

Public Musings on Acoustical Privacy

In offices, it's not only what you hear but what you don't hear that matters.

By Michael Chusid



Continuing Education

Use the following learning objectives to focus your study while reading this month's ARCHITECTURAL RECORD / AIA Continuing Education article.

Learning Objective:
After reading this article, you will be able to:

1. Describe key performance criteria for wall, ceiling and floor assemblies.
2. Explain what roles ASTM and UL play in the specification process.
3. Describe why modified ASTM tests are used.

At my first job in an architecture firm, I was berated on more than one occasion for eavesdropping on the conversations of the firm's junior partners. Although my fellow interns and I did pay close attention to what they were saying (how else were we to learn the business?), it also happened to be exceptionally easy to overhear conversations in that office. Working in an open office, the junior partners were consigned to cubicles along the building's masonry and glass perimeter. These hard surfaces reflected their voices directly to the drafting tables occupied by the interns, located merely six feet away. In addition to inhibiting their ability to discuss sensitive work and personal issues, the fact that we could hear the conversations of the junior partners, while sometimes informative, was distracting and surely reduced our productivity.

This example underscores the importance of speech privacy as a crucial concern in the acoustics of office environments. A number of trends have coalesced to make speech privacy an even greater issue today than before. Foremost is the increased use of open office environments. It is estimated that 58 percent of office denizens now work in open offices. Furthermore, many businesses have reduced the space assigned to each employee to lower their overhead expenses. This results in more people and noise in any given room. It also means that people sit closer together, an important factor in acoustics because the intensity of a sound increases exponentially as the distance between the source and receiver is reduced. With many professionals, managers, and even top executives now working in open offices, it's much harder to ignore speech privacy than it was in the days when only the administrative underclass sat at open desks.

Fundamentals

A comprehensive program of acoustical design should conform to ASTM E1374 - Standard Guide for Open Office Acoustics and Applicable ASTM Standards. According to Charles C. Roy of CCR Associates LLC, a company that provides turnkey solutions for office acoustics, the fundamentals of speech privacy can be expressed as the “ABCs of absorb, block, and cover unwanted acoustical information.”

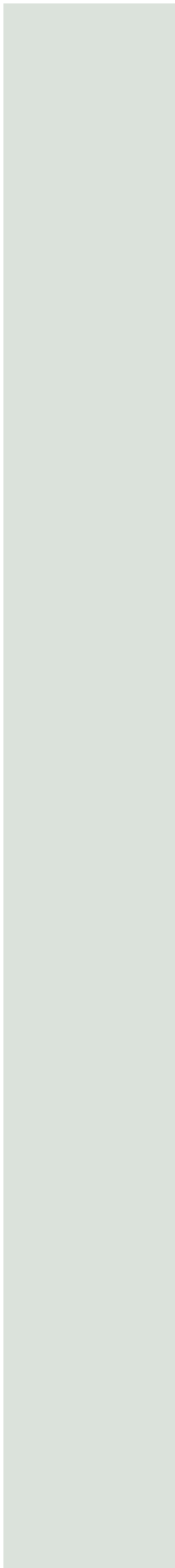
Absorb: The most useful measurement of noise absorption is the noise reduction coefficient (NRC), the arithmetic average of a material's sound absorption coefficients at 250, 500, 1000, and 2000 Hz, rounded to the closest 0.05. These mid-range frequencies are those most commonly associated with speech privacy. Ceiling systems are the primary means of absorbing unwanted sounds in open offices, and the desired NRC for a ceiling depends on a room's noise level and function. While ceiling systems with an NRC of .60 may be adequate for private or small open offices, ceilings with higher NRC are increasingly desirable in large open offices, for optimum noise attenuation and speech privacy.

Closely related to the absorption of the ceiling system is the type of lighting used. Ceiling-mounted fixtures with large flat lenses can bounce noise from one workstation to another. While troffers with deep parabolic louvers are an improvement, Peter Ngai, vice president of engineering at Peerless Lighting, says there is growing acceptance of pendant-mounted linear fluorescent fixtures. Their narrow, convex profiles are less likely to act as acoustical mirrors, and they leave more of a ceiling's surface exposed, thus improving the ceiling's sound absorbing capabilities.



At left, partition height is a trade off between privacy and accessibility: higher partitions block speech, but lower partitions allow greater visibility. Above, reflective ceilings in the center of a conference room can make it easier for conversations around the table to be heard. Conference room acoustics must also be designed for teleconferencing and multimedia presentations.

Block: Sound travels in waves and can be blocked by

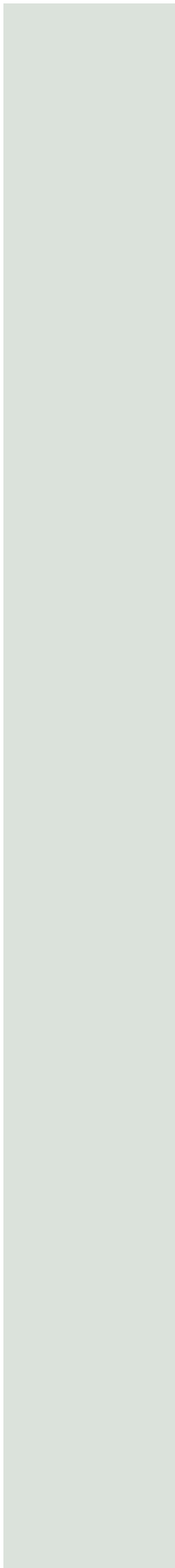


materials with a sufficiently high sound transmission class (STC), which ranges from zero (no privacy) to 70 (complete privacy). While STC ratings for office furniture partition systems range from 15 to 30 (compared to an STC of 40 to 44 for a 5¼8-inch gypsum board partition with 35¼8-inch metal studs), they are an important component in speech privacy. Many cubicle systems feature fabric-covered acoustical insulation surfaces which can reduce noise reflection within a cubicle, but their ability to absorb sound is often compromised by office furniture and papers hung on partitions. The direction of one's voice affects how audible it is to nearby listeners—thus, good cubicle design enables occupants to turn easily toward a partition while engaged in conversation with coworkers or on the phone.

Partitions less than 60 inches in height lose effectiveness as acoustical barriers because they're not high enough to block the voices of most standing adults. According to Pam Brenner, manager of workplace issues for Steelcase, decisions about partition height often represent a tradeoff between accessibility and privacy needs. Accessibility may be necessary for collaboration and ease of communication within a workgroup. Issues of visual privacy and territoriality must also be taken into consideration.

Blocking sound is also an issue with enclosed private offices and conference rooms. In addition to using a partition system with a satisfactory STC, it is crucial to seal all openings and the perimeter of the partitions to prevent flanking sound. Where confidential levels of speech privacy are required, partitions should be extended through the ceiling and sealed to the structure above. Ductwork and air diffusers should be arranged to prevent sound transmission from space to space. Similarly, doors that face each other on opposite sides hallways should be staggered to reduce the direct transmission of sound from room to room.

Cover: Designers rely increasingly on sound masking (i.e., background noise) to cover unwanted noise. It is ironic that speech privacy concerns are higher today than they were in the past when office equipment made the workplace even noisier. Gone are the clatter of impact typewriters and daisywheel printers, the clamor of mechanical telephone bells, and rumble of street noise through open windows. Even the whoosh of air flowing through ductwork doesn't always provide background noise, because contemporary energy management systems often dictate the use of variable volume diffusers or other air distribution systems that cycle off for energy conservation. In a quiet office, any speech has a high signal-to-noise ratio that makes it easier for listeners to make out words—which is why sound masking systems have gained popularity.



Additional background noise is generally provided via an electronic sound masking system. According to Dennis Paoletti, faia, an acoustician with Shen Milsom & Wilke/Paoletti, today's masking systems are an improvement over the white noise generators of the past. Now, a signal from a random noise generator is through an equalizer to create a shaped spectrum tuned to the room's acoustical environment. The ideal, he says, "is to produce a uniform level of background noise so no one notices it." Loudspeakers are then strategically located throughout a space to produce the masking noise. While Armstrong has introduced a tile with built-in loudspeakers, the best place to mount a masking noise generator, says acoustical consultant Ron Eligator of Acoustic Dimensions, is above a ceiling, so the masking noise can be distributed inside the plenum and produce a more uniform sound field throughout an office.

New Dimensions Overhead

Most offices still use the traditional 2 x 4-foot lay-in ceiling, and new types of mineral fiber, wood, and fabric-covered panels have been introduced by several manufacturers to address the needs of open offices. Designers are increasingly eschewing the Cartesian world of the rectangular grid by seeking variations in ceiling scale, shape and trim, and using materials that can be morphed into three-dimensional forms. A manifestation of this trend is that perforated metal ceilings are now at home in office environments. Vaults, domes, and other unique configurations have become more feasible due to advances in CAD and computer-aided metal-forming techniques. Perforated metal also offers designers a new palette of visual aesthetics: A wide range of metals and finishes can be specified; perforation patterns can be customized to control a ceiling's opacity and luminosity; and panels can be integrated with lighting, air distribution, and other services. Nancy Mercolino, president of Ceilings Plus, a metal ceiling producer, notes, "Metal panels are lightweight, easy to install, and provide easy access to cabling and equipment located in ceiling plenums."



In large open-office areas, vaults and other three-dimensional configurations provide relief from visual monotony and create a better sense of orientation. The use of larger panels is in keeping with the scale of this room.

Though metal does not absorb sound, perforations the panels acoustically transparent so they can be used to support and cover sound absorbing materials. A new type of acoustical insulation, non-woven fabric, has been engineered specifically for this application. One non-woven product, SoundTex, is manufactured by Freudenberg Nonwovens Limited and is only 0.2 mm thick. When factory-laminated to the back of a panel, it creates resistance to airflow and dissipates noise by converting vibrational energy into heat. This new acoustic insulation can be used where concerns about airborne glass fibers may limit the use of traditional acoustical materials. Recent tests conducted by Ceilings Plus showed that its panels had an NRC of up to .75 when used with non-woven fabric insulation and up to .90 with one inch of glass fiber insulation. Other manufacturers of metal ceilings are beginning to compile data on acoustical performance of their ceiling systems as well.

Design Soundings

The fundamentals of good acoustics are well understood, but the challenge remains to harness the physics of sound in the service of architecture. This charge has become more daunting since designers, influenced perhaps by the irreverent trappings of the com industry, are using stylistic motifs which may look fresh but which make acoustical control more difficult. For example, omitting a suspended ceiling can increase reverberation time, exaggerate the impact of noise produced by the mechanical system, and expose hard, reflective structural surfaces. To produce acceptable results, a designer must begin by understanding the types of work to be performed in a space and assessing the firm's work style and corporate culture.

While telecommuting may allow a lucky few to work in

the pastoral quiet of a mountain glade, the open-office concept continues to gain momentum in many businesses, and such projects continue to grow in size. Fletcher Thompson, Inc., an architecture, engineering, and interior design firm, recently completed a corporate headquarters in which 250 employees work in one 45,000-square-foot "room." Designed to support collaboration and teaming, the facility "has a hushed but vibrant quality, like the main reading room at the New York Public Library," notes Douglas Disbrow, the studio design leader.

Many prognosticators say that office acoustical privacy concerns will only get more serious as digital technologies continue to change the workplace. To the existing volume of speakerphones, wireless telephones, and audible computer prompts will be added even more teleconferencing, voice recognition software, and desktop multimedia software.



A custom beech perforated-wood ceiling was used in conjunction with non-woven acoustical fabric for this office space in Los Angeles.

If these trends continue, there may be a limit to what can be achieved through acoustical abatement. Are we all doomed, then, to wear earplugs just to hear ourselves think? Or instead, will we see the fostering of a new type of corporate behavior in the workplace? Brenner suggests, for example, that co-workers should send directly to their voice mail without ringing when they are away from their workstations. She cites another example of a salesman who was trained to stand when making important calls to convey energy and strength. When he was moved from a private to an open office, he had to learn to sit when speaking so his voice wouldn't sail into

neighboring cubicles.

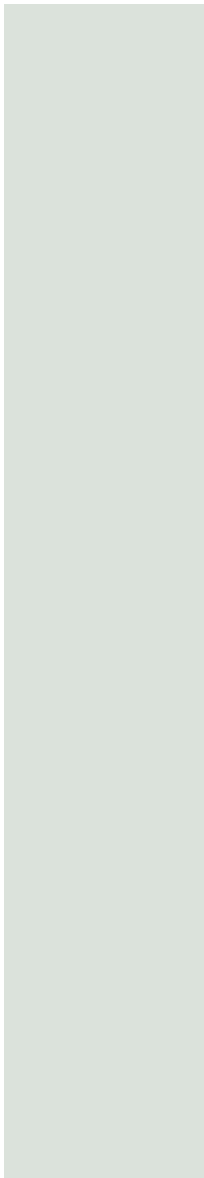
If such an epidemic of civility does break out, I will have only one regret—that it didn't happen 20 years sooner, when I was still working in that noisy architectural office.

Questions:

1. What are the ABCs of acoustical privacy?
2. What are the design tradeoffs in limiting the height of office partitions?
3. What is the role of ceilings in an open-plan office?
4. What acoustical considerations must be given to a facility's air distribution system?
5. Why have perforated metal ceilings become more popular?

Answers:

1. "A" is for absorbing mid-range frequency sounds by using a ceiling system with a satisfactory noise reduction coefficient (NRC) to prevent speech from bouncing off the ceiling from one cubicle to another. "B" is for blocking sound by using partitions of sufficient height and sound transmission class (STC) to block speech, preventing direct passage of sound into adjacent workstations. "C" is for covering unwanted sound by using sound masking to decrease the signal-to-noise ratio.
2. For acoustical privacy, partitions should be higher than the head height of personnel sitting or standing in adjacent workstations. However, lower partitions may be required for visibility and to enable communication among individuals engaged in collaborative work. Ultimately, though, workers need to direct their voices into acoustical panels when possible so that the panels can absorb sound effectively.
3. The ceiling is the largest surface in an open office, so it plays an important role both visually and acoustically. A high NRC is required both to reduce ambient noise levels and to enhance speech privacy by preventing sound from reflecting from one cubicle to an adjacent one.



Aesthetically, designers are exploring new dimensions and configurations to avoid the monotony of a large, flat, 2 x 4-foot grid.

4. While the whoosh of air from an air distribution system can contribute background noise for sound masking, increased reliance on variable volume air distribution systems means that supplemental sound masking systems may be required for times when the air distribution system is shut off. High-pitched hissing sounds or the opening or closing of valves can also be distracting; locating ductwork above a suspended ceiling can help distribute any noise, lessening its potential to become a distraction. Ductwork entering enclosed rooms needs to be treated to prevent the transmission of speech from one side of a wall to the other.

5. Many designers have begun to use perforated metal panels in open-plan offices because they can be fabricated in a wide range of shapes and configurations, which increase ceiling design options. Although metal panels don't block sound, new non-woven fabric insulations make it simpler to install acoustical insulation in a metal panel. Using these two materials in combination can lead to satisfactory acoustical performance in large, open spaces.