

Noise in Office Environments: Its effects and Means to Reduce and Control It.

The introduction and strategic location of sound-absorbing surfaces, such as acoustic ceilings, chairs, screens and floor finishes together with appropriate acoustic barriers and partitions and, where necessary, noise masking systems, if carefully designed together, all contribute towards providing an environment that provides maximum acoustic comfort to staff, strengthening the feeling of community and, in turn, helps to deliver the best from each employee.

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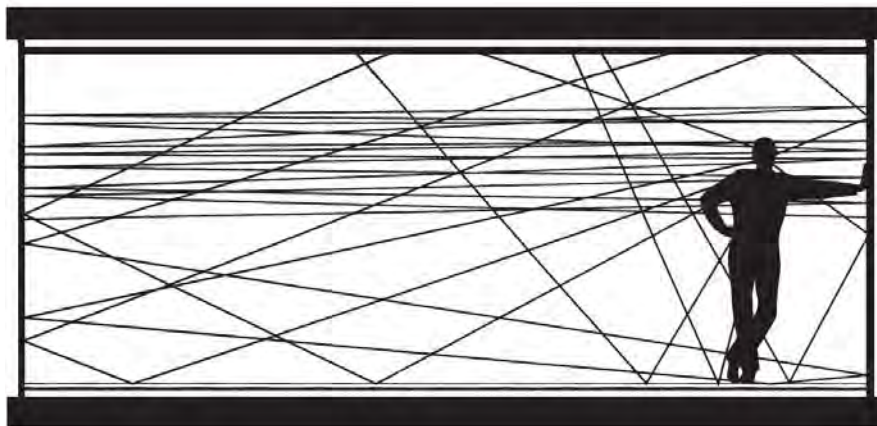
References

Noise in Office Environments: Its effects and Means to Reduce and Control It.

1.0 Introduction

Sound Principles

1.1 When any sound is created in a room such as an office, sound waves travel from the source throughout the surrounding environment. When a sound wave encounters a surface, for example a wall or ceiling, part of it is absorbed and part is reflected. The reflected sound wave continues to travel until it reaches another surface from which it can be reflected once again. Energy from multiple reflections accumulates and adds to the sound within the room. This is called reverberation. The greater the reverberation in a room, the longer the sound takes to disappear. The time it takes for a sound created in a room to reduce by 60 decibels is referred to as the reverberation time.



Sound Reflections Creating Reverberation

Sound Reflections Creating Reverberation

1.2 Rooms that comprise predominantly hard, shiny surfaces are likely to have a high reverberation time as more sound will be reflected off surfaces than absorbed. A good example of this is the sound in a bathroom. This has a merging effect on speech which becomes unintelligible as the energy created from one sound overlaps with the next. However, rooms whose surfaces are clad with sound absorbing materials such as thick carpets and padded furniture have a low reverberation time. Here, individual speech sounds may be heard cleanly without overlap which allows for a high degree of speech intelligibility.

Sound in Office Environments

1.3 Today's workplace dictates the need for open and easy communication between staff to provide an efficient working environment that promotes the exchange of ideas. In fact, in 2004, approximately 73 percent of office workers performed their work in open plan offices (Sykes, 2004). As a result modern office environments have a requirement for both a flexible and efficient use of space. In addition, it has been found that organisations can save up to 20 percent in development costs in creating an open plan office environment rather than the traditional format of offices (Hedge, 1982). Whilst these spaces may satisfy many of the practical requirements of modern business, they can lead to conflict in the workplace.

1.4 Employee satisfaction is extremely important in the work place as it influences an organisation's success and performance by improving morale. This, in turn, reduces staff turnover (Dole & Schroeder, 2001). It has been shown that employees who are comfortable with their working environment are more likely to generate better work as the physical environment affects their job perception, attitudes and job satisfaction (Lee & Brand, 2005; Sundstrom, Town, Rice, Osborn, & Brill, 1994). Careful attention must therefore be paid to design of work environments in order to facilitate productive work outcomes.

1.5 The acoustic design of offices often does not receive the attention that most other architectural systems, such as thermal and ventilation systems, would. However, unwanted levels of ambient noise, often caused by an excessively reverberant environment, can cause difficulties with communication as well as with concentration at work (Perham, Banbury, & Jones, 2007). Since the production force in any office consists primarily of people, anything that affects those people, including noise will affect their productivity (Sykes, 2004).

1.6 Noise is regarded as a source of distraction, frustration and ultimately stress amongst office workers, which can lead to higher incidents of illness and staff turnover and ultimately can affect the company's bottom line (Evans & Johnson, 2000). Some 'extremists' refer to excessive noise in the workplace as a 'hazard', not necessarily because of the effects that it can have on health and safety, but because of its effects on worker productivity. Studies indicate that approximately 80 percent of office workers believe that their productivity would increase if their working environment was more acoustically private (American Society of Interior Designers; Armstrong World Industries, Inc.; DynaSound, Inc.; Milliken and Co.; Steelcase, Inc, 2005).

1.7 Concentration is negatively affected by high levels of background noise, particularly impulsive sporadic sounds such as telephones ringing and people talking nearby. One must be aware that the human auditory system is particularly sensitive to sounds within the speech frequency spectrum which means that employees are likely to be distracted by their colleagues' speech. However, some noise in the working environment, such as steady state noise from air conditioning units, can be advantageous as it provides a useful background to aid speech privacy and hence provides an environment where confidential conversation can be held without being overheard. This acoustic backdrop may also aid in masking the more disturbing, sporadic sounds mentioned above.

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1.8 Generally, time spent working in an office environment is divided between tasks requiring concentration and tasks requiring communication. Successful communication requires a high level of speech intelligibility between communication partners. Speech intelligibility is negatively influenced by a high reverberation time within the room. Lowering this reverberation time will therefore not only increase speech intelligibility, but reduce ambient noise level improving employees' concentration and decreasing their level of annoyance.

1.9 As the effects of noise in the workplace can be positive as well as detrimental the need for good acoustic design cannot be over-emphasized. This can be achieved with the introduction and strategic location of sound-absorbing surfaces, such as acoustic ceilings, chairs, and floor finishes together with appropriate acoustic screens and partitions and, where necessary, noise masking systems. If carefully designed together, all of these elements contribute towards providing an environment that provides maximum acoustic comfort to staff, strengthening the feeling of privacy and, in turn, increasing employee satisfaction and productivity.

1.10 Section 2 of this paper provides a review of scientific papers that have studied the relationship between noise in office environments and the effects upon the workforce using these offices. Section 3 includes details of the strategies and types of products that may be employed in order to optimise the acoustic environment in offices, enabling employers to provide a healthier and more productive environment for their employees and clients.

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2.0 The Effects of Noise in the Workplace: Summary of Recent Research

2.1 Numerous research studies have confirmed that noise, in addition to causing nuisance and disturbance in an office environment, is a primary cause of reduction in productivity and can contribute to stress and illness which, in turn, can also contribute to absenteeism and turnover of staff (Abbot, 2004). Stress, whilst being a psychological condition can, if prolonged, cause physiological effects, which include headaches and nausea and, in the long-term conditions such as diabetes and elevated blood pressure all of which can lead to loss of productivity and absenteeism (Oomen, Knowles, & Zhao, 2008).

2.2 One specific study (Banbury & Berry, 2005) assessed subjective reports of distraction from various office sounds among employees at two different sites. The study examined the amount of exposure the workers had to the noise in order to determine any evidence of habituation (the ability of workers to get used to the noise so that it is less distracting). 99 percent of the respondents reported that their concentration was impaired by various components of office noise (particularly telephones left ringing on unoccupied desks and people talking in the background). The study also indicated that employees are unable to habituate to noise in office environments over time, indicating that this noise is a problem, for most employees, which does not improve over time.

2.3 A survey was conducted at the Centre for the Built Environment (CBE) at the University of California Berkeley (Jensen, Arens, & Zagreus, 2005) in which 23,450 respondents from 142 buildings were included. It was found that occupants of private offices were significantly more satisfied with noise levels and speech privacy than were occupants in open plan offices. In fact, over 50 percent of cubicle occupants expressed that acoustics interfere with their daily work. It must be additionally noted that 30 percent of occupants of private offices also felt that acoustics influenced their productivity.

2.4 A study undertaken in Japan (Mouri, Akiyama, & Ando, 2001) investigated the relationship between a telephone ringing and mental tasks which would typically be undertaken in an office environment. The results, which were based upon an adding and a drawing task, indicated that both were performed to a higher standard when the telephone was not ringing, providing an indication of the effect of noise from ringing telephones on cognitive performance.

2.5 A study, published in the British Journal of Psychology, asked workers to perform two tasks. In one they memorised and then recalled a piece of prose and in other they undertook simple mental arithmetic. During the tests the subjects were played recordings of general office noise. It was found that the accuracy of their work, when exposed to this noise, reduced by approximately 67% (Banbury & Berry, 1998).

2.6 Another study was undertaken at a call centre when measures were taken to improve the acoustic environment following a refurbishment. A 300 percent increase in perceived 'worker satisfaction' was reported as a result of the reduction in noise levels from conversational noise. In addition a measured 20% increase in sales productivity was recorded at the end of the six months following the refurbishment (American Society of Interior Designers; Armstrong World Industries, Inc.; DynaSound, Inc.; Milliken and Co.; Steelcase, Inc, 2005).

2.7 A paper was written in 2004 reviewing research relating to the effects of conversational noise on office workers. It was found that when conversational noise was reduced and speech privacy increased, the ability of office workers to focus on tasks improved by 48%, conversational distractions decreased by 51%, performance of tasks relating to accuracy and memory improved by 10% and the actual physical symptoms of stress such as high blood pressure and increased heart rate were reduced by 27% (Sykes, 2004).

2.8 A review was published late in 2008 which caught the attention of several newspapers internationally. The authors assessed many articles and studies carried out involving the effects of working in open plan offices. It was found that noise is a dominant disturbing force in the open plan office environment which leads to poor employee satisfaction, lower morale, decreased productivity, increased stress levels, increased absenteeism and overall increased staff turnover (Oomen, Knowles, & Zhao, 2008).

2.9 The studies reviewed all indicate that even low levels of noise in an office environment can cause increased distraction and stress amongst employees which can lead to a reduction in productivity and can ultimately affect a company's financial performance.

"Noise is a dominant disturbing force in the open plan office environment which leads to poor employee satisfaction, lower moral, decreased productivity, increased stress levels, increased absenteeism and overall increased staff turnover"

The following section describes how good office design, with selection of appropriate products can overcome the problems of excessive noise in office environments.

3.0 Solving the Problem of Noise in the Workplace

3.1 Methods for controlling and solving acoustics problems can be summarised by the acronym ABC:

A – Absorb – Describes the absorption of sound waves by suitable materials

B – Block – Describes the alteration of the sound path using screens, panels, walls etc..

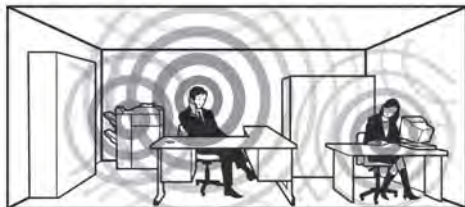
C – Cover – Describes the use of a system which produces background sound such as white noise systems and speech privacy systems.

The effects of these methods of noise control are addressed in the following sections of this paper.

A – Absorb: The Effects of Acoustic Absorptive Materials in Improving the Office Acoustic Environment

3.2 Acoustic absorption is vital in an office environment to absorb sound and prevent the space from becoming excessively reverberant. The presence of multiple speakers in a highly reverberant environment creates a phenomenon referred to as 'the cocktail party effect' (Arons, 1992). This occurs due to the high level of reverberant energy causing an increase in the overall loudness of the ambient noise and affecting speech intelligibility. Speech sounds from the speakers cause a further increase in this noise,

causing them to exert greater vocal effort in order to be heard. This has a circular effect in, once again, raising the ambient noise level and decreasing speech intelligibility.



Room with little sound absorption



Room with sound absorption through acoustically treated office furniture



Room with sound absorption through acoustically treated furniture, floor and ceiling

3.3 Acoustic absorption may be provided by a number of different products, including acoustic ceilings, wall absorbers, absorbing acoustic screens, floor coverings and by chairs and other furniture. Absorptive materials absorb much of the sound that is incident upon them, minimizing the amount of reflection, reducing the amount of reverberation in the space and hence reducing the ambient noise level and improving speech intelligibility. In addition, these lowered ambient noise levels will cause employees to speak at a lower sound level, thereby preventing the occurrence of the cocktail party effect.

B – Block: The Effects of Acoustic Screens in Improving the Office Acoustic Environment

3.4 According to some studies, speech has been found to be the most annoying sound source in open-plan offices. The most distracting speech originates from the nearest workstations. Therefore, speech privacy between workstations should be as high as possible. Acoustic screens are commonly installed between workstations and can act as a sound barrier as well as providing sound absorption. Screens may also be used as temporary partitions to provide cellular office space. The screens aid speech privacy by reducing the level of sound transmitted (for example from an operator using a telephone) between workstations or, where screens are used as temporary partitions, to provide a degree of privacy for the occupants of the cellular space.

“Speech has been found to be the most annoying sound source in open-plan offices. The most distracting speech originates from the nearest workstations. Therefore, speech privacy between workstations should be as high as possible.”

C – Cover: The Effects of Noise Masking Systems in Improving the Office Acoustic Environment

3.5 A ceiling manufacturer conducted studies in which ceiling systems were replaced with absorbent equivalents and sound masking systems. Employees in a number of companies were surveyed prior to and following the works. The workers indicated that ‘freedom from auditory distractions was the most important feature in efficiently and effectively accomplishing their work tasks’. 80 percent of workers believed they would be more productive if their workspace provided more acoustical privacy and, in cases where distractions from noise were reduced, a 25 percent increase in the perceived quality of the work environment was reported, with a 27 percent reduction in stress and a 20 percent increase in productivity (American Society of Interior Designers; Armstrong World Industries, Inc.; DynaSound, Inc.; Millikin and Co.; Steelcase, Inc, 2005).

3.6 Noise masking systems are commonly used to artificially increase the ambient noise level in a particular area to provide a background noise ‘mask’ to aid speech privacy. They work by providing a constant, low-level background noise and are particularly suitable for use in areas where confidential conversations are required (such as within meeting rooms) but where the sound insulation between these noise-sensitive areas and the areas outside is not adequate. Introducing a source of steady ambient noise to the area outside of the sensitive space can significantly improve speech privacy but, due to the broadband nature of the sound used, does not cause worsening speech intelligibility.

3.7 The design of a noise masking system is particularly critical as it effectively introduces a new source of noise into an area and could, if incorrectly designed, provide a source of distraction. Noise masking systems should therefore be designed within the context of each particular space, taking into account the absorptive properties of each area.

4.0 Conclusions

4.1 A review of recent scientific studies has confirmed that excessive noise in office environments can be a source of disruption and stress, ultimately leading to a decrease in the productivity of office workers.

4.2 As we progress deeper into a multi-media age it is likely that new technology will introduce new potentially intrusive sources of noise into the office environment. Examples include internal communications via multi-media sources (such as video casts), the use of voice-controlled software and PC hardware, delivery of training by audio/multimedia and text-to-speech technology, allowing users to listen to their email, reports and other written communications (Ross, 2003). This means that while one may enjoy the acoustics in a particular open-plan office, this may very well change in the near future.

4.3 These issues, however, can be mitigated by proper acoustic design to support both individual and team workspace acoustic requirements. The ABC system can be dealt with in 5 different areas within every office environment. These areas are furniture (including chairs, screens and storage), ceilings, walls and windows (including wall mounted systems and blinds), flooring and masking systems. In addition, consideration should be given to space planning and layout to ensure that there is no conflict between areas with different acoustic requirements associated with the communication and concentration that forms the main tasks in an office environment.

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