Evolution of Office Acoustics

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Until recently, workplace design emphasized delivering privacy using partitions between work stations, plenty of overhead absorption, and background sound levels that masked sound levels. More modern workplace designs are trending toward increased collaboration by removing visual barriers between workstations to improve openness between occupants. With visual connections, these spaces are more inviting to the audible presence of others, promoting greater interaction and participation between team members. However, these workspaces do not provide the same level of perceived speech privacy and separation of privileged information, such as information contained in private phone calls or private meetings. With the migration away from individual private offices and high-walled cubicles to these open office concepts, expectations for office acoustics must be re-evaluated. This article summarizes the evolution of office acoustics, current design approaches, and future design considerations.

Once upon a time, office design emphasized enclosed offices and separating partitions between workstations. This design emphasized acoustic privacy and noise control. A proper balance of acoustical metrics such as STC, CAC, and NC (Sound Transmission Class, Ceiling Attenuation Class, Noise Criterion) afforded the sense of the separating architcture, amount of acoustical absorption, and background noise level.

A combination of private offices and high to moderately high-partition workstations was used for decades (Figure 1). However, there has been a shift in office design in an effort to increase collaboration and openness, leading to a decrease in the number of private offices and the lowering or complete removal of architectural partitions separating individual workstations (Figure 2).

Other design aspects such as access to natural light, facilities and scalability have contributed to this push for the current open office layouts. However, this shift to higher degrees of openness has resulted in significant effects on the office space acoustical environment, including dissatisfaction over the perception of speech privacy and individual control over acoustical disruptions. Has the office space design pendulum swung too far for acoustical designers? And what will the future of open office acoustics be?

Open Office Design

Brief History of Office Design. For enclosed office layouts, acoustical design focused on acoustical separation (Figure 3). This was done in primarily three ways:

Airborne noise reduction of surrounding architecture (STC of a wall type or CAC performance of an acoustical ceiling tile). Amount of absorption included in the space, particularly on the ceiling plane (NRC or noise absorbed in the speech frequency range). Controlling background noise in the space, since acoustical separation is fundamentally an issue of signal-to-noise ratio. The higher the background noise levels, up to a limit, the more likely an acoustic signal can be masked.

Since office design has moved away from completely enclosed offices to a combination of executive level private offices and shared partitions in an open-plan format, the ability of the surrounding architecture to reduce airborne sound has dropped. (After all, a partition only performs as well as the weakest link, and air provides an STC of 0.)

In an attempt to increase acoustical separation in these open-plan offices, acoustical design worked with limited partition heights and acoustical absorption in the space to help reduce reflections that contribute to noise levels. Additionally, increasing background noise levels of HVAC systems or environmental noise sources

Figure 1. Example of traditional open office design; note high partitions and acoustical tile ceiling that provide noise barrier and overhead absorption.
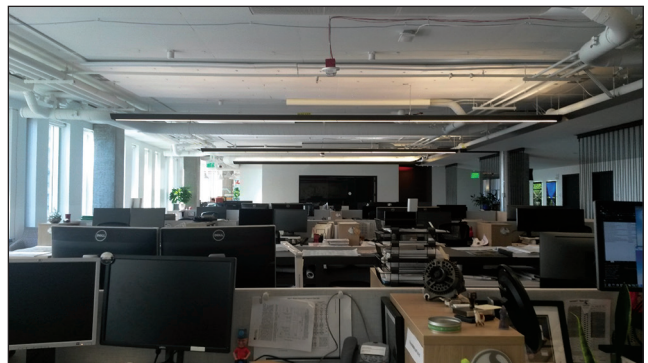

Figure 2. Example of newer open office design; note minimal partition heights and white polyester panels that provide overhead absorption.
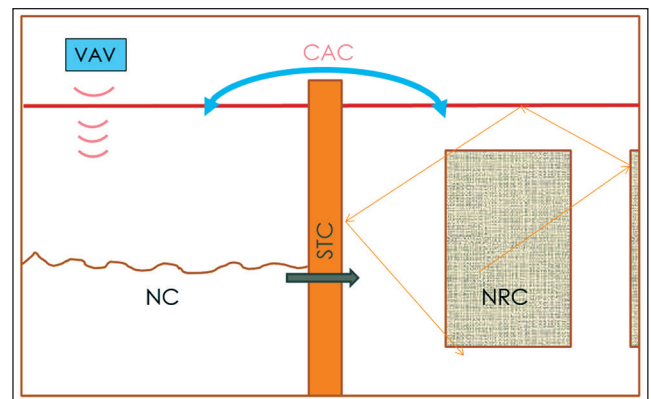

Figure 3. Image of enclosed office separation. Airborne noise reduction provided by walls (STC) and acoustical tile ceiling (CAC). Additional absorption provided by panels on walls or carpet on floor and acoustical tile ceiling (NRC). Electronic masking system or HVAC provides masking noise (NC).

to provide sound masking, or, if necessary, using an electronic sound-masking system. However, as partitions continue to shorten or disappear in the move to a true open office design, the reality becomes clear that acoustical separation and acoustic privacy, or
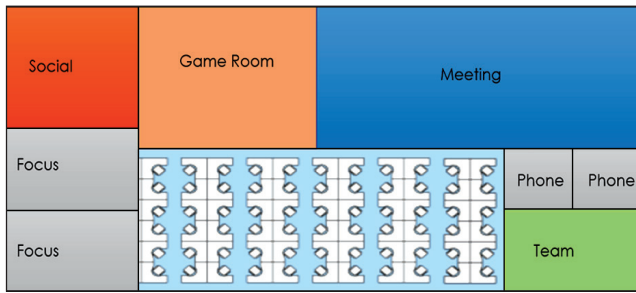
Figure 4. Example of future open office design with locations for all three types of attention. Focus and team rooms (controlled attention), the open office and meeting room (stimulus-driven attention), and the social/game and phone rooms (rejuvenation).

Figure 5. Relationship of acoustics to different aspects of office design and worker productivity, and developing new acoustical metrics.

the perception of such privacy, are minimal in most open offices.

User Response to Open Offices. Increased open-plan office flexibility brings significant acoustical compromises. Workers in open-plan offices are more likely to complain about acoustics than workers in a more traditional, enclosed office structure. More than 50% of cubicle occupants think that poor acoustics interferes with their ability to get work done and was found to be a significant environmental stressor to users.[1] Acoustic satisfaction is a function of both noise and speech privacy. Usually acoustic dissatisfaction is the result of intruding speech and telephone rings; rarely is it background mechanical noise. This acoustical dissatisfaction can lead to office conflict and strain.[1, 2, 3]

Interestingly, Jensen, et al., found that occupants in completely open office environments were more satisfied with their acoustics than occupants in cubicles, though again less satisfied than occupants in enclosed offices. This could be that open office design encourages its users to lower their acoustic output due to greater visibility. Another possibility is that the users had lower expectations of the acoustics due to perceived limitations of the space.[1]

Attention/Perceptual Load. Intruding speech and telephone noise is rarely something that a listener can control. Congdon, et al.,[4] additionally note that workplace satisfaction (not necessarily acoustical) is connected to one's sense of control over the environment.[5] This must be looked at relative to three different modes of attention:

Controlled attention (top-down), by which the user chooses which task or object to focus on. This mode of attention is the most susceptible to being interrupted by outside stimuli, since it is dependent on memory limits in the brain or the total perceptual load that allows them to attend to a specific task. The greater the amount of incoming noise that may conflict with the work task, the less memory capacity that is available for the original task.[5] As it relates to acoustics, Kocinksi, Sarampalis, et al., and Marsh, et al. have found a reduced memory capacity in the presence of noise.[6, 7, 8] This has implications on the productivity of employees in noisy environments.

Stimulus-driven attention (bottom-up), by which users let objects direct their attention. An example would be responding to emails as they come into the inbox or chatting with coworkers as work-related information comes up.[4]

The last mode is when attention is not engaged at all. Congdon, et al., name it as rejuvenation, by which individuals have the ability to recover their attentive facilities. Interruptions may or may not be welcome here, depending on whether the individuals wish to engage with others or not during this recuperation time.

So despite the reduction in acoustic privacy, what is it that makes open offices appealing? Benefits include increased collaboration – workers are more likely to collaborate and communicate with each other with closer physical proximity. This holds true even with the advent of email and advanced communication technologies.[9] Increased access to natural light, customizability in office layout – the option of being able to use a space for multiple functions, move employees without having to build up and tear down walls, is appealing from a facilities and scalability standpoint.

Conclusions / Future Design

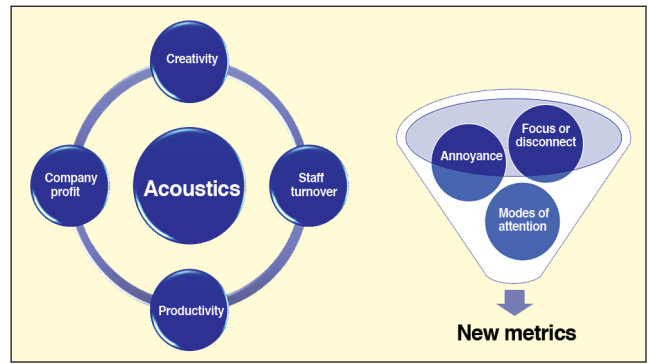In recent history, the primary goals of acoustical office designs have been to provide acoustical privacy between workstations or offices and to address office environment noise issues. Traditional metrics of privacy and intelligibility have been employed to determine when adequate amounts of privacy are provided and the level to which speech content is intelligible.

The future appears to be shifting to providing acoustical privacy programmatically (Figure 4). Separate meeting rooms and focus rooms provided for individuals to use during times where controlled attention is necessary. Nooks and other such designed spaces may also be included in office layouts as an option for rejuvenation.

This variety of spaces offers users some choice in when to engage acoustically with the environment, helping to restore a sense of individual control. Office protocols can also work to enforce policies that lead users to be thoughtful of each other's acoustic environment and privacy – electronic messaging programs have the ability to place "do-not-disturb-signs" to let people know electronically that one is busy.

Privacy within enclosed rooms will still employ traditional metrics and be provided by the proper balance between STC of demising partitions, CAC and absorption of overhead materials, and background noise or electronic sound masking. DeLoach, et al. even propose the use of "natural" sounds such as running water for use in electronic masking.[10] Further, when moving private conversations into enclosed rooms, the design mandates that a sense of privacy must be present to fulfill user expectations of the designed enclosed private spaces.

Therefore, when the privacy issue of open offices is addressed by moving private conversations into enclosed rooms or other layout options, such as nooks or booths, these traditional metrics of privacy and intelligibility are no longer valid for the noise or comfort issues remaining in the open office environment.

The future should include the development of metrics to measure or subjectively define proper open office acoustics (Figure 5). These metrics may include how to quantify annoyance, provide environments allowing for necessary workplace modes of attention, and the ability to focus on tasks and disconnect from surrounding noise.

The future could also include considering the desired results of a workforce within open office configurations and identify which acoustical elements of open office design contribute to the desired outcome. Determining the relationship between acoustical elements of office space designs and the impact or enhancements to creativity, productivity, staff turnover, and company profit may lead the acoustical design industry to these future subjective and quantitative metrics.

As for traditional acoustical design, including ample amounts of acoustically absorptive material to help reduce reflections of adjacent surfaces, particularly on the ceiling, and background noise can help to reduce the area of a person's acoustical influence.[11] But given the limited ability of acoustical separation in open offices, what does this mean for the future of open office acoustical design?

The benefits of open office design (collaboration, creativity, etc.) are pushing acousticians to find a way to balance the collaborative aspects of open design with some return to enclosed spaces for privacy. With this evolution of office acoustics, there is certainly some work ahead.

Acknowledgements

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