# HermanMiller

It's a Matter of Balance

Acoustics in the Open Plan

Most office workers—in developed and developing countries alike—worked in bullpens until the advent of systems furniture in 1968. The transition to open plan brought more visual privacy and a better acoustical environment. It wasn't long, however, before these workers became accustomed to these improvements and wanted more.

But as experts worked on solutions for corralling sound and reducing distractions in open plan spaces, two trends were slowly altering the very landscape that those consultants were fine-tuning: more compact work areas and an increasing need to accommodate teamwork and collaboration.

Both trends began emerging about the same time. From the standard 12' x 12' workspaces of the early 1970s, individual workstation size appears to be decreasing across all job types. For example, the International Facility Management Association reports that, between 1994 and 2002, the average size of middle-management stations dropped nearly 17 percent. Meanwhile, the average technical/professional station shrank 12 percent and general/ clerical stations stayed about the same.[1]

These closer quarters were intended to improve team communications and reduce costs, but they have also generated more discontent about acoustics. Other factors have increased this unhappiness, including the introduction of more noise-generating equipment and the trend toward more cognitive work.
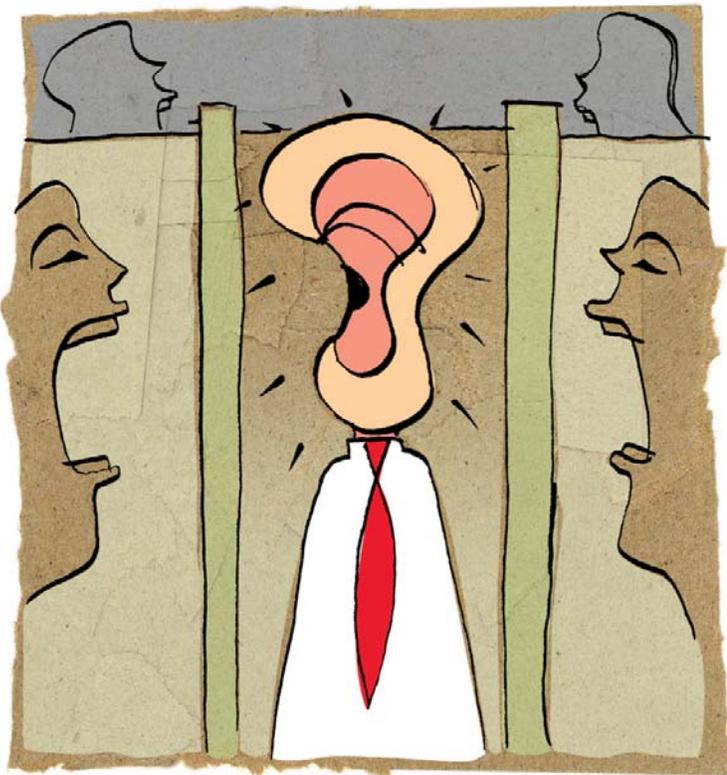
While factors affecting acoustics are all intertwined, one sound in the office often stands out as the biggest source of frustration—other people's voices. Office workers who participated in a 2002 study on privacy-related issues conducted by Herman Miller, Inc., cited overheard conversation as their biggest workday gripe. Most respondents agreed with the statement, "When I am working in my workspace, I'm distracted by conversations of my immediate neighbors."[2]

Another study on office sound and employee performance found that well over 1,000 of the 2,000 participants involved were bothered by sounds in the workplace, with conversations and ringing telephones rated as the most annoying sounds.[3] A third study confirmed that 40 percent of the office occupants polled felt that "workplace acoustics" made it more difficult for them to do their jobs.[4] In response to these and other acoustics studies, one researcher developed a model that predicts a seven percent reduction in the performance of complex tasks when overheard speech is highly intelligible.[5]

Although employees find other people's voices distracting and irritating, there's another aspect that's also currently getting attention in recent research: These same employees are actively concerned about other people being able to hear *them*. As privacy becomes a more overarching concern in the workplace, the downscaling of today's open plan workstations adds another layer of challenge to office design—how to deliver voice privacy to people while controlling distractions from others.

Face to Face with the Soundscape

In terms of creating spaces that are acoustically comfortable, human reactions to sound are more important than the physics of acoustics. The issues involved include the kind of sound, the circumstances under which people hear it, and the individual sensitivities that shape what they find annoying. Frequently, a person's perception and interpretation of sound in the work environment, not just its decibel level, determines its distracting and annoying effects.

Sound in an office is what one researcher has termed "the soundscape," a component of "the perceptual landscape" of a work environment.[6] People hear all sorts of things in an office—keyboarding at computers, the HVAC system cooling the workspace on a hot day, the sound of phones being answered pleasantly and professionally—that reinforce a feeling of being part of a team that's getting work done.

In other words, not all sound is bad, and some of it may actually support productivity. In the 2002 Herman Miller study noted earlier, it was discovered that fewer people agreed with the statement, "When I am working in my office, I am distracted by background noise from machines, printers, etc." than those who said that conversations bothered them.[7]

Sound Level—It's Not Just Loudness

Although people tend to assert that it's the loudness of sounds that distracts them, the reality is more complicated. If the acoustical problem in an open plan office was simply a function of loudness, that would be relatively simple to address. But it's not.

In spaces where all surfaces are hard and reflective, sound waves bounce around and take longer to dissipate. These environments are called reverberant spaces, because the sound reverberates persistently for several seconds. Open offices range from low in reverberation to, more typically, extremely low in reverberation (dead).

While overall "liveness" of the space is important, specific reflections are often at least equally important. An open office is typically a rather dead space, where much of the sound energy is captured by ceilings, systems panels and other space dividers, and carpets. As a result, the typical open office might be very pleasant in terms of average sound level, but occasional sounds, such as people talking normally nearby, can be highly distracting in a generally quiet sound environment.

It is interesting to note that the sound level in the average office is probably quieter than it was in the

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crowded Paris bistro where Hemingway says he wrote his best stuff, "one true simple sentence" at a time.[8] The street sounds were loud, but not distracting. That's because the blend of many sounds often masks individual sounds that would be highly distracting on their own. Being in a café with many people talking is much less distracting than hearing a single person talking normally nearby. All of which confirms that there are many factors at play when employees are driven to distraction by certain office sounds.

The Psychology of Sound

Sound can be measured. Noise cannot. Noise is subjective; it's whatever an individual finds annoying or distracting. People rarely think of their own conversations, background music, or cell phone ring as "noise," but that doesn't mean it isn't perceived as noise by others. Playing an iPod at 70 dBA (a single-number measurement based on a weighted scale to approximate the range of loudness to which the ear is sensitive at speech levels) may sound enjoyable to one person, but hearing two colleagues talking at 55 dBA about last weekend's game may be distracting enough to keep that same person from finishing an e-mail.[9] This is because it is not the loudness but the content that is often the primary source of distraction.

In an office, the main distracters are "people sounds"—two-way conversations, bits and pieces of phone conversations, throat clearings, squeaky new shoes walking by, anything a listener can detect and particularly those that attract his or her curiosity. Background sounds that are regular and predictable are easier to block out; it's variety and suddenness that demand attention. That's why the hum of the HVAC fan doesn't disrupt thinking, but a burst of laughter might.

Speech Intelligibility:
How Well We Hear What We Hear

People are distracted by intermittent sounds more than a continuous sound like a hard drive or a copy machine. Therefore, intermittent sounds attract more attention, sometimes interfering with tasks and even short-term memory processes.[10] So, although a normal conversation is only half as loud as a running copy machine, the "information content"[11] of that

conversation makes it much more distracting in the open plan environment than many louder sounds.

The information also carries a long way. The most important variables for acoustical privacy in the normal open plan office are the distance between two people, the level of background sound, the orientation of the person talking, and how loud the person is talking. Any one of these variables can affect acoustical privacy.

If the sound of a person's voice is heard by a listener above background sounds, it is *audible;* if individual words can be understood, it's *intelligible.*[12] It would appear, then, that one way to help people focus on doing their jobs in an open plan space is to control all of the spreading sound waves generated by other people doing *their* jobs.

Workstation configuration can also help, since people who are aware of the presence of others may modulate their voices to a lower level. This obviously varies depending on the culture of a particular office and an individual's work style. It may be more effective to change the orientation of the seated person in a workstation, altering where his or her voice is directed on a phone call and when talking to visitors.

Employees as Sound Wave Receivers

Ironically, there's an additional reason why sound seems to travel more readily in an open office, and it has partly to do with the fact that panels are doing their job—as are the ceiling and carpeting. Because large portions of the sound energy have been absorbed, what sounds are left to travel unimpeded seem clearer, even when they are quieter.[13]

When those sounds reach an office occupant, they find a sensitized listener. People's senses are muted in an open plan environment. They are not as visually stimulated as they might be in, say, Hemingway's Paris bistro. Workstation panels block airflow so thermal perceptions are diminished. Unless someone's making microwave popcorn, there's nothing to smell.

But the open plan space does not muffle hearing, which is therefore sharpened as the other senses are not as active due to a lack of stimuli. This may be the very reason why so many people complain about acoustics in open plan offices—hearing is put on high alert and is ready to receive whatever sound is bouncing around the office environment, as it is the dominant remaining stimulus.[14]

Applying Acoustical Solutions at Three Points

Experts have found that there are three points where sound can be controlled in the workplace: source control, path control, and receiver control. In other words,

one can control sound at its place of origin, as it travels, or when it arrives at a listener's workstation.

Source control can be achieved by simply asking people to talk more softly, and by changing work surfaces to reorient the direction the talker is facing. Improving sound absorption in workstations with surfaces that are reflecting sound or applying effective sound blocking are two examples of path control. Two ways to accomplish receiver control are to provide headsets to an employee or install sound-masking technology at a workstation.[15]

Privacy and Distraction in Open Spaces

Open plan office workers almost universally report they desire more acoustical privacy and fewer distractions. The distinction between the two relates to perspective. Privacy involves a person concerned about being overheard. Distraction comes into play when a person is focusing on tasks that require a high level of mental engagement and sounds in the environment interfere with his or her concentration.[16]

Sounds, whether they relate to one's perception of privacy or one's definition of distraction, are vital parts of work life. They connect us to others and create a sense of community. This could be one reason why many private-office occupants leave their doors open so much of the time.

What workers in an open plan space really want is the same thing that the private-office occupant has: the option for privacy. But the simple fact of the matter is that most employees do not have significant continuous privacy requirements, while many actually do require higher degrees of collaboration than were needed a few decades ago.

Based on information collected from 13,000 participants in 2002, researchers found that 80 percent of all work the participants did was either quiet, solitary work or sound-producing interactions—discussions or phone conversations—all of which took place within or near the participants' own workspaces.[17] These two incompatible activities underscore just how difficult it is to achieve a balanced soundscape within an open plan space.

The annoyance level a person feels can be common to most of his or her coworkers, or it can come down to individual response and preference. People are the point. No matter how much sound is controlled in an environment, individual differences partially determine the perceived quality of sound in the workplace. Managing how a person relates to his or her environment, and to other workers, may be a useful means of sound management much like modifying the physical space. Discovering how to improve the *perception* of sound quality, therefore, becomes crucial to having satisfied workers in every type of office.

Privacy and Policy

Overhearing conversations diminishes the sense of privacy in the office. Studies show that a continued lack of voice privacy has a negative impact on productivity and job satisfaction. One aspect of speech privacy is the ability to have confidential conversations, important for nearly all knowledge workers but critical for those involved in, for example, human resources and finance.

In cases involving sensitive personal information, privacy is no longer just a personal worker preference; it is legislated. Issues such as identity theft and the privacy of medical records have stepped up the need for voice privacy in specific office settings. Canada's Privacy Act of 1983 was a groundbreaking law that limited the amount of personal information the government was allowed to collect or disclose. In the United States, the Health Insurance Portability and Accountability Act (HIPAA) forbids even accidental disclosures of patient information, such as might be gained from overhearing a doctor on the phone or a face-to-face discussion between two doctors.[18] This has now been broadly interpreted to apply to employee benefit information.

There are also some state-specific laws, such as California's new identity-theft legislation. It requires companies to notify people if there's any kind of breach that suggests personal information has been taken. To be more careful and comply with this law, companies are reexamining their office layouts and data storage.[19]

Another response to legislated privacy has been the emergence of a new technology known as voice scrambling. To date, it is one of the most effective ways to provide voice privacy. This technology uses a person's natural voice to create a complex set of voice sounds. These sounds make speech—on the phone or in face-to-face conversations—more difficult for others to understand, even at small distances.[20]

Planning: Laying the Groundwork

Acoustical needs can be addressed effectively in open plan spaces, particularly when the project starts with careful planning. It should come as no surprise that in the toolboxes of designers and acoustics experts, planning is first among important strategies. And the earlier the planning starts, the better.

Planning first involves programming the needs of the occupants by job description and by their position in

the proposed space. This information then must be tested against what is possible and how much of the project budget can be used to invest in acoustical performance.

Evaluating and addressing a building's acoustics before occupants move in improves the probability that the overall space itself will offer the best acoustical quality possible. Building performance extends beyond acoustics to issues such as natural light accessibility, lighting quality, thermal comfort, and indoor air quality, but it's especially crucial for sound.

In working with an acoustics expert, designers can begin to lay out the broad strokes for the sound solutions they will later have to fine-tune once people's voices, outside traffic, office equipment, music, and all the other elements of the office soundscape are added.[21]

The privacy and collaboration needs of occupants enter into this preliminary work as well. First, however, planning prepares for the success of the space itself, the "careful coordination of the several components, ceiling, wall treatments, furniture and furnishings, heating, ventilation, and air conditioning system, and appropriate sound masking and voice privacy systems."[22]

Planning that starts early in the building project is also the most cost-effective way to go, because mistakes in the acoustical environment can be much more expensive to fix after an office is up and running. Here's an example of the difference between up-front work and retrofitting. A wall separating a conference room from an open plan area can have sound-blocking materials applied cheaply during construction—fiberglass insulation, layers of gypsum board and acoustical caulk, HVAC noise isolation, along with a ceiling chosen based on its sound-absorption and transmission qualities. A retrofitted solution may involve completely rebuilding the wall and replacing the ceiling tiles, at many times the expense.[23]

Over a 10-year period, the workplace represents about 5 percent of the total cost and technology about 10 percent. However, employee salaries and benefits account for over 80 percent of the total.[24] Therefore, planning for a good acoustical environment that satisfies the largest number of employees will protect the biggest resource investment that a business makes—in its workforce.

To help the workforce be as productive as possible, three specific techniques can be applied during planning and in application to deal with sound waves as they travel on their diffracting, reflecting, and direct

paths between sources and receivers. These are sound absorption, sound blocking, and sound conditioning of a space.

Sound Absorption: For Reflecting and Direct Paths

Everyone knows how rugs and pillows, thick curtains, and overstuffed chairs can take the echo out of a big, empty room. Like a thick paper towel soaking up water, these sound-absorbing materials soak up sound waves; they are trapped in an internal maze of air pockets. As the sound waves work their way through the maze, they slowly lose the sound energy they are carrying. Emerging from the absorbing material, the waves are weaker and softer in volume.

In early open plan offices, acoustics experts added sound-absorbent materials such as fiberglass, shredded wood fiber, or paper honeycomb to the structure of ceilings and walls, along with adding carpeting to bare floors in order to weaken reflecting sound waves. By adding barrier materials between absorbent layers, they reduced the travel of direct sound.

Today, experts have confirmed that, although a ceiling cannot accomplish the sound absorption task by itself, ceilings with the correct absorption properties, used in combination with appropriate barrier materials, play an essential role in office acoustics.[25]

Spray-on applications can be used on beamed or concrete-slab ceilings, and sound-absorbing elements can also be hung from the ceiling to improve their absorptive qualities. Incorporating environmentally friendly acoustical enhancing materials—in the form of wall treatments and freestanding elements—absorbs excess sound energy and reduces the echo in a space to make it a more comfortable and pleasing environment.

Floor coverings also present important sound-absorption opportunities—with carpeting absorbing many times the airborne sound that can be dealt with by other flooring materials.[26] Typically, the thicker and higher quality the carpet the better it is at absorbing sound. And it's best at absorbing high frequency sounds.

The direct path that sound waves take through panels can be addressed by sound barriers. Looking at one critical variable—distance between speakers—highlights how sound barriers can help. When people in adjacent workstations are at least 12 feet apart, direct sound waves are weakened by the traveling distance, allowing sound absorption to become effective. This tactic is obviously less useful in smaller workstations.

Sound Blocking:
For Direct Paths and Shorter Distances

Sound blocking materials added to the panel have a strong additional benefit in stopping sound transmitting through the panels. Although the best sound-absorption materials are lightweight and porous, the best sound-blocking materials are dense and heavy. Solid masonite, metal, hardboard, and glass are good examples of sound-blocking barriers. With little air space for the sound waves to slip through, panels with tightly packed, sound-blocking barriers reduce the direct paths into these close, neighboring workstations.

Barriers with a high sound transmission class (STC) rating are more effective at redirecting the path of sound waves. For the best acoustical results, these barriers, such as systems furniture panels, need to be at least 65 inches high.[27]

In spaces where the trend continues for lower-height panels, panels will play no significant role in acoustical control. It's important to keep this in mind, especially in workstation areas where speech privacy is now required by law, such as a call center that handles credit card information or medical records. It's also important to note that without barriers for blocking, speech can often be heard 50 to 70 feet away without sound masking and 25 to 35 feet away with sound masking.

Sound-blocking strategies are also important in environments with multiple venues for work, each supporting a focused range of activities instead of trying to meet all of a worker's privacy needs in one space. Approaches can include slab-to-slab partitions for especially noisy fixed-wall spaces, such as conference rooms; sound seals around any fixed-wall doors; and retractable door bottoms that help seal a door once it's closed.[28]

Sound Masking:
Disguising the Sound Waves Left Behind

Even with the best sound absorption and sound blocking, there will always be some sound waves left to travel around an open plan space. Sometimes, additional benefit can be gained by adding sound, not subtracting it.

Sound masking conditions a space, enlivening it with a consistent, unobtrusive background sound that makes other sounds less clear. Though sound masking will not provide total voice privacy and confidentiality, it makes many office sounds less noticeable and reduces distractions, allowing workers to concentrate better.

The best sound-masking technology produces a speech-range spectrum, which sounds like moving air and targets the frequencies of the human voice in order to mask them. "Pink noise" has become a popular way to refer to this spectrum. It comes from a loose analogy between sound and light spectrums. (Compare "white noise," a term popularly used to describe sound from a broader spectrum of frequencies.)

Sound-masking systems are of two basic types, self-contained and centralized. A self-contained system has individual sources, each producing its own constant sound. Each speaker has its own sound source, and in some systems that are available, each speaker's volume can be adjusted independently. These systems work best in smaller spaces, up to 5,000 square feet.

A second type of sound-masking system is centralized, and is used in larger spaces. The speakers are hung above the ceiling and are spaced, arranged, and tuned to meet different masking needs in different zones of the office environment. Each speaker zone can be controlled from a central location so that changes can be made if new offices are added, occupants move, or individual needs change.

New technologies have also emerged that are specifically designed to address speech privacy. These technologies continue to evolve, but already they provide a high degree of speech privacy for people talking on the phone or having face-to-face conversations.

No "One Size Fits All" Solution

Managing sound, a constantly moving and shifting entity, is not simple. Acoustical experts have come to realize that it's futile to attempt a cookie-cutter solution for every open plan office. These spaces vary greatly in both architecture and design, and typically they change over time, possibly making an initial solution less effective.

Elements such as room dimensions, ceiling height and structure, and placement of doors, windows, and lighting fixtures will all affect each office's soundscape. The number of elements that contribute to an acoustically pleasing space and the flexibility of open plan design can provide tremendous advantages in dealing with acoustical issues if they are approached holistically.

Planning open-office spaces should involve a partnership among many practitioners, including architect, facility manager, furnishings supplier, and acoustics experts. Working together, they can select the appro-

priate furniture components, ceiling and carpeting treatments, and sound-masking systems. As these people with their various areas of expertise work through the details for a space—along with an acoustical expert as a team member—they are much more likely to achieve a favorable balance for the office soundscape.

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