

Design Guidance on eliminating office noise: **A psychoacoustic approach**

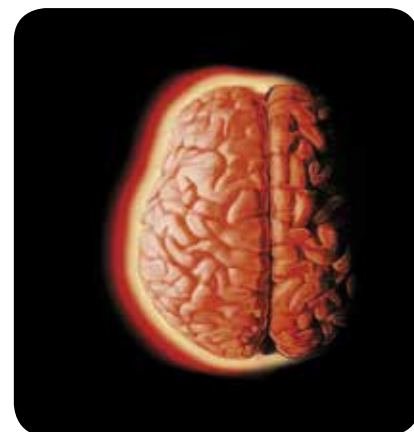


Psychoacoustics - addressing psychological and physiological factors

In our previous “sister” document, we presented the findings from our literature review and research survey and the case for a psychoacoustical approach to resolving noise in the office.¹ This short guidance document builds on those findings and explains the implications for open-plan office design and how to realistically create a more acoustically comfortable working environment.

When conducting our extensive literature review we found that approximately 75% of perceived noise annoyance can be attributed to personal and psychological factors.² This is not surprising as noise is usually defined as “unwanted sound”, where we each individually decide whether we consider a particular sound to be a noise or not. The factors affecting our interpretation include; personality, age, activity, perceived control and context (time of day, source and type of sound etc).

“Psychoacoustics is the scientific study of the psychological and physiological responses associated with sound”



At the neurophysiological level, each person is uniquely wired and therefore interprets and responds differently to each of the senses. We are genetically programmed as to how much sensory information our brains need in order to process this sensory information. This is known as a threshold. Individuals have different auditory thresholds.³

To resolve noise distraction in the office therefore requires exploring the psychological, physiological and physical factors – the realm of psychophysics. More specifically, psychoacoustics is the scientific study of the psychological and physiological responses associated with sound. In other words, the understanding of how people perceive, interpret and react to sound. Our approach outlined below is therefore grounded in psychoacoustics.

DARE to tackle noise

Displace the noise by providing easy access to separate areas for noisy activities to take place e.g. informal meeting areas, breakout and brainstorming rooms. Ensure such spaces are located away from the main work areas.

Avoid noise by allowing the occupants the choice of where to work so they can find quiet spaces e.g. focus rooms and home-working. Locate noisy teams together and away from the quieter teams, or designate quiet zones within the office where people can work free from distraction.

Reduce the noise distraction by providing a reasonable desk size and limiting the occupational density. Use good acoustic treatments to reduce speech intelligibility across open-plan areas and noise transference between rooms.

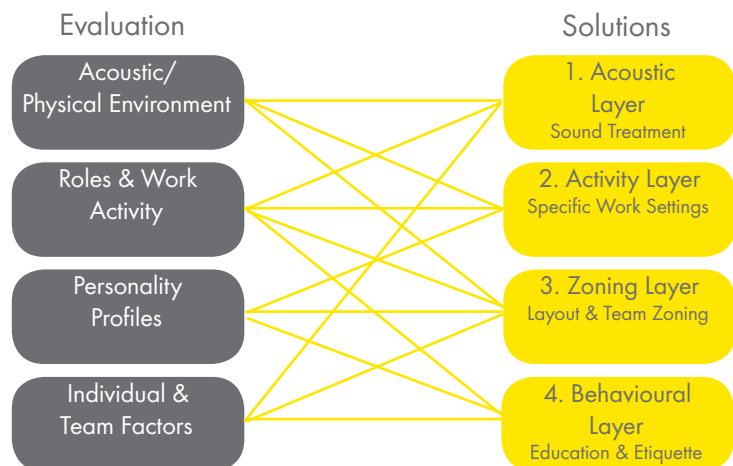
Educate by introducing a form of office etiquette, covering phone use, loud conversations, music, headphones, managing interruptions, how different work-settings are used and appropriate use of “do not disturb” signals. Explain to staff how the office layout works, the facilities available to them and how they can control noise.

Displace
Avoid
Reduce
Educate



Evaluation toolkit and key factors

Based on our research findings we have developed a toolkit to help us create better acoustic working environments. There are three core evaluation elements to the toolkit; acoustic measurement, an occupant survey, and an expert appraisal.^{3,4} Each evaluation method inputs to the required solutions, of which there are four layers. The layers all build on the DARE principles identified in our previous report (see box on previous page).



Acoustic measurement – Physical measurements are carried out by acousticians and may include for open plan offices: STI (speech transmission index) in the nearest workstation, distraction distance (rD), privacy distance (rP), the spatial decay rate of A-weighted SPL (sound pressure level) of speech (D2,S) and an A-weighted SPL of speech at 4 metres (Lp,A,S,4 m).⁵ An expert walkthrough, either physically or via notations on the floor plans, will also help verify any acoustic issues raised by the building occupants or design team.

Occupant survey – An online survey is used to profile the proportion of personality types in each team, to determine job roles and associated key work activities, to ascertain relevant individual factors such as age, and understand any team factors. The personality profiles are based on the Big Five personality inventory or OCEAN: Openness, Conscientiousness, Extroversion, Agreeableness and Neuroticism.⁶

Expert appraisal – This involves a short session with the facilities manager or estates team where relevant factors are assessed for current, or proposed, offices. The appraisal session is used to review the personality profiles, activities, options for choice/control and acoustic design features. Our appraisal tool then automatically recommends the appropriate solutions to help create a better acoustic environment.

Design guidance and layered solutions

1. Acoustic layer

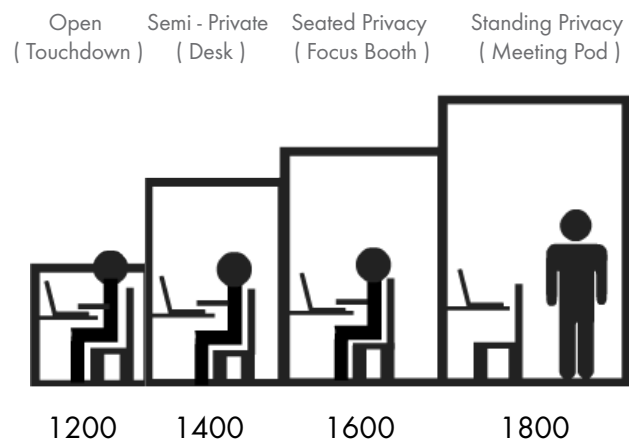
Our approach to resolving noise distraction is a psychophysical one and this starts with good basic acoustic treatment of the workspace. The primary purpose of physical acoustic solutions is to reduce speech propagation – this is mainly achieved through absorption, diffusion and barriers.

Acoustic ceiling tiles will absorb much of the transmitted sounds. A current trend in office design is to have an exposed ceiling slab; whilst this is aesthetically pleasing it will cause sounds to reflect and travel over distance. In such circumstances consider installing ceiling “rafts”. They come in a range of colours and shapes which can enhance the overall design.



Similarly, wall panels can be added for absorption to reduce speech travelling across the space particularly when the ceiling height exceeds 4m) and also in conference rooms to aide clear speech and comfort. Where there is limited space, free-standing acoustic screens or furniture can be used and panels can be hung vertically from the ceiling. This has the added benefit of breaking up the open plan space or separating equipment areas and breakout or informal meeting spaces, etc. Again, there are an unlimited range of design options for acoustic screens and panels and they can also be screen printed for visual impact or designed to blend in.

Evaluation toolkit and key factors



Desk screens are also an important means of absorption, especially for teams spending much of their time making telephone or video calls. Ideally desks screens should be placed between those sitting opposite each other and at a height sufficient to hide the mouth, typically 1400 mm, but allow visual connectivity. The more fashionable lower screens offer some control over personal space but have little acoustic benefit; side screens (as in cubicles) can lead to reduced communication, loss of perceived space and possibly isolation. Tall (1400-1600 mm) cabinets, bookshelves or other taller barriers, such as meeting pods or focus booths, placed between blocks of desks will also reduce sound/speech transference and improve acoustic privacy. Also consider the layout of the desks and whether occupants can face away from each other rather than sit face to face.

A lower density, more spacious, workplace also helps reduce noise transference. The trend for smaller desks simply means that the occupants are closer together and more likely to be distracted by their neighbours speech (unless all agree to sit in silence and not use phones, or alternatively wear headphones). The trend for increasing space efficiencies, synonymous with higher desk densities and fewer alternative work-settings, results in noisy activities being carried out in the main desk area.

Enclosed spaces, whether a focus/quiet room or meeting room, need to be designed for acoustic privacy. Poor sound treatment of such rooms may result in them being sources of distraction. Invest in well-designed acoustic partitions and if possible, build the partition up to the ceiling slab (not the underside of the ceiling tile). If this is not feasible, consider adding rigid acoustic barriers above the ceiling tiles and wall partitions to stop sound transference over the partition.

The floor treatment also needs to be considered. Carpet offers more absorption than hard flooring surfaces such as tiles or wood; at minimum consider rugs in areas were hard flooring is used. Carpet on walkways reduces distraction from footstep noise and carpet in meeting spaces will reduce noise transference.

Biophilic design

Biophilia is explained as our affinity to nature, including planting, water, natural ventilation and daylight etc. Introducing biophilic elements into the workplace has been proven to improve wellbeing and performance. Many biophilic elements also offer an acoustic design solution.⁷



Natural planting such as moss walls provide some sound absorption as well as providing a welcoming design feature. Most larger plants, including bamboo and grasses can create sound diffusion (breaking up the sound waves) as well as some visual privacy. When natural planting is not available, then products depicting nature such as green tufted carpets, or acoustic panels with nature images, may be used.

The sound level preferred by humans indoors is similar to that found outdoors in a natural environment, (approximately 50 dB) and by adding absorption it is possible to “mimic” the outside atmosphere. In nature complete quiet equates with danger and so can be unnerving in the office. Natural sounds, such as water and birdsong, have been found to have both a calming and re-energising effect leading to increased performance. Soundscapes, where subtle natural sounds are introduced to breakout spaces, may help create a more productive working environment.



Project: Google, HQ EMEA, Photographer: Peter Wuerkli Photography

2. Activity layer

In the design of any office, the work activities carried out by the occupants must be considered so that a range of work-settings can be introduced to best suit those tasks. This approach to designing workplaces is commonly referred to as Activity Based Working (ABW). For instance, if the organisation or team holds a high proportion of necessary meetings then provide the appropriate proportion of meeting spaces to support them. However, also consider the type of meeting and relevant type of space, e.g. to facilitating a productive personal 1:1 meeting requires a differently designed space to a group brainstorming session.

Successful ABW offices have a wide range of readily accessible work-settings, some enclosed and some in the open-plan. Spaces include; meeting rooms, informal meeting areas, breakout spaces, quiet booths, focus rooms or pods, refreshment/vend/café areas, brainstorming areas or rooms, project rooms etc. However, it is not only the visual design and layout of the work-settings that is important but also the acoustic design.⁸ If the work-setting is to facilitate noisy activity then that noise needs to be contained. In contrast, if the work-setting supports focussed or quiet work then it needs to reduce noise ingress.

(Informal Meeting Room)



(Breakout/Open space)



(Focus Room or Pod)



(Brainstorming)



3. Zoning layer

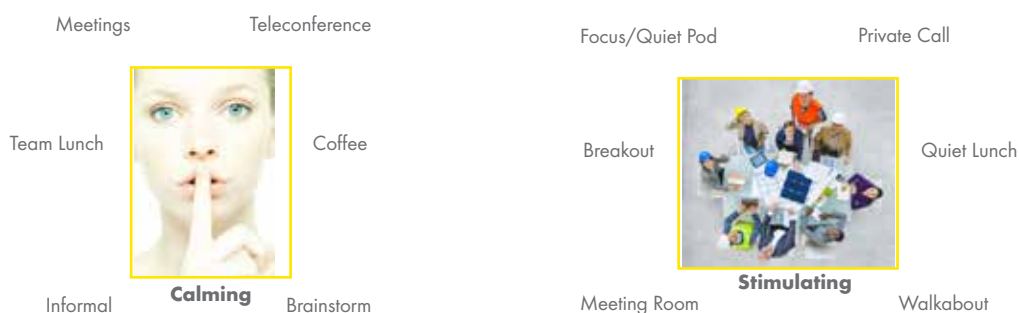
The location of the work-settings also requires consideration; far too often work-settings facilitating noisy activities are co-located in the open-plan with work-settings supporting quiet activities. Potentially noisy spaces, e.g. breakout, should not be placed directly next to areas where focussed work is being carried out, quite often the team's main desk area, unless a good acoustic barrier is provided. The workplace could also be zoned according to the potential level of noise generated in each of the work-settings, with noisy work-settings clustered together and separated from quieter work-settings, and possibly the main desk area.

Whilst zoning applies to location of the work-settings, it is more relevant to the core activities of the teams and the proportions of personality types within those teams. Our research shows that certain personality types, in particular introverts and the more anxious (neurotic), find noisy environments more stressful than their counterparts leading to poor wellbeing and loss of productivity. In contrast, some personality types such as extroverts find noisy environments stimulating which depending on the task they are carrying out, can improve their productivity. If the proportion of personality traits in each team is known then the appropriate acoustic environment can be created for the predominant type, i.e. either a quiet or noisy base zone.

Zoning according to personality type may on first appearance seem impractical, with a preference to co-locate team members. However, research shows that certain personality types are attracted to particular jobs so it is likely those discipline-based (functional) teams will have a high proportion of the same personality type. For example, a finance team involved in heavy processing of data will usually attract a high proportion of introverts who are better suited for conducting repetitive detailed tasks. In contrast, a sales team will attract more extroverts who seek stimulation and take more risks, focus more on the big concept than details, and thrive on meeting and socialising with people. It seems counter-productive that many organisations use personality profiling to fit their recruits to their ideal role but then locate them all in the same large open-plan workspace even though they require quite different environments to succeed.

| Personality | Task | Quiet | Noisy |
|-------------|---------|-------|-------|
| Introvert | Simple | 😊 | 😐 |
| | Complex | 😊 | 😡 |
| Extrovert | Simple | 😡 | 😊 |
| | Complex | 😐 | 😐 |

Of course, many organisations have multidisciplinary teams based on projects or accounts. Previous research has indeed shown that the most successful and productive teams usually have a rich mix of personality types.⁸ In such cases the team members occasionally need to come together to collaborate. Offering choice over where to sit, a core ABW principle, allows different personality types to co-locate when required but then they can retreat to the workplace zone that best suits them and their core work activities.



Creating a base quiet or noisy zone is the first stage of the design process. For example, whilst the majority of work may involve concentration and require quiet, at other times the worker will be involved in meetings and presentations or wish to break from their work and socialise with colleagues. So spaces around and accessible from the quiet zone will be needed for noisy activities. Similarly, those in a base noisy zone will occasionally require access to quieter spaces for concentration, contemplation or conducting activities requiring privacy.

4. Behavioural layer

Even the best designed workspace will not be successful if it is inappropriately used. This final layer is less about the physical design but more about how to influence the behaviour of those using the space.

Choice and control – A first step to changing behaviour is to provide a genuine choice of work-settings that support a range of personality types carrying out different work activities. These settings should be within the workplace, as part of the ABW menu, but also outside of the workplace such as occasional home-working or remote working in cafés and libraries etc. Research shows perceived control is critical in reducing noise distraction. A range of different work-settings offers perceived control and this relates as much to when they are used as well as their design. Choosing the time of day to work, whether early or late, and where to work, including occasional home-working, reduces noise distraction. Clearly demarcating the noisy and quiet spaces within the office will inform choice and control.

Acoustic etiquette – The occupants may require reminding or educating on acceptable behaviour within the open-plan office. Any guidance or charter on how to use the office is best generated and agreed by the occupants. Whilst some occupants may find this approach trivial, some personality types (agreeable, introverted, neurotic) welcome some structure and agreed guidelines to refer to. For example, the guidance may include advice on respecting people's time and recognising when they are busy and should not be interrupted. It may include advice on how to tackle people making unnecessary noise through chat, or impromptu meetings, and telephone calls (in particular mobile phones and hands-free). Introducing acoustic etiquette tends to be less successful if a choice of work-settings are not also provided.

Signals and visual cues – Acoustic etiquette involves reading whether colleagues are busy or available. This usually relates to posture and observed concentration but some organisations have experimented with using coloured flags or other devices on their desks. An electronic version of "do not disturb" traffic light systems are the presence indicators on instant messaging. Many people actually use headphones or ear buds to just indicate that they are busy, rather than to actually play music to mask the noise. Our behaviour in an environment is affected by our expectations and experience of that place such that certain design elements can invoke a particular behaviour (sometimes referred to as "nudging"). To clarify, we all know how to behave appropriately in a library (or church) and introducing the design elements of such environments into the workplace can influence the use of space. For example, bookshelves and books not only offer sound barriers and absorption but also invoke quieter behaviour.

Practical / example office layout and design

- The hard floor surfaces, particularly along the circulation route, are replaced with carpet to reduce impact sound distractions (footsteps).
- Acoustic rafts are added to the exposed ceiling slab.
- Acoustic wall panels are added to reduce speech propagation.
- The windowless wall is replaced with a live (or artificial) moss wall.
- The meeting room partition is upgraded to double glazing.
- An acoustic wall panel is added to the meeting room walls to improve speech clarity and reduce "echoes".
- The height of the desk screens is increased and tall bookshelves, cabinets and plantings are added to provide semi-private partitioning between the desks.
- The informal meeting furniture along the circulation route is replaced with high-backed seating for acoustic and visual privacy.
- The breakout furniture is upgraded with heavier, more absorbing, upholstery.
- Nearby enclosed meeting pods are also introduced.
- The floor plan is zoned with quieter spaces at one end and noisier meeting spaces at the other.
- The shelving and plantings are applied to help create noisy/quiet and team zones.
- An office charter is introduced which explains the available work-settings and how to use them to reduce noise distraction. For example, use the pods and high-backed seating for loud (private) mobile phone conversations.

Before



After



Before



After



Before



After





Produced by Nigel Oseland and Paige Hodsman on behalf of Ecophon.

- ¹ People-centred Offices: A Psychological Approach to Resolving Office Noise Distraction. Ecophon, 2015.
- ² Lombard, A, Sensory Intelligence: Why it matters more than IQ and EQ. Metz Press, 2007
- ³ Oseland & Hodsman, Planning for Psychoacoustics: A Psychological Approach to Resolving Office Noise Distraction. Workplace Unlimited, 2015.
- ⁴ Oseland, Psychoacoustics Survey Results: Psychological Factors Affecting Noise Distraction. Workplace Unlimited, 2015.
- ⁵ ISO Standard 3382-3, Acoustic Parameters for Open Plan Offices, 2012-01-15
- ⁶ Pervin & John, Handbook of Personality: Theory and Research. Guilford Press, 1991, pp. 102-138.
- ⁷ Browning, Ryan & Clancy, 14 Patterns of Biophilic Design. Terrapin Bright Green, 2014.
- ⁸ van Meel, Martens & van Ree, Planning Office Spaces: A Practical Guide for Managers and Designers. Laurence King, 2010.
- ⁹ Oseland, The Psychology of Collaboration Space. Herman Miller, 2012.



Ecophon dates back to 1958, when the first sound absorbers manufactured from glass wool and designed to improve the acoustic working environment were produced in Sweden. Today, as part of the Saint-Gobain Group, the company is a global supplier of acoustic systems that contribute to good room acoustics and support a healthy indoor environment, with the focus on offices, education, healthcare, retail and industrial manufacturing premises.

Ecophon's efforts are guided by a vision of earning global leadership in room acoustic comfort through the design and manufacture of sound-absorbing systems that enhance end users' performance and wellbeing. Ecophon maintains an on-going dialogue with government agencies, organisations and research institutes, and is involved in formulating national standards in the field of room acoustics.

Ecophon contributes to a better working environment wherever people work and communicate.

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