

Workplace Research

Noise at Work

Addressing noise in the open plan



Knoll

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Open offices are a reality of the workplace. With as many as eight out of ten knowledge workers in open plan environments, the recognized benefits of increased collaboration, engagement and knowledge transfer, not to mention greater space efficiency, means they are here to stay.

For all their value, open offices bring acoustic challenges that have profound impact on the people who occupy them.

Nearly 75% of employees feel managed noise levels are an important quality in an effective workplace, according to the Leesman Index, a workplace experience survey of more than 350,000 employees across 2,700 workplaces in 69 countries.

However, just 30% of employees in the Leesman database are satisfied with noise levels in their workplace. Dissatisfaction with noise is statistically the strongest indicator of poorly perceived productivity and the main source of workspace dissatisfaction.

“Acoustics have a very big lever on the ability of the workplace to be a productive environment,” related Steve Johnson, founder, ADI Workplace Acoustics, who warns, “the most well-designed workplace environment will be a failure if you don’t get the acoustics right.”

It’s important to distinguish between sound and noise. Sound is vibrations that travel through the air or another medium and can be heard when they reach a person’s ear. Noise is unwanted sound that can be loud or merely annoying: a coworker’s conversation, a loud paper shredder, a noisy air conditioner.

The Cost of Noise

Well-designed sound environments favor concentration and facilitate communication, freeing people up to collaborate without distracting their neighbors.

On the opposite spectrum, poor office acoustics impact health and wellness. They create fatigue and increased stress, which is linked to high blood pressure, digestive disorders, headaches, hypertension and ulcers.

Noise exposure is also linked to cardiovascular disease, hormonal changes, psychosomatic illnesses, sleep disorders, reduced physical and mental performance, aggression, constant feelings of displeasure and reduction in general well-being.

Key Takeaways

Unless properly managed, noise in the open plan can become an unwanted distraction, lowering employee well-being, productivity and satisfaction, potentially costing companies more than the real estate savings they may experience.

However, a combination of carefully selected furnishings, strategic location of groups and activities, and a quality sound-masking system can create a productive and comfortable setting with the community, collaboration and connections an open office environment is designed to deliver.

Some thoughts to consider:

- 1 Unmanaged noise has true costs on employee well-being that can make a significant impact on a company’s bottom line relative to healthcare costs, lost productivity and employee satisfaction.
- 2 Reducing speech intelligibility—not necessarily eliminating it—is a primary goal in creating a comfortable sound level.
- 3 Implementing all three elements of an ABC strategy (Absorb, Block and Cover), at levels customized to suit the particular building requirements, is the most effective way to reduce noise levels.
 - a Integrating materials with Absorption properties into décor, such as drapery, panel and screen dividers, ceiling baffles and more, can pay large dividends in reducing noise levels.
 - b Applying workplace strategy, such as separating front-facing employees from focus areas, is one of the numerous ways to Block sound.
 - c To Cover noise, pink noise provides smoother and more soothing sound-masking than white noise.

Noise can also impact motivation and productivity. Studies have shown it can take up to 25 minutes to regain concentration after a distraction, causing employees to lose up to 86 minutes a day.

However, when distractions are reduced, 75% of employees are more productive, 57% have increased motivation, and 49% are happier at work overall¹.

People are a company's greatest asset and expenditure, comprising 85% of an organization's expense, versus 15% for real estate related costs². A focus on simply reducing real estate expense can quickly be offset by drops in employee satisfaction and productivity.

Investing in acoustics on the front end—planning strategies, quality materials, proper furnishings and sound masking systems—can pay huge dividends in employee well-being, productivity and happiness at work that can ultimately boost a company's bottom line.

What Makes Noise Uncomfortable

Why speech is distracting

While most office conversations aren't noisy or loud enough to cause discomfort, speech is particularly disturbing when we can understand it, but it isn't relevant to us.

"If I'm hearing a conversation and it is intelligible, my brain is very inclined to want to listen to it and that is where the problem really starts," Johnson explains. "That speech creates content that our brain is consciously or subconsciously trying to decode into language." It's why speech is a major distraction for the human brain.

How sound transfer exacerbates noise

The way sound behaves in a space depends on the levels of reverberation in the building. Thus, good acoustics requires managing the paths that sounds travel between the sources, which are people and equipment.

"Sound travels off a highly reflective surface like a car doing laps around a track until it wears out," explains Johnson, which is why a room of highly reflective surfaces—a concrete floor, open ceiling, exposed brick walls, windows—can be so uncomfortably loud.

Additionally, certain situations exacerbate reflective sound. For example, parallel walls will bounce sound back and forth like a ping pong ball, creating an echo cacophony.

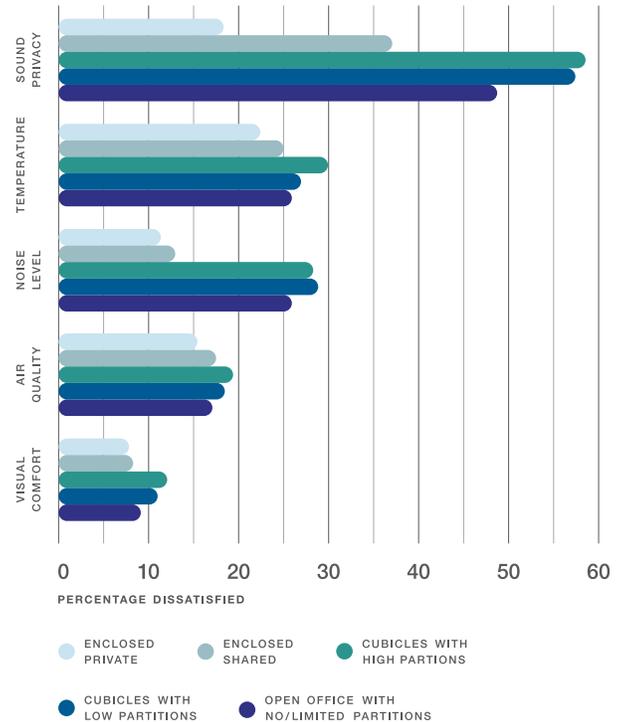
In a café or other amenity space with a proliferation of hard surfaces (such as kitchen cabinets, laminate counters, stone floor, an untreated ceiling), sound transfer creates a bandshell effect. Sound is being concentrated and directed off reflective surfaces and creating a megaphone effect, which is why an audience seated up a grassy hill can hear musicians or actors clearly in a bandshell below.

A narrow corridor of glass, tile, concrete and/or other hard surfaces can funnel sound from a loud area to a quieter one. Glass phone rooms or huddle rooms can create an especially unnerving effect. As speech reverberates from the walls, occupants use an even louder voice that can be overheard in surrounding spaces, ultimately defeating the purpose of providing a place for private conversation.

Everyone Can Hear You, Now

Lack of sound privacy is the biggest frustration with the open plan.

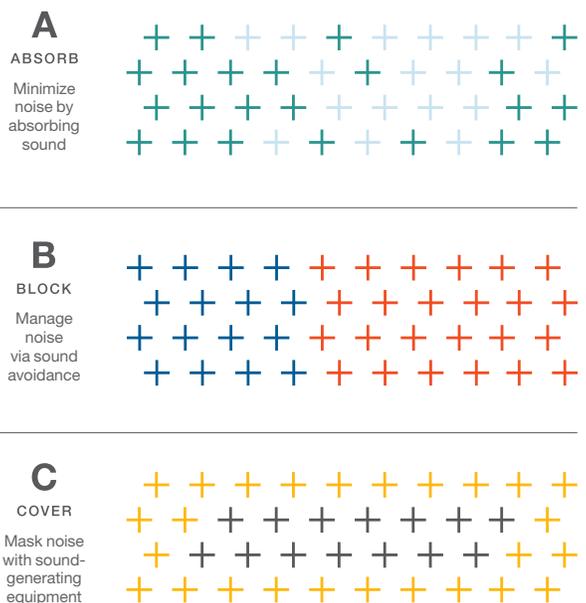
TOP 5 FRUSTRATIONS EMPLOYEES REPORT HAVING WITH OPEN PLAN ENVIRONMENTS



Additional data that was surveyed: overall workplace, amount of light, ease of interaction, comfort of furnishings, adjustability of furniture, colors and textures, building cleanliness, workspace cleanliness and building maintenance.

Source: Analysis of data from The Center on the Built Environment by Jungsoo Kim and Richard De Dear, University of Sydney.

The ABC of Acoustics



Noise Reduction Strategies

The good news is that numerous strategies exist to make the noise level bearable for all occupants in an open work environment.

Such an environment provides speech privacy, which is the ability to have conversations with various levels of confidentiality, as well as the ability to concentrate and be productive individually or as a group collaborating.

“Speech creates content that our brain is trying to decode into language. It’s why speech is a major distraction for the human brain.”

STEVE JOHNSON
FOUNDER, ADI WORKPLACE ACOUSTICS

The ABC of Acoustics

An acoustically balanced environment can be created with the right combination of the ABCs of noise control: Absorb, Block, Cover

Absorb: Minimize noise by absorbing sound

Sound levels can be attenuated by controlling reflective sound with porous materials that catch and hold the sound rather than bounce it back. Each material has particular strengths and properties that vary whether used individually or in combination with others.

To best mitigate sound, all six surfaces of a room should be considered: four walls, ceiling and floor.

- + **Ceilings.** High ceilings create reverberant acoustics that blur voices in the distance, so occupants can converse face to face, but conversations more than a few feet away will be unintelligible. An average acoustical ceiling absorbs about 50% of sound, according to Johnson. Acoustics may be improved with varied forms and materials: FilzFelt hanging baffles in shapes and other decorative designs, suspended ceiling tiles or acoustic foam that is sprayed into designated areas.
- + **Floors.** Soft carpets dampen noise, helping in open offices particularly with foot-fall sounds. Cushion-backing adds more sound attenuation.
- + **Walls.** Wrapping two perpendicular walls with acoustical panels, such as KnollTextiles Acoustically Neutral Panel Fabrics, or incorporating angled or curved walls in meeting rooms can reduce reverberation of sound. Such treatments eliminate parallel walls that bounce sound back and forth or maximize the effect of the acoustical substrate itself.
- + **Furnishings.** Interior elements and free-standing surfaces can attenuate sound without compromising design. Applications and corresponding material choices should also be considered.

Fabric and Draperies. Fabric and draperies have been part of sound-absorbing strategies for centuries. The drapery fullness and the distance from the window increase the basic

About NRC Ratings

The Noise Reduction Coefficient (NRC) measures a material’s ability to absorb sound. The higher the number, the better.

For example: a rating of .6 means 60% of sound’s energy does not bounce back. An NRC value of 0.2 and higher is considered sound absorbing; anything below that is considered reflective.

A material’s NRC rating can vary depending on the type of product, application and whether it is used in combination with other materials. Additional factors that cause materials to respond differently include material composition, location, room size and types of surfaces, according to Peter Harenda, an Environmental, Health and Safety Product Testing Coordinator for Knoll brands Spinnybeck and FilzFelt.

For example, a ceiling baffle mounted flush to the surface might register 0.85; the same product rates a 1.2 when suspended several inches since sound levels lessen when trapped between pockets of air.

Effect of Material Combinations on Sound Ratings

Knoll has tested various combinations of fabrics and materials to study how NRC ratings vary. Below is one example of how different materials used on a Knoll Rockwell Unscripted Creative Wall application affect sound.

	NOISE REDUCTION COEFFICIENT	SOUND TRANSMISSION CLASS	SOUND ABSORPTION AVERAGE
Fabric/Fabric Fabric wrapped on a .5” fiberglass, both faces, 3” air cavity	.55	22	.59
Veneer/Veneer Veneer on .5-inch MDF, both faces, 3” air cavity	.05	32	.10
Felt/Felt 3 mm FilzFelt on 12mm acoustic board, both faces, 3” air cavity	.40	29	.41
Fabric/Veneer Fabric one face, veneer one face, 3” air cavity	.30	28	.36

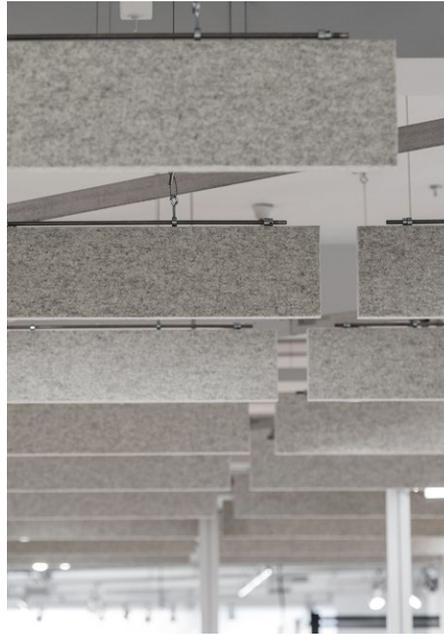
Glossary:

Noise Reduction Coefficient (NRC): Measures the ability of a material to absorb sound. An NRC value of 0.2 and higher is considered sound absorbing, while an NRC value of .19 and lower is considered reflective. NRC is typically used to measure sound absorption for floors, ceilings and wall assemblies.

Sound Transmission Class (STC): A numerical rating that indicates the transmission of sound through construction materials. The higher the STC rating, the better the material is at stopping sound from being transmitted through it.

Sound Absorption Average (SAA): Published in most product literature that offers acoustic ratings. The lower the SAA value, the more reflective the material is (0.0 = no absorption). A higher SAA value indicates a more absorptive material (1.0 = total absorption).

absorption offered by the fabric itself. Typically, the greater the weight of the fabric, the higher the absorption, but KnollTextiles’ innovative sound absorbing draperies offer up to .75 NRC with the appearance of a traditional sheer fabric. Another option is



From left to right: The Knoll Creative Wall from the Rockwell Unscripted line offers the ability to use a range of materials to divide space or create enclosed spaces with doors and windows for private phone conversations or highly focused work; a FilzFelt ceiling system adds texture, color and dynamic acoustic performance to any open office space; KnollTextiles' innovative drapery with unique acoustical properties absorbs up to 65% of the sound energy that contacts the fabric without interfering with the transmission of daylight into an interior.

the use of drapery away from the building curtain wall: these large-scale, architectural drapery installations in the open plan contribute to sound absorption and offer a softer take on architectural subdivision of space.

Workstation Elements. Sound should be captured as close to the source as possible, making desktop elements with absorbent materials an effective sound-reduction strategy. Fabric-backed workstation panels or screens and/or bookshelves, tackable surfaces, acoustical panels, screens and dividers are options.

Free-standing Vertical Surfaces. Vertical barriers should be located 3 to 7 feet above the floor since that covers a foot below speaking level while sitting and a foot above typical standing height. Covering both sides of the wall surface with fabric or FilzFelt provides maximum sound attenuation. In some cases, layout and usage may dictate use of a "harder" material, such as markerboard, laminate or veneer, which will stop sound, but also act as a reflective surface. Covering the other side with fabric or felt can help mitigate sound. Additionally, Knoll Rockwell Unscripted Creative Walls, which have a 3-inch internal cavity that helps stop sound transmission, can be used as a freestanding plane to absorb sound. (See "Effect of Material Combinations on Sound Ratings" on page 3 for more information.)

Accessories. Plants and decorative objects with sound diffusing qualities help scatter noise, while glass, metal or plastic objects or art can create a reflective surface.

Block: Manage noise via sound avoidance

Space planning and workplace strategy are important tools in delivering acoustical comfort and productivity. Blocking sound in

Sound Travels via Three Paths

Direct

A straight-line path between the source and receiver.



Reflected

A path as the sound bounces off surfaces.



Detracted

Sound that travels above and around partitions.



select locations and separating noise-generating activities from quieter ones helps manage noise and improve speech privacy in an open office.

Additionally, establishing office protocols encourages neighborly behaviors and sets the right office etiquette and culture to maintain comfortable sound levels.

+ Managing place with workplace planning and strategy.

The successful implementation of an open office environment requires proper planning and the execution of appropriate workplace strategies. When designing an open workspace, consider:

- + Separating front-facing teams with frequent phone interactions from those who spend good portions of the day in focus work.
- + Dividing groups of people. For example, instead of 150 people in one area, break them up into three groups of 50 people, separated with a meeting room, fabric panels, carpet expanse or similar.
- + Reducing the radius of distracting conversations (the distance from talker to distracted party) so collaboration and sharing in benching and similar environments does not impact other groups.
- + Factoring in noise and activity associated with each operation when developing adjacencies. For example: isolate copiers, shredders and other noise-generating machines from open areas, position individual workstations so that there are no uninterrupted sound paths between connected or neighboring workstations, stagger workstations and orient layouts so individuals face away from one another, close off space with dividing screens, partitions, hanging floor-to-ceiling panels, bookshelves, plants or other sound absorbing objects.
- + Creating dedicated spaces and breakout rooms that separate loud and quiet. In all cases, ensure employees know where to locate the spaces and the intent of the space.

Quiet Spaces. Much like a train's quiet car, a dedicated zone for heads down, non-collaborative work by multiple users can eliminate outside distractions and boost productivity. Designate an unused office or conference room or create a space with furniture, screens, fabric or felt panels or Rockwell Unscripted Creative Wall. Include spaces for both quiet focused work and silent reflection.

Loud Spaces. Designate collaborative, lounge, socializing, café, training, meeting and other spaces intended for interaction and locate away from quiet areas. Include an outdoor space when possible.

Enclaves. Providing well-designed small enclaves encourages employees to make phone calls without disturbing surrounding workers. Rooms can also be used for in-person meetings, webinars, speaker phone conversations, video calls and presentations that can be disruptive to neighbors.

+ **Managing behavior with office etiquette and culture.**

Making an open floor plan work is a cultural decision and requires company-wide commitment to respect and quiet. The success of any open environment not only includes the initial planning and design, but also, and just as important, entails setting clear standards, articulating expectations for behaviors and etiquette, and training staff to use areas of the office considerately and effectively.

Examples might be holding meetings away from desks; keeping device ringers, notifications and alarms on vibrate or lowest setting; and signaling when they do not want to be disturbed by wearing headphones or other gestures.

How is pink noise different from white noise?

White noise and pink noise are similar in that they are both audible to humans. Beyond that, they differ. White noise has an equal intensity throughout all frequencies (sound of steam hissing from the radiator or static on the television), in contrast, pink noise is inversely proportional to the frequency of the signal (white noise with the bass turned up: a "shhh" sound with a low rumble mixed in.)

Pink noise is often found in nature, such as waves lapping on the beach, leaves rustling in the trees or a steady rainfall.

Such behaviors have been shown to significantly impact workplace satisfaction.

Some additional considerations:

- + Noise breeds noise. People are quiet in quiet spaces and noisy in noisy spaces.
- + With minimal or lower partitions, people are aware of the lack of acoustical barriers and will talk softer ("the library effect").
- + High partitions may afford visual privacy and the perception of acoustical privacy, when in fact sound is traveling over the divider and people are inclined to speak louder.

Cover: Mask noise with sound-generation equipment

With increasingly quiet HVAC systems, and text-based interactions supplanting phone and in-person conversations, background sound levels in some offices can border on "dead quiet" and create an atmosphere where small noises produce an out-of-proportion disturbance.

"It's not that people are loud or making a lot of noise. It's just that nothing is competing with it," explains Johnson. Sound can be attenuated with continuous, low-level ambient noise that masks conversation and other noise, lowering the intelligibility of neighboring conversations by as much as two-thirds and therefore making them much easier to ignore.

When voices get lost in the fog of sound masking, you lose intelligibility, according to Johnson. "That's where the magic happens," he notes. "It doesn't even need to disappear 100%; it just needs to disappear enough that it's not drilling into our consciousness." The goal is to create organic sound that people are accustomed to hearing. Pink noise is smoother and more soothing across all frequencies than white noise, which can sound like a static or hiss, harsh and unpleasant. (See sidebar above for more information about pink and white noise.) Balance and location of speakers is vital. Too low and it will not be effective. Too loud and it will be distracting and may cause people to talk louder.

Another sound-masking strategy is the use of high quality headsets with highly directional microphones that mute background noise.

Combining Strategies

A combination of sound absorption, blocking and covering are the 1-2-3 punch that can make a measurable difference in the acoustic comfort of an open work environment.



Each space possesses its own acoustical needs. Considerations like square footage, number of people, types of furniture and application may help to inform the solution required to manage noise. A shared meeting space may require a combination of Spinneybeck and FilzFelt wall mounted solutions as opposed to a touchdown work area that may only require a FilzFelt desktop screen.

NRC ratings, square footage and volume should be considered collectively when planning spaces and solutions. Layering a wall surface with one or more materials magnifies sound reduction. Not only does each layer absorb sound, but the air sandwiched in between helps as well. Spinneybeck/FilzFelt partnered with an acoustical consultant to develop a formula to determine the optimal product combination for a space.

Each variable has a different effect, explained Peter Harenda of Spinneybeck/FilzFelt. “It breaks down to composition of material, what you’re looking to accomplish and what will achieve that for you,” he said. “For example, are you incorporating a wall application? Ceiling baffles? Acoustical desktop screens? We determine what the application is and where it will be located. Is it located close to a wall? Away from furnishings? Have a low screen?”

“We can calculate the product combination needed to achieve a certain reverberation time for a room of designated dimension, such as carpet vs. laminate, brick vs. glass, tin vs. acoustic, effect of 120 square feet of baffles versus 240 square feet for another price. It allows us to be nimble and really help a customer achieve the desired results.”

The Bottom Line

In the knowledge economy, human resources are a company’s most expensive and highly valued asset. Creating an environment that fosters collaboration, supports productivity and improves workplace satisfaction is arguably an organization’s most important investment in its success.

And in many cases, a portion of that workspace will more than likely be open plan, which presents potential issues of noise in the workplace that can jeopardize the qualities the firm worked so hard to create.

Fortunately, some upfront planning and investment can mitigate noise and avoid many issues that could arise relative to acoustics and worker comfort and concentration. By applying a combination of strategies early in planning that absorb, block and cover noise, a workplace can deliver all the benefits of an open environment—collaboration, connection and space efficiency—and avoid many noise-related problems that might otherwise plague the space.

High performance environments have been shown to benefit the people who occupy them, and positively impact a company’s bottom line. Investing in healthy and sustainable workplace strategies that foster occupant happiness enhances employee lifestyles at such a scale that such capital investments not only pay for themselves, they also boost profits for companies occupying them³. 

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Through research, Knoll explores the connection between workspace design and human behavior, health and performance, and the quality of the user experience. We share and apply what we learn to inform product development and help our customers shape their work environments.

To learn more about this topic or other research resources Knoll can provide, visit www.knoll.com/research.

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