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The ABCs of Acoustic Design

The goals of acoustic design

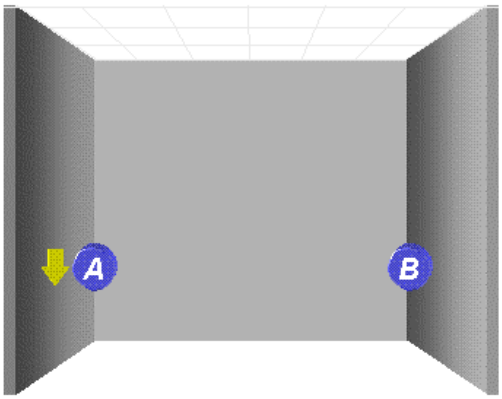
The workplace should provide occupants with speech privacy, comfort and freedom from distracting noises, and enable them to work without disrupting others. The creation of such a space should be cost-effective, while maintaining the flexibility required to accommodate change.

Noise control methods

The formula many professionals use to achieve these results is the “ABC Rule,” meaning Absorb, Block and Cover Up. In recognition of the fact that a combination of these three elements is required to create proper acoustical conditions, this guideline is also known as the “Rule of Threes.” While it acknowledges the role of absorption, physical barriers and sound masking, this rule ignores one valid and frequently used method of addressing office noise: reducing noise at the source.

Reduce noise at the source

This strategy requires the identification and subsequent reduction or elimination of unnecessary sources of noise in the office. This task can be accomplished by modifying employees’ noise-producing behaviors and by replacing noisy office equipment with quieter technologies.



Despite its exclusion from the ABC Rule, noise source reduction has been one of the defining influences in creating the acoustic environment in modern offices. Building mechanicals, such as heating, ventilating and air-conditioning equipment, have become progressively more silent. Office equipment has followed the same path, progressing from typewriters and noisy copy machines to early printers, and, finally, to modern keyboards, laser printers and photocopiers. However, some new technologies, such as speakerphones, can actually increase noise levels, and their use should be carefully considered.

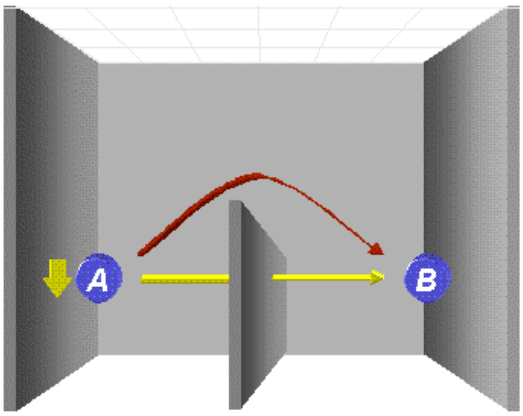
Changing behaviours can also significantly reduce the level of noise in the office. Reasonable office etiquette should be enforced, but it should be recognized that some necessary noise is created while employees perform their tasks. One of the goals of good acoustic design is to provide employees with a comfortable

working environment that allows them to perform these tasks without feeling as though they are disrupting or irritating others within the space.

Reducing noise at the source has practical limitations. Once this method has been exhausted, any remaining noises in the office are there by necessity or because it is unfeasible to eliminate them. These noises must be controlled in other ways.

Block noise

Another method of controlling noise is to block sound transmission. Closed plan designs achieve the majority of noise control in this manner, but blocking is also a relevant consideration in the open concept office. There are several strategies to review.



The most basic barrier is a wall, though efforts to increase the flexibility of offices and reduce construction costs have reduced their use in most offices. However, walls should still be used in areas where absolute confidentiality is required. Ensure doors are well sealed and that there are no gaps between the walls and the suspended ceiling. When walls are built along the building's perimeter, do not allow spaces to remain between the wall and the window mullion, because they provide a clear path for the transmission of sounds from one office to another. If not properly designed or treated, HVAC components can also provide a path for noises and conversations to travel through the walls.

Plenum barriers are used to block sound transmission over walls that extend only to the suspended ceiling. They can be expensive and somewhat difficult to properly install. Breaks – either from initial installation or from subsequent damage – significantly reduce the effectiveness of lead, drywall or rigid fiberglass barriers. Furthermore, the use of plenum barriers can require the installation of expensive acoustic air return ducts in order to limit the transmission of sound through the ductwork while maintaining airflow.

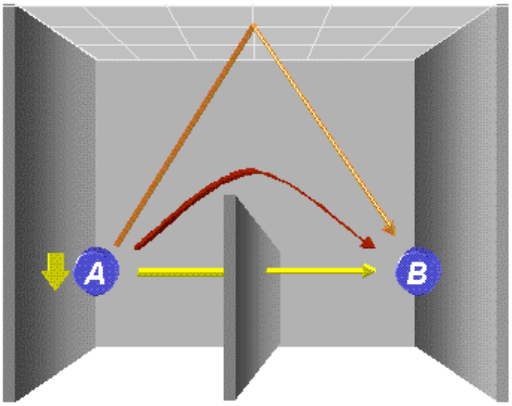
In open plan environments, the office layout can be used to maximize blocking of sound to prevent noise from interfering with office occupants' ability to concentrate. Locate noisy office machines and areas with high activity and noise levels, such as call centers, in remote or isolated areas. Try to maximize the distance between employees because the volume of noises and conversations will decrease over distance.

Blocking in open plan areas can also be achieved through the use of physical barriers such as workstation partitions. Minimize direct paths of sound transmission from one person to another by seating employees facing away from each other on either side of partitions. The height of the partitions is also acoustically significant. Partitions lower than 50 inches (1.25 meters) essentially provide an office with the same acoustic benefits from one workstation to another as no partition system. Generally speaking, 64 inches (1.60 meters) is effective because it extends beyond seated head height. Partitions higher than 70 inches (1.75 meters) offer decreasing acoustic benefits relative to their cost; however, using slightly higher partitions in high traffic areas can be beneficial.

In the end, however, an over-reliance on physical barriers can raise costs and render an office relatively inflexible, while still failing to satisfy all occupants' acoustical needs.

Absorb noise

Adding absorptive wall materials, ceiling tiles and flooring reduces the energy and, therefore, the volume of sounds reflected off their surfaces back into the office space.



Because the ceiling is usually the largest unbroken surface in a facility, a good absorptive tile helps lessen the distance over which noises and conversations can be heard. Offices should invest in the best tile they can afford and ensure consistent coverage throughout the facility. Any partial treatment of a space will decrease acoustic control.

Ceiling absorption is often rated using Noise Reduction Criteria (NRC), which essentially ranges from 0 (0% absorption) to 1.00 (100% absorption). The higher the NRC, the better. In decreasing order of acoustic performance, ceilings typically rank as follows: fiberglass tile, mineral tile, perforated metal tile, no dropped ceiling, drywall and solid metal tile. The last four types usually exhibit a significant decline in acoustic performance; however, there are mineral and perforated metal products that demonstrate better than average NRC ratings. The thickness of a mineral or fiberglass tile will affect its acoustic performance. Generally, the thinner the tile, the more transparent and less absorptive it will be. Foil backing on a fiberglass tile helps contain sounds within closed offices. Foil also increases the dispersion of a sound masking signal, ensuring greater consistency in masking levels throughout the space. Placing fiberglass insulation above the ceiling tiles has only marginal acoustic benefits and will hinder access to the ceiling.

Lighting components can increase the acoustic reflectivity of the ceiling because they replace these absorptive ceiling materials with hard surfaces. In order to limit the lighting system's impact on the absorptive performance of the ceiling, select a system that incorporates a minimum number of ceiling fixtures while still meeting the specified lighting requirements. From an acoustic perspective, indirect lighting systems are best because they are suspended from the ceiling and maintain the maximum surface area of the acoustic ceiling tiles. When it is not possible to install an indirect system, consider using a deep parabolic lens instead of the traditional solid plastic lens. Standard acrylic lenses are highly reflective and, because they can take up to 20% of the ceiling, they have an obvious effect on sound transmission.

Though they are used less frequently than acoustical ceilings, absorptive wall materials can also play a significant role in office acoustics. Absorptive panels are effective when applied to large vertical surfaces and to key reflective locations, such as atrium walls or walls that reflect noise from the foyer up into the office space. They can also be used in areas where the ceiling treatment is not absorptive.

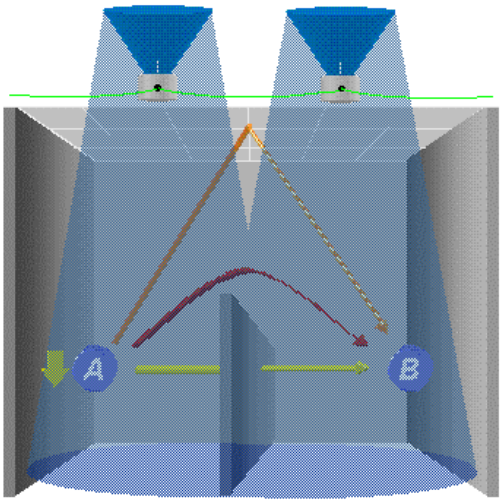
Workstation partitions can also perform an absorptive function. To reduce sound paths, minimize openings between and around the workstation panels, as well as underneath them if carpeting has not been used. Also minimize the number and size of reflective surfaces, such as glass, metal and drywall components, in the workstation because they will increase the reflection of noise and conversation, causing them to be heard over greater distances.

Absorption and the reduction of footfall noise are the main acoustic considerations when selecting flooring. Hard flooring is highly reflective and results in a more reverberant environment. Carpeting greatly reduces footfall noise, but typically provides only minimal absorption of frequencies in the range of human speech. Flooring will have a greater absorptive effect when special under-padding is used.

While the inclusion of absorptive materials in the office is necessary, their use lowers the ambient or background sound level, actually making the environment sound noisier and less private. Conversations will be more distinguishable and intelligible. In other words, absorption addresses one acoustical problem while making another worse.

Cover up noise

Basically, a sound masking system consists of a series of speakers that distribute an electronically generated background sound within a facility. Many people refer to such systems as "white noise systems;" however, this is a misnomer. The term "white noise" describes a very specific type of sound used in early masking systems developed in the 1970s. These systems were unsuccessful due to their inflexibility and the irritating hissing quality of the sound they produced, but the name became widely adopted. Newer sound masking products do not use a white noise signal; rather, they offer an engineered sound that is much more comfortable, unobtrusive and effective.



Sound masking addresses the lack of sufficient background sound that is characteristic of most office spaces. It is the only acoustical treatment that reduces noise disruptions and speech intelligibility by increasing the noise floor. All other treatments cause a reduction in the level of the noise itself. Masking works because the ear cannot perceive simultaneous sounds of similar volume and frequency. The masking system adds a constant background sound across a wide frequency range in order to reduce intelligibility, decrease the dynamic range, provide an acceptable background sound level, and minimize the differences in the quality and level of sound across the facility. The result is that unwanted noises are more difficult, or impossible, to hear or comprehend.

As with all acoustical treatments, the benefits of a masking system are maximized when used in conjunction with other noise control methods. Since sounds decay over distance, masking requires some distance to become effective, and this distance is minimized when sufficient physical barriers and absorptive materials are used in the design of the office. Furthermore, if absorption is increased, the masking system's volume can be reduced without affecting its performance level.

Use of a sound masking system can reduce costs by eliminating the need for additional insulation, extra layers of drywall, plenum barriers, high-spec walls, or permanent walls around private offices. In this way, masking also maintains the flexibility of the office space for future renovations and changes. In open plan spaces, masking can help maintain a level of acoustical control as density increases and workstation partitions become lower.

A combined approach is needed

As we saw from our case study, most evaluations of the acoustical environment have only focused on the quantity, or volume, of sound. In so doing, sound control strategies have been pursued in what we call the "Quest for Silence" – the notion that good acoustics are achieved when the sound levels in a space are as low as possible, with zero being the best. This is a flawed assumption. Just as with ergonomic factors such as temperature, light and humidity, there is a comfort zone for the volume of sound.
Absorptive treatments are often used in the "Quest for Silence." While absorption is a vital acoustical component, it is insufficient to satisfy all of the acoustical requirements we have outlined. Only masking

systems can be used to attain a proper noise floor level. Masking reduces the dynamic range, creates an acceptable average sound level (not too high and not too low) and covers up noises that occur beneath the level of the masking. In addition, masking reduces the signal to noise ratio for sounds still above the masking level, thereby making them less noticeable and distracting. Another benefit of sound masking is the ability to maximize the consistency of the acoustic environment across the entire office space.

Armed with a better understanding of the determinants of an effective acoustical environment, we see that an environment conducive to speech privacy, concentration and productivity can only be created through the balanced application of the methods of noise control we have described: reducing noise at the source, blocking noise transmission, absorbing noise, and masking noise.

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