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Acoustics: Absorb, Block, and Cover

A balanced acoustic design employs soundmasking technology and the right interior products



“Even though a normal conversation is only half as loud as a ringing telephone or [one-quarter] as loud as a copy machine, the ‘information content’ of normal conversation makes it much more distracting than the much louder equipment noise in an open-plan office. That information content also carries a long, long way: Even with a sound-absorbent ceiling and carpet, a conversation held in an open space can still be easily understood at least 32 feet away.”

SOURCE: *IT'S A MATTER OF BALANCE: NEW UNDERSTANDINGS OF OPEN PLAN ACOUSTICS*, HERMAN MILLER INC., 2002

## KEY CONCEPTS

- To create a balanced acoustic design, sound must be absorbed, blocked, *and* covered.
- Sound-absorbing materials can help eliminate the problems of reverberation and echoes.
- Block sound from spreading to adjacent areas by selecting walls, carpet, and furniture panels with high STC ratings.
- Soundmasking can effectively increase speech privacy by introducing a nondescript sound into the space and elevating background noise levels.

## The Results of Poor Acoustics:

- Stress.
- Lost productivity.
- Reduced learning.
- Low morale.
- Increased errors.
- Absenteeism.
- Illness.
- Minimal confidentiality.

### Additional Acoustic Factors

According to Kenric Van Wyk, president, Acoustics By Design Inc., Grand Rapids, MI, there are many factors that can impact the acoustic environment of an office building. Here is a sampling of some of the most significant:

- Furniture layout.
- Furniture performance.
- Ceiling systems (are trade-offs being made for a “look” rather than acoustical performance?).
- Mechanical systems.
- Isolation (how much external, unwanted noise gets into the office?).
- Need for privacy.
- Employee satisfaction, well-being, and comfort.
- Type of business activities (e.g. call-center or customer-service environment, team/group work vs. independent work, medical-center setting, etc.).
- Applicable local or federal standards for privacy or work comfort/safety.

“A qualified, independent, acoustical consultant can help to set design criteria and aid in the selection of materials that will meet such criteria,” Van Wyk explains.

How do you know if a space has poor acoustics? Employees easily overhear conversations and take comments out of context. Rumors spread. Bosses unintentionally leak confidential business agreements. Doctors in an adjacent room are overheard discussing another patient’s treatment. Students’ scores dip. Patrons shout across the table during dinner. While acoustics are invisible, it’s easy to see which spaces lack the sound control needed for privacy, productivity, learning, and enjoyment.

A balanced acoustic design **a**bsorbs, **b**locks, and **c**overs (the ABCs of acoustics) sound. This can be achieved by employing soundmasking technology and installing interior products with acoustic properties. An acoustician can also provide professional advice on layout and design to help optimize acoustics.

To fully appreciate how important the ABCs are, consider how sound travels. The Arlington, VA-based Alliance for Flexible Polyurethane Foam, in its *Sound Absorption in the Workplace* report, explains: “Much like the expanding ripples that result from tossing a pebble into a pond, sound begins from a point of disturbance. From that point, a series of pressure waves expand out in all directions. When these pressure fluctuations reach our ears, they are processed by the brain and interpreted as sound.”

An acoustically positive environment reduces speech intelligibility (which results in increased speech privacy) and lowers the level of noise distraction. This is accomplished by masking noise or altering and halting the path that sound travels. When sound strikes a surface, a number of reactions occur. The Melville, NY-based Acoustical Society of America (ASA), in the publication *Classroom Acoustics: A Resource for Creating Learning Environments with Desired Listening Conditions*, explains sound/surface interactions in the following four ways:

- **Transmission.** The sound passes through the surface into the space beyond it (like light passing through a window).
- **Absorption.** The surface absorbs the sound (like a sponge absorbs water).
- **Reflection.** The sound strikes the surface and changes direction (like a ball bouncing off a wall).

- **Diffusion.** The sound strikes the surface and is scattered in many directions (like pins being hit by a bowling ball).

The ASA reports that multiple reactions can occur simultaneously. “For instance, a sound wave can, at the same time, be both reflected by and partially absorbed by a wall.”

### **Absorb Sound**

“The most direct way to address the control of unwanted noise within a space is to properly treat its shell (floor, ceiling, and walls),” says Mary Ellen Magee, marketing manager, Teknion LLC, Mount Hazel, NJ. A room filled with hard finishes can be an acoustic nightmare - echoes and reverberation distort sound and can make communication difficult. To eliminate these problems, purchase products and systems with sound-absorbing characteristics. “Like a thick paper towel soaking up water, these porous/fibrous sound-absorbing materials soak up sound waves by trapping them in an internal maze of air pockets. As sound waves work their way through that maze, they slowly lose the sound energy they carry as it dissipates into microscopic heat. When they emerge from that maze, sound waves are weaker and, therefore, less loud,” explains Herman Miller Inc. in its 2002 *It’s a Matter of Balance: New Understandings of Open Plan Acoustics* white paper.

Schools, offices, and healthcare facilities are just a few of the environments using acoustic ceiling systems to improve acoustics. While ceilings absorb sound, they can control sound in other ways as well. “Ceilings can also be used to deflect or distribute sound more evenly throughout a space,” says Kim Graaskamp, director of sales and marketing, Hunter Douglas Contract Ceilings, Thornton, CO.

When comparing products and systems, look for the Noise Reduction Coefficient (NRC), an industry rating that calculates a material’s ability to absorb sound. The rating is expressed as a number ranging from 0 to 1; the higher the number, the greater the material’s ability to absorb sound. According to Graaskamp, “A ceiling is generally judged [as] acoustical (as opposed to reflective) if the NRC is better than 0.50. Obviously, the higher the NRC value, the more absorptive the ceiling. Certain materials are more noise absorbent - for instance, fiber glass has a high NRC.”

Especially in classrooms plagued by long reverberation time, acoustical ceilings are a must. The ASA recommends ceilings with an NRC of 0.75 or higher. In the research paper *Making a Cubicle a Better Place to Work*, author Guy Newsham, head of the Lighting Research Group at the National Research Council Canada’s Institute for Research in Construction, recommends that offices install ceiling tiles with an NRC of 0.90 or higher to reduce the level of reflected sounds from speech.

Articulation Class (AC) is another measure of a ceiling’s acoustical performance. In the recently updated *Sound Solutions: Increasing Office Productivity Through Integrated Acoustic Planning and Noise Reduction Strategies* report, the American Society of Interior Designers (ASID) explains: “The AC rating of the ceiling is a measure of its performance in limiting the sound reflection off the ceiling plane over an angle of approximately 46 to 60 degrees, which represents most situations for adjacent cubicles separated by furniture panels.” In open-plan offices, invest in ceiling products within the range of 170 to 210 AC.

To reap the greatest acoustic benefits from these high-performance ceilings, Norcross, GA-based soundmasking provider Dynasound Inc. recommends adding closure/seal components to prevent sound leaks through return-air grills, lay-in light fixtures, sprinkler heads, and other utility penetrations.

Installation of carpet - especially when it includes a layer of cushion - is also beneficial. The Herman Miller report identifies numerous advantages, including the absorption of airborne sound and reduced footfall noise: “In addition, in many settings, carpet helps to create an aesthetic ambiance conducive to lowered voices, a heightened sense of privacy, and reduced distractions.” Like acoustic ceiling tiles, it’s important to review the NRC rating of the floorcovering under consideration. Lab results in ASID’s *Sound Solutions* reveal that polyurethane cushion-backed carpet has a higher NRC rating when compared to bare concrete and conventional jute-backed carpet. Additional tests conducted by the Dalton, GA-based Carpet and Rug Institute (CRI) show that cut-pile (vs. loop pile) carpet with a permeable carpet backing laid over cushion exhibits higher NRC ratings.

A carpet’s Impact Insulation Class (IIC) rating reflects the carpet’s insulation capabilities in floor-ceiling assemblies. Results from independent tests were consistent with NRC test results; polyurethane cushion-backed carpet has higher IIC ratings.

### **Block Sound**

Sound absorption is just one way to improve acoustics; blocking sound from spreading into adjacent areas or workstations is *equally* important. Both walls and carpet block sound transmission; however, in open-plan offices, the most widely used sound-blocking product is furniture panels. Herman Miller’s *It’s a Matter of Balance* report explains: “Whereas the best sound *absorption* relies on lightweight, porous materials, the best sound-*blocking* materials (solid masonite, metal, or hardboard) are dense and heavy. With no air spaces for sound waves to slip into and through, panels containing these tightly packed interiors essentially cut off the direct path into adjacent workstations.” These divider panels can be extremely effective at blocking and absorbing sound simultaneously. To be effective at both and provide non-intrusive levels of speech privacy, the panel should meet the following criteria (as recommended by ASID):

- Panel heights should be a minimum of 60 inches; 72 inches is preferred.
- The recommended NRC is 0.60.
- A Sound Transmission Class (STC) rating between 18 and 20 is ideal.

STC is another helpful industry rating, and can be used to distinguish which products are more equipped to block sound than others. “STC [is] a single-number rating of the acoustical-blocking capability of a single panel or system. It rates the amount of sound that is transmitted through a wall, panel, ceiling, etc. A higher STC means that the panel will ‘block’ more sound and result in better privacy,” explains Kenric Van Wyk, president, Acoustics By Design Inc., Grand Rapids, MI. Unfortunately, office accessories hung on furniture panels can reduce the acoustic properties of systems-furniture panels.

Remember, partition height and STC are *both* important: While a tall panel with a poor STC rating might increase *visual* privacy, it will do little to improve speech privacy and workspace acoustics. Panels should be high enough to block conversational noise from traveling over the top of partitions into adjacent spaces. “The lower the panel, the less acoustics it provides. This has more to do with the fact that noise travels in all directions. If the panel is low, the likelihood is that sound will just travel over it. The higher the panel, the more sound blocking that occurs,” says Mark Murdoch, senior product manager, Herman Miller Inc., Zeeland, MI. While panels taller than 60 inches are best, studies have found that sound-blocking benefits level off in panels that are 75 inches or higher.

To successfully block sound in open-plan workspaces, workstation design should limit line-of-sight layouts between workers and, when possible, ensure that occupants are not facing into the panel (find alternatives to locating computers in a workstation corner).

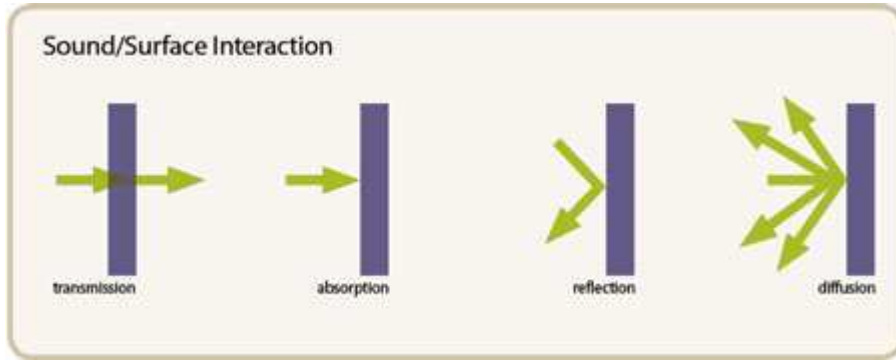


ILLUSTRATION: ACOUSTIC SOCIETY OF AMERICA

### Cover Sound

Environments with advantageous acoustics *control* noise rather than eliminate it altogether. “It is more important to have a mix of noise than it is to have it completely quiet. If there isn’t any noise, then every sound will be heard,” explains Murdoch. Once the interior shell is outfitted with sound-absorbing and sound-blocking products, the last step is covering sound with masking technology. “By slightly raising the overall building’s background sound level, the masking system will cover or dampen the level of typical speech conversation,” explains Fred Folsom, executive vice president, Dynasound Inc. The evenly distributed background sound emitted by a soundmasking system is often compared to the sound typically produced by HVAC equipment.

“Soundmasking is similar to turning on a water faucet when someone is speaking in another room. Before the faucet is turned on, a person can hear and respond to the words just fine. When the faucet is turned on, however, the ambient background sound level increases, reducing the ear’s sensitivity to the intrusive speech. If the water is turned up even more, one may remain aware that someone is talking, but won’t be able to understand what’s being said, no matter how hard one tries,” the Herman Miller report explains. The system consists of a set of electronic components and speakers, and can be installed above a suspended ceiling system, pendant-mounted in areas with open ceilings, or placed under access flooring.

While most widely used in open-plan workspaces, soundmasking is also successful at covering speech noise in private offices. “Soundmasking systems provide benefits in most indoor, non-industrial spaces, including commercial office, financial, government, medical, military, institutional, educational, hospitality, judicial, and some retail environments,” says Niklas Moeller, vice president, KR Moeller Associates Ltd., Burlington, Ontario.

Once the system has been purchased and installed, it is tuned to a specific frequency. ASID advises that tuning take place *after* the space is fitted out, but *before* occupation. “The best tuning capabilities will adjust the spectrum of the masking sound being emitted to the specific acoustical signature or physics of the individual room,” says Folsom.

While masking is extremely effective, experts warn that relying on it too heavily - or on any other single sound-control method - will result in poor acoustics. “Soundmasking is not a magic solution for all acoustical needs. It is necessary, but not sufficient on its own to provide for effective acoustical performance in a space,” says Moeller. “Good acoustical performance requires a balanced approach of absorption, physical barriers, *and* soundmasking.”

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