to Reverberation Control

Designing an interior space that optimises comfort and functionality requires a nuanced understanding of acoustic principles, particularly reverberation. This comprehensive guide is a compass for interior designers navigating the complex realm of reverberation control to shape spatial experiences and enhance well-being.

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Harmonising Spaces:

The Art of Controlling Reverberation for Enhanced Comfort and Functionality

Controlling reverberation and ensuring speech intelligibility are the two most critical acoustic objectives when designing any interior space. Today, designers can transform spaces into havens of tranquility, productivity, and inspiration by strategically integrating high-performance acoustic solutions. Whether planning a library, law court, office, school, hospital, or restaurant – the artful manipulation of reverberation can profoundly impact people's experiences in a space.

This guide is designed to help you harness the transformative power of reverberation control, unlocking new dimensions of comfort, functionality, and well-being in the spaces you create.

When communication is essential and human interactions matter, low reverberation times make the space better for all occupants.

Understanding interior ‘acoustics’.

The concept of interior ‘acoustics’ in a space encompasses the sounds experienced by its occupants when they enter the space, move through it, or stay to work or relax in it. What sounds do they hear? How loud are they? Do the sounds have a particular quality that sets this space apart? Do they work to enhance the function of the space, or do they work against it?

There are several aspects to good acoustic design, including selecting background sounds and preventing unwanted intrusion of sound from outside. This guide focuses on another vital aspect of that process: controlling reverberation.

What is reverberation?

In understanding reverberation, it is important to distinguish between two types of sound: direct sound and reverberant sound. Direct sound travels directly from the source to the listener without any reflections, providing clarity and immediacy. Reverberation, on the other hand, occurs when sound bounces multiple times from the walls, floor, ceiling, or objects within a room. The more times it bounces, the longer it takes for the sound to reach the listener’s ears and the longer the sound appears to ‘ring’.

This phenomenon is quantified by the ‘reverberation time’ of the space, typically measured in seconds. For instance, a ‘dead’ space like a recording studio may have a reverberation time of around 0.2 seconds, while a ‘live’ space such as a cathedral can exceed two seconds.

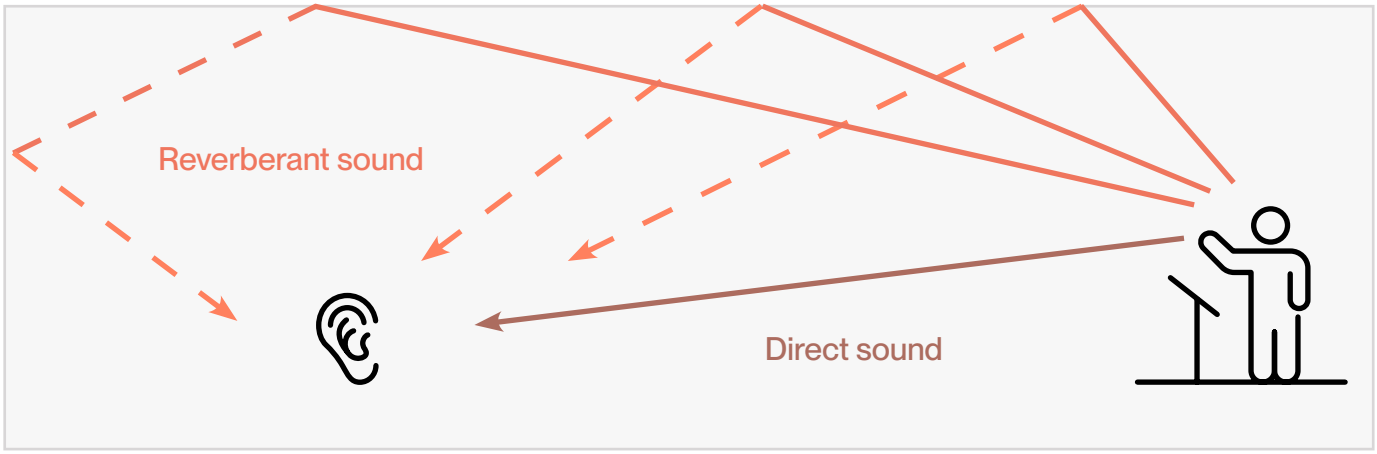


Figure 1: The difference between reverberant and direct sound.

How does reverberation affect people's experiences of a space?

When people step into a space with a reverberation time of 0.5 seconds or less, they will usually

- slow down
- speak more quietly
- relax
- engage in conversation more easily, and
- stay longer in the space.

On the other hand, a space like a sports bar or stadium with a second or more reverberation time can feel lively and exciting. A quiet, high-reverberation space like those in large, old public buildings can feel distant and austere.

Are there Australian reverberation control standards?

The Australian/New Zealand Standard™ AS/NZS 2107:2016 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors provides design criteria to ensure a healthy, comfortable, and productive environment for occupants and users. Interior designers can obtain a copy of this Standard by clicking this link.

Figure 2 illustrates recommended reverberation times for various spaces. These recommendations offer flexibility to accommodate different design intentions. For instance, in a café where the desired ambiance is vibrant and connected with the street, a reverberation time close to a second may be suitable. Conversely, if the design goal is to create a tranquil haven for relaxation, a reverberation time of 0.4 seconds or less is preferable.

Collaborating with an acoustical consultant ensures that your space's reverberation times align with industry standards and best practices. If you need help finding a local consultant, the Association of Australian Acoustical Consultants enables you to search member firms by state on its website.

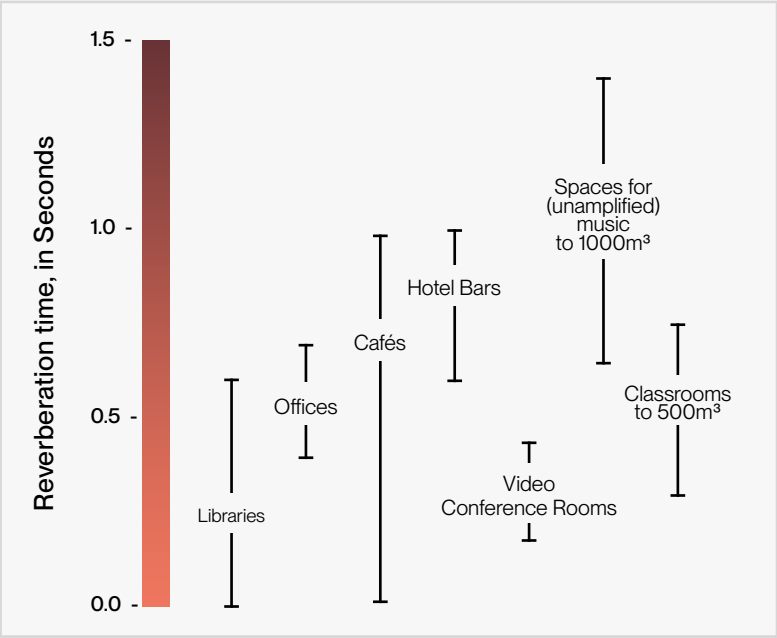


Figure 2: Recommended reverberation times for a selection of interior spaces, from Australian Standard 2170.

The artful manipulation of reverberation can profoundly impact people's experiences in a space.

Exploring additional reverberation control standards:

WELL Building Standard® in Australia

In 2021, in the wake of the global pandemic, the International WELL Building Institute (IWBI) announced a significant increase in the adoption of WELL programs across the Asia-Pacific region, reaching nearly 80 million square meters.[1]

Australia stands out as a leader in this trend, with approximately 25 per cent of all commercial spaces engaged in a WELL pathway.[1] This surge reflects organisations' growing commitment to prioritise people's health, wellness, and safety in building development and refurbishment projects.

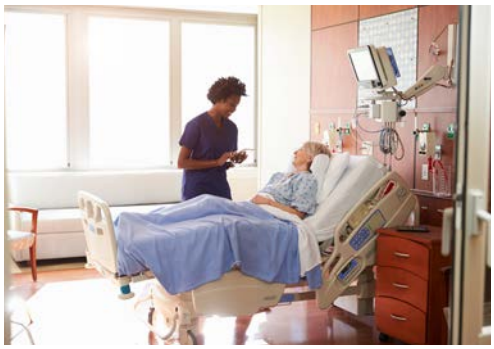
As well as complying with the relevant Australian Standard®, companies engaging in a WELL pathway need to address the acoustic comfort considerations outlined within the WELL v2™ Standard framework. Requirements are in place to control reverberation time, ensuring optimal conditions for occupants. Click here to learn more about the WELL v2™ Standard and here to review the WELL v2™ Sound Feature S04.

More reverberation control standards to explore

LEED® (Leadership in Energy and Environmental Design), the world's most widely used green building rating system, requires consideration of reverberation time control as part of its Indoor Environmental Quality (IEQ) criteria.

Similarly, BREEAM® (Building Research Establishment Environmental Assessment Methodology) also addresses reverberation time and acoustic treatments in its Hea 05 – Acoustic Performance section.

These standards emphasise the importance of creating indoor environments that support occupant comfort, health, and well-being, including addressing acoustic conditions.



So, how can interior designers control the amount of reverberation in a space?

The reverberation time in any space depends fundamentally on two things:

- the volume of the space (the higher the volume, the higher the reverberation), and
- the **total acoustic absorption** from all the surfaces in the space (walls, floor, ceiling, and objects in the space).

When sound hits a surface, three things happen to it (see Figure 3):

- some of the sound will be reflected back into the space
- some will pass straight through to the other side, and
- some will be absorbed by the material on the surface.

Therefore, sound absorption becomes a critical factor in controlling reverberation, and interior acoustic products play a pivotal role in this process. The Noise Reduction Coefficient (NRC) is a metric used to quantify the sound absorption capabilities of materials, indicating the percentage of sound energy absorbed rather than reflected.

Designers can effectively reduce reverberation and improve acoustic comfort by selecting materials with higher NRC values for the walls, floors, ceilings, and objects within a space. This strategic use of materials enhances speech intelligibility and clarity and creates a more pleasant and functional environment for occupants.

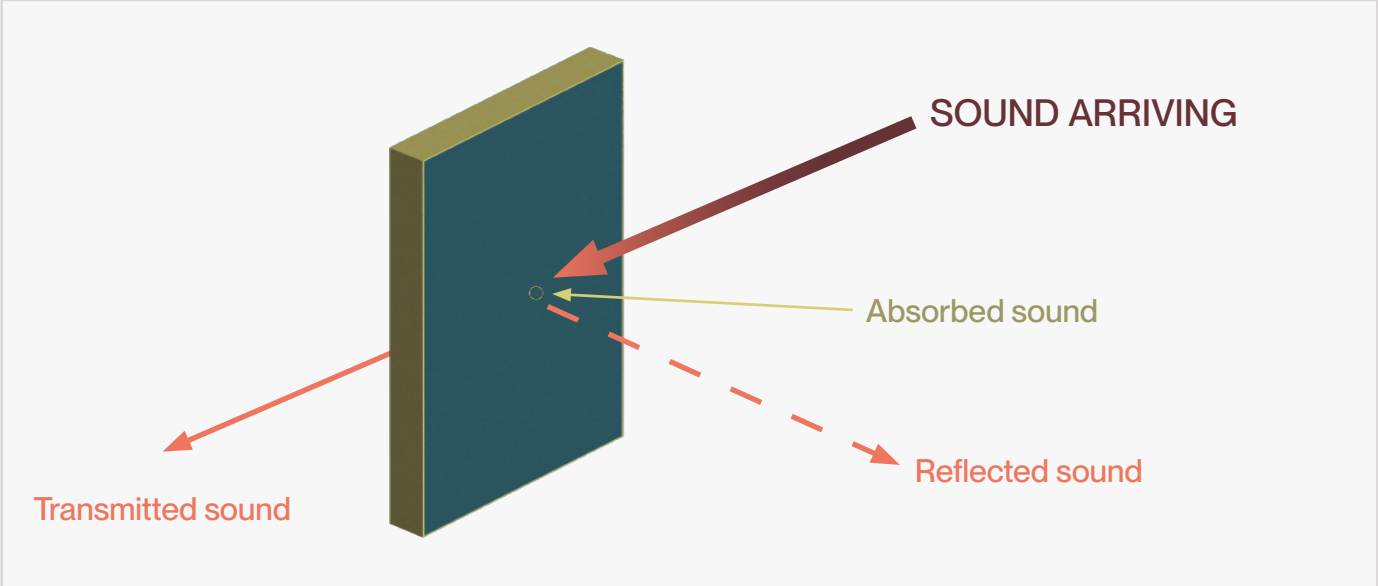


Figure 3: What happens when sound hits an interior surface.

Designers can effectively reduce reverberation and improve acoustic comfort by selecting materials with higher NRC values for the walls, floors, ceilings, and objects within a space.

Understanding Noise Reduction Coefficient (NRC)

The NRC represents the proportion of sound absorbed by a material for speech and similar sounds. And that is what is important in most spaces. Interior acoustic products have varying values of NRC. For instance, high-quality absorbing materials may have an NRC of 0.90, while average-quality materials might have an NRC of 0.45. See Figure 4 for the NRC values for a selection of materials available to designers today.

How to calculate the quantity of absorption material needed for a space

The **absorption area** of a material is its absorption coefficient **multiplied by its area in square metres**. The total acoustic absorption in a space, which determines the reverberation time, is just the total of the absorption areas of all the materials in the space. Therefore, reducing the reverberation time means introducing materials with high absorption and large surface areas.

For example, if you have a 6m x 10m x 2.8m room with a reverberation time of one second for speech sounds, then to reduce that reverberation time to 0.5 seconds, you can introduce:

- 30 m² of high-quality absorbing material with NRC 0.90, or
- 60 m² of average-quality absorbing material with NRC 0.45.

Figure 4: The NRC values of various interior acoustic products.

What kinds of materials have high acoustic absorption values?

As you can see from Figure 4, the best-performing sound absorbers are light, fluffy materials such as fibreglass blankets. However, because these materials may not stand up to wear and tear nor consider aesthetics, they are usually covered in fabric or a rigid material such as wood or metal with perforations that allow the sound to reach the absorber. Surprisingly, the perforations only need to be about 20 per cent of the surface area of the covering material to allow the underlying absorber to do its job.

Solutions such as prefinished PANELS systems can achieve NRC ratings of between 0.7 and 1.0 depending on the choice of absorbing material incorporated. Because products such as these are aesthetically resolved, they do not require the expense of additional coverings.

New interior acoustic products such as Screenwood Australia's SOUNDLINA™ perforated acoustic wall coverings are breaking new ground, achieving up to 0.85 NRC when installed as recommended. They offer the chance to incorporate high acoustic absorption into a surface that functions as a normal building element, such as a wall.

Such cost-effective products offer immense value due to their ability to combine acoustic performance with aesthetics and application versatility.

Thick fabrics like plush carpets, hangings, and curtains are slightly lower on the absorption scale. Thin carpets, cork tiles, and specially designed 'acoustic' plasterboard are lower again.

Remember, it is not just the absorption coefficient, or NRC, of the material that is important – it is also the number of square metres that you can design into your space.

New interior products such as SOUNDLINA™ perforated wall coverings combine high acoustic performance with a choice of natural aesthetics. Image courtesy of Screenwood Australia.

Does it matter where I place acoustic materials in my space?

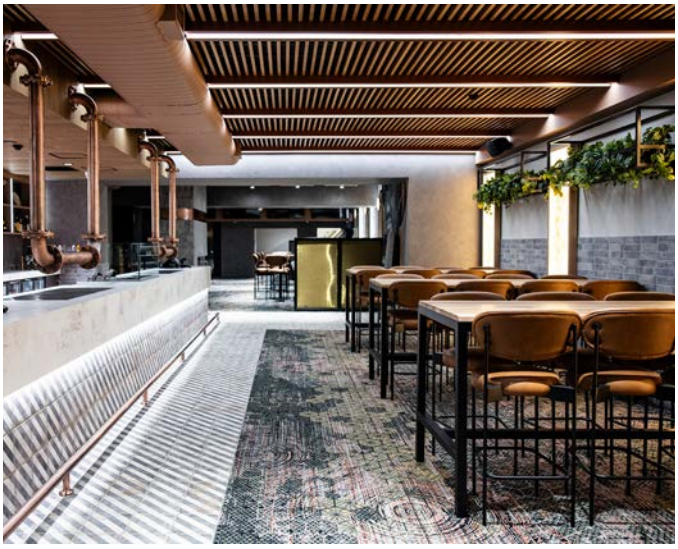
In acoustically critical spaces – yes. These include music performance venues, recording spaces, spaces where accurate speech perception is vital (e.g. courtrooms), and quiet spaces such as libraries and galleries. In these cases, you should seek advice from an acoustical consultant to avoid subtle effects related to the way absorbing materials are placed. They will help you define the measures needed to achieve desired results for your space's purpose that align with recommended standards.

However, in most everyday spaces, such as residences, restaurants, offices, lecture theatres or shopping centres, it is just the total amount of acoustic absorption in the space that is essential. It can be on the walls, on the floor, on the ceiling, in material hung from the ceiling, or anywhere else that sound can 'see' it. The more absorption in the space, the lower the reverberation time.

The ACT Law Courts' use of high-performance acoustic PANELS provides a calming and welcoming ambiance while controlling reverberation in courtrooms where speech intelligibility is paramount. Images courtesy of Screenwood Australia.

Is it possible to influence reverberation in specific interior zones?

The functionality of some interiors – such as open-plan offices and hospitality venues – benefit from reverberation control zoning.



Kiama Leagues Club's Cedar Cutters Bar uses PANELS for reverberation control zoning to enhance patrons' live TV experiences. Photo courtesy of Screenwood Australia.

Kiama Leagues Club's Cedar Cutters Sports Bar in New South Wales is one example where controlling reverberation in zones enhances the ambience. As a sports bar, the design brief required reverberation control to ensure live TV action was audible in a potentially noisy environment. Carley Austin, Director of EMVY Design, who led the interior design project, noted, "While the Sports Bar encourages vibrancy in volume, we needed acoustic materials that could absorb sound, create warmth, and complement our industrial materials. The bar's main areas have floor-to-ceiling screen zones to view sporting events. It was essential to contain the noise within these zones and control direct sound and reverberation throughout."

Similarly, VCAT Human Rights Division uses acoustic panels for collaborative work breakout areas, controlling reverberations and improving speech intelligibility for increased productivity.

The interior design of VCAT's collaboration spaces incorporates PANELS to influence acoustics. Photo courtesy of Screenwood Australia.

The Proven Benefits of Reverberation Control

Education study

One study in Germany[2] recorded a teacher's heart rate in different acoustic conditions. Of course, when a class is noisy, teaching is always more difficult. In a classroom with a reverberation time of 0.4 seconds, the teacher's heart rate increased by four beats per minute for every 10-decibel increase in noise. However, in a classroom with a reverberation time of 0.7 seconds, it increased by ten beats per minute for every 10 decibel increase. In this environment, noise is stressful, but noise **and** reverberation are **really** stressful.

When communication is essential and human interactions matter, low reverberation times make the space better for all occupants.

CASE STUDY

The Proven Benefits of Reverberation Control

Healthcare study

A study in Sweden[3] looked at patient outcomes in an intensive care ward before and after the installation of material that reduced the reverberation time from 0.9 seconds to 0.4 seconds. In subsequent interviews, patients in the two groups had significantly different answers to just one question – how much they believed the staff **cared for them**. Lower reverberation times mean human interactions are easier, communication is facilitated, and the environment is more peaceful, caring and, in this case, more healing. (For patients in the low-reverberation environment, the readmission rate to the hospital after three months was **halved**.)

When cultivating an environment designed to evoke excitement or awe, high reverberation can enhance the intended experience. However, when communication is essential and human interactions matter, low reverberation times make the space better for all occupants.

The Proven Benefits of Reverberation Control

A Best Practice Checklist for Selecting Architectural Reverberation Control Products

The following product consideration checklist encompasses acoustic prerequisites, versatility, aesthetic appeal, cost-effectiveness and ease of installation, certifications, product longevity, obtaining samples, and local manufacturing. Using this checklist will help you to make an informed product choice that balances functionality and design excellence.

1 Understand your precise acoustic prerequisites.

Once you have defined your architectural vision, collaborating with an acoustical consultant becomes pivotal in deciphering the precise acoustic prerequisites and NRC (Noise Reduction Coefficient) specifications tailored to the space's intended functionality. Working together facilitates the exploration of diverse options to achieve optimal acoustics and reverberation control through strategic surface area treatments.

2 Look for a versatile product that doesn't compromise your design vision.

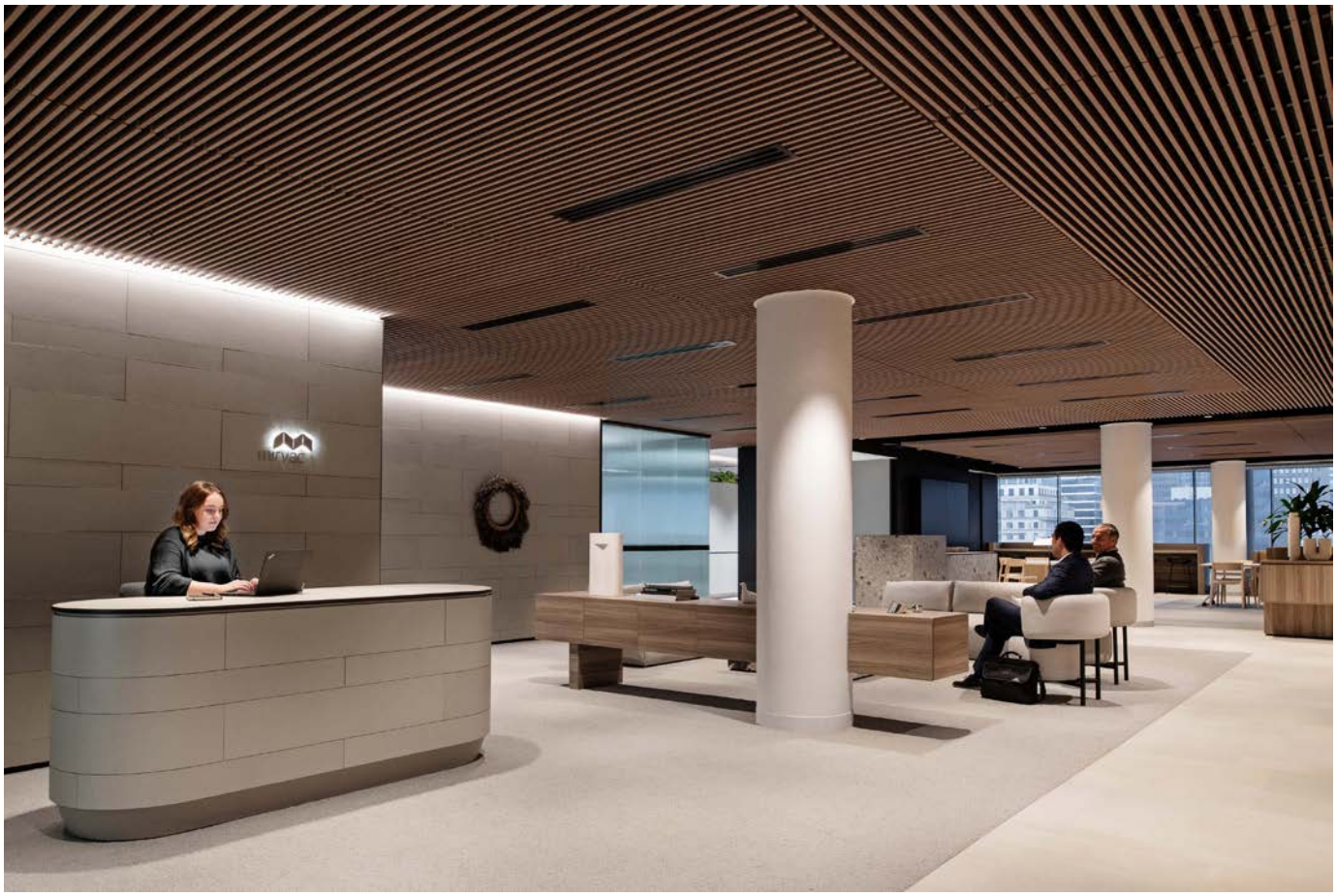
Today, reverberation control product advancements empower you to push the boundaries in interior architecture without compromise. If you are embracing sculptural, biophilic, biomimetic, or environmental design trends, consider products that can be easily and cost-effectively applied to walls, ceilings, corners and curved surfaces.

Ippudo restaurant's name, meaning 'gust of wind,' is represented in its undulating ceiling, sculpted using versatile reverberation control PANELS. Photo courtesy of Screenwood Australia.

3 Choose a product that fuses aesthetics with high reverberation control performance.

Consider the aesthetic ambience you would like to achieve. For instance, incorporating timber infuses a space with natural warmth and fosters a connection to nature, a central tenet of biophilic design.

Look for high NRC reverberation control solutions that offer superior aesthetics and durable finishes, ideally with an extensive array of colours you can match across finishes and material selections. Products prefinished in NAVURBAN™, for example, empower seamless colour matching with decorative, acoustic and flat joinery in the same finish.



The Mirvac head office in Melbourne showcases reverberation control PANELS, finished in NAVURBAN™, enabling seamless colour matching across the project. Photo courtesy of Screenwood Australia.

4 Consider cost-effectiveness and ease of installation.

Prioritise prefinished material options that offer simplicity, affordability, and easy installation, eliminating the need for costly proprietary finishes or specialised equipment.

Opting for prefinished products accelerates project timelines and removes the need for off-site fabrication. Furthermore, they provide reassurance through precise colour matching, minimising the risk of unforeseen finishing expenses.

SOUNDLINA™ acoustic wall coverings eliminate the need for expensive joiners, making installation easy without compromising performance and aesthetics. Photo courtesy of Screenwood Australia.

5 Understand the product's certifications and capability to achieve your sustainability vision.

Gain an understanding of the product's certifications and capability to align with your sustainability objectives, alongside meeting necessary acoustic performance standards.

- Transparent supply chain: Select a product from a company with stringent and transparent supply chain protocols. If selecting wood-based products, ensure they hold PEFC™ wood certifications.
- Best practice sustainability: Choose products certified by Global GreenTag™, as this comprehensive certification aligns with major green building rating tools such as LEED®, International WELL™, Building Standard, Green Star®, and BREEAM®.
- Fire rating: For interiors requiring high fire ratings, select a high-performance acoustic product with a certified Group 1 fire rating that also maintains aesthetic appeal.
- Low VOC: Verify that the product meets ASTM D5116-2017 small chamber test standards for low VOC emissions.

Right: PEFC™ certified PANELS helped ensure Hydro Tasmania upheld its advanced sustainable and carbon-reducing practices, achieving 5-Star Green Star accreditation. Photo courtesy of Screenwood Australia.

6 Consider longevity and ongoing maintenance.

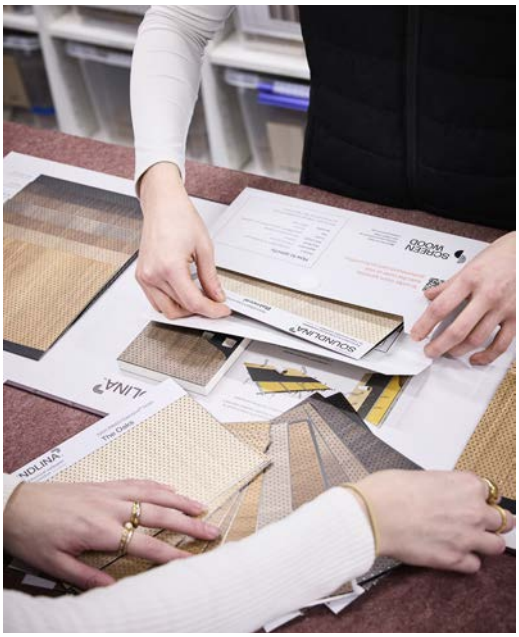
Select an interior reverberation control product prefinished with a tough, durable surface that eliminates the need for annual staining or oiling.

Choose surfaces known for their exceptional durability, like NAVURBAN™ prefinishes, which uphold the occupant experience and reduce maintenance expenses even in the most demanding interior environments.

Demanding environments like The Pullman Hotel at the Western Sydney Conference Centre use reverberation control PANELS, prefinished in UV stable, scratch, abrasion, stain, and water-resistant NAVURBAN™. Photo courtesy of Screenwood Australia.

7 Obtain high-quality samples, request demos, and visit completed projects.

Physical prefinished samples allow you to assess the quality and colour firsthand. At this stage, contacting the manufacturer and organising site visits to view interiors that have used the product under consideration is highly beneficial. The manufacturer can usually provide a list of public spaces or facilitate viewings of private installations upon request.



Ordering samples lets you visually assess the product's quality, texture, colour, and compatibility. Photo courtesy of Screenwood Australia.

8 Choose a collaborative, local manufacturer.

When selecting a manufacturer, prioritise collaboration, locality, and on-the-ground support. Ensure they have robust product warranties and explore online reviews or case studies for insight into their reputation.

Access to a knowledgeable local team ensures expert guidance on a product's technical capabilities (such as curve radiuses), accessories such as end panels, and installation techniques. Ensuring complete transparency regarding certifications, particularly acoustic testing results, Global GreenTag™ certifications, low VOC, and fire ratings, is also imperative.

Australian-made and owned architectural product manufacturers may offer many advantages, including better technical support. Photo courtesy of Screenwood Australia.

AUSTRALIAN MADE

Contributors

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Founder and Director, Screenwood Australia

Screenwood empowers visionary interior architecture by championing the principles of strength, utility, and beauty in architectural and acoustic decorative lining innovations. As designers and manufacturers, the company strives to create a positive impact through technical expertise, master craftsmanship, and genuine care for people and the planet.

Since its foundation, Screenwood has collaborated with some of the world's leading interior architects, designers, and builders, shaping rich and sustainable spatial experiences that enhance comfort, well-being, and a connection to our natural world.

Screenwood is proud to earn customer trust through consistency, delivering meticulously engineered products and systems that set the benchmark in performance, cost-effectiveness and ease of installation.

Today, millions of people experience Screenwood's systems, whether enjoying a library's tranquillity, a stadium's energy, or receiving medical care. Screenwood is proud that its architectural products have also been selected for prominent corporate headquarters, five-star hotels, and countless beautiful residences.

For more information, visit screenwood.com.au.

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Rob Bullen Consulting Acoustic and Vibration Services

Rob Bullen has over 35 years of experience assessing and controlling environmental noise and vibration. This includes internationally-recognised research into noise impact assessment and provision of advice to regulatory bodies, including the NSW Environment Protection Authority, on noise policy and guidelines.

Rob has been responsible for the calculation and assessment of noise and vibration impacts in numerous large and controversial projects, including Western Sydney Airport, Brisbane Airport's new parallel runway, M5 Freeway extension, mines and quarries including Mount Pleasant and Mount Arthur North, and rail projects including the Epping to Chatswood Rail Link and the WestRail project in Hong Kong.

For more information, visit robbullenconsulting.com.

SCREENWOOD FOR ALL

Our products are for everyone, and so is our workplace.

We believe in constantly building a diverse and inclusive culture for a more equitable world.

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[2]G. Tiesler, R. Machner and H. Brockmann, “Classroom acoustics and impact on health and social behaviour,” Energy Procedia, vol. 78, pp. 3108-3113, 2018.

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