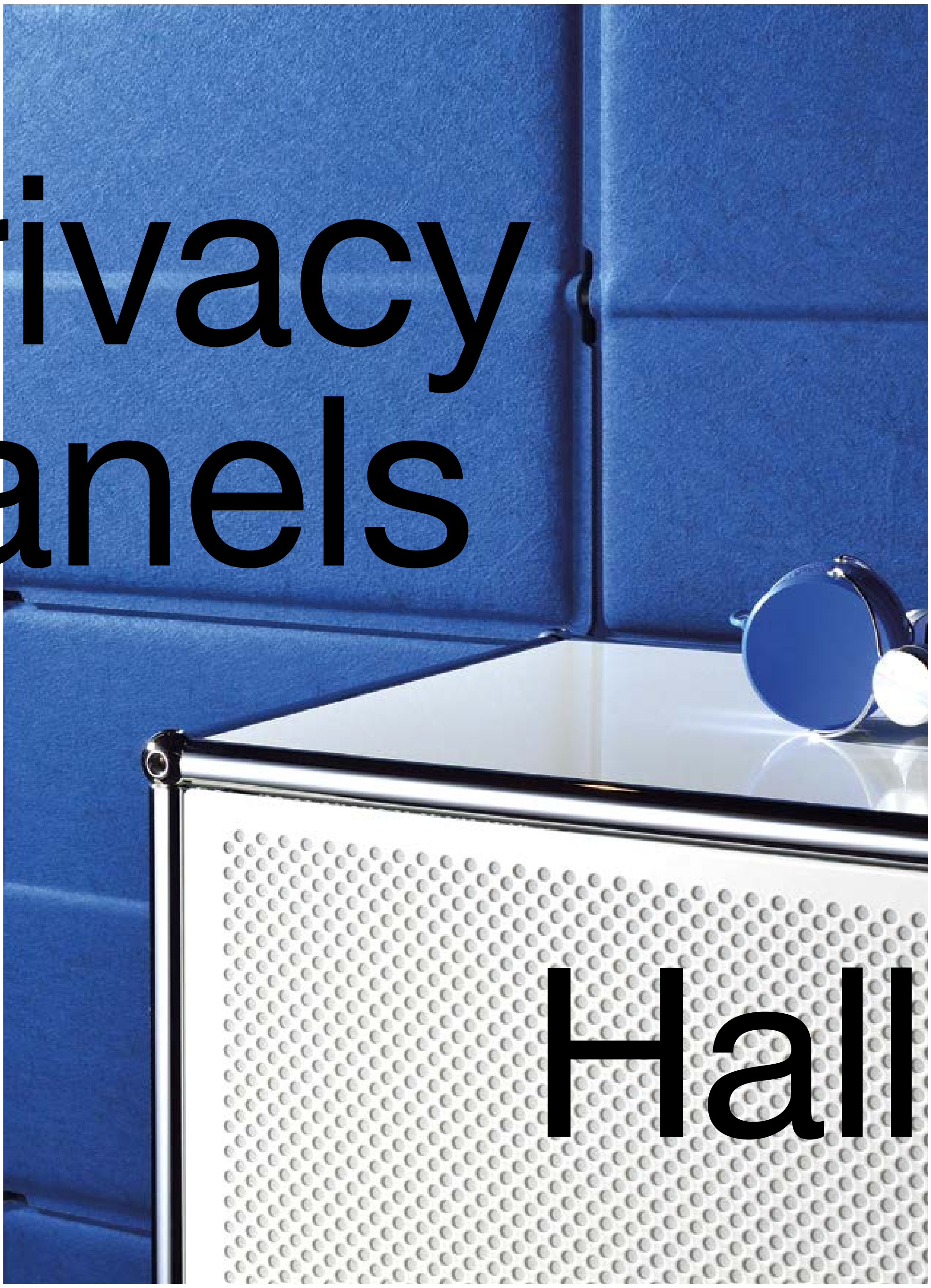
Privacy Panels



Haller

Modular acoustics

Room acoustics play a decisive role in determining how we feel in our built environment; whether we find the atmosphere pleasant and soothing or stressful and distracting.

We are continuously exposed to noise, tones and voices – all of which are very powerful sensations. Our hearing is extremely sensitive and always switched on, even when we are asleep. It thus accounts for a correspondingly large part of how we perceive our environment. And we cannot simply turn it off, even when everything around us gets too loud and stressful.

Acoustics is a complex and extremely important issue, especially in the workplace, where new ways of working and open plan spaces are becoming increasingly popular. This brochure aims to answer relevant questions, define key terms and provide examples of acoustically enhanced USM Modular Furniture Haller and USM Privacy Panels that complement architectural design.

The development of a modular absorption system using acoustically enhanced USM elements is the result of a long-standing partnership between USM and renowned acoustician Dr. Christian Nocke, Akustikbüro Oldenburg.

Why are room acoustics important?

Eight fundamental questions about room acoustics

1

As the user, architect or builder of a building, why should I be concerned with this issue?

The most important question concerning room acoustics is: What surfaces should I use to create optimum listening conditions in a room? The surfaces – walls, floors and ceilings, together with fixtures and fittings – are the basic components of the architecture. They form the space in which we live, work, communicate and relax. The materiality, characteristics and quality of these surfaces determine the essence of an architectural design.

Good room acoustics are not a luxury or optional extra – they are an integral part of good, well-conceived architectural design. And that's why they concern everyone involved. It is thought that around 70 percent of the working population work in offices. Studies and surveys repeatedly show that alongside lighting conditions, acoustics are the most significant factor determining the well-being and thus the productivity of office workers. This is all the more important when we consider that informal communication in open plan, flexible office spaces is becoming more widespread and workers generally perceive noise as the most significant source of disturbance in t he workplace.

Where there is less noise, there is less stress, more concentration, a lower turnover of workers and fewer days lost to stress-related illness. In short: A company which takes active steps to improve room acoustics will save a great deal of money in the long term.

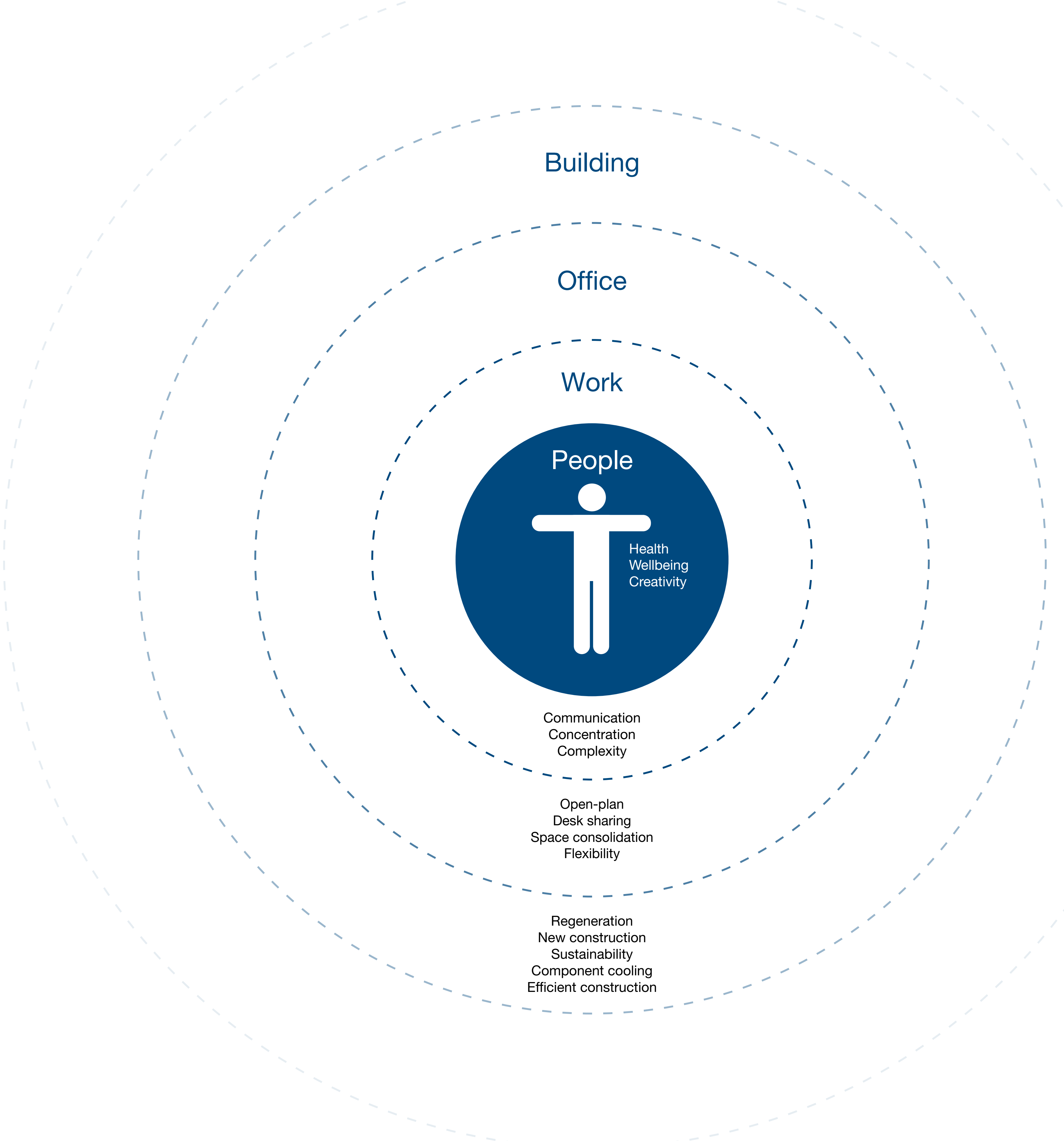
– If as a user or tenant, I discover that rooms which initially seemed ideal for my purposes in fact suffer from poor acoustics, I will face unexpected expenses as a consequence.

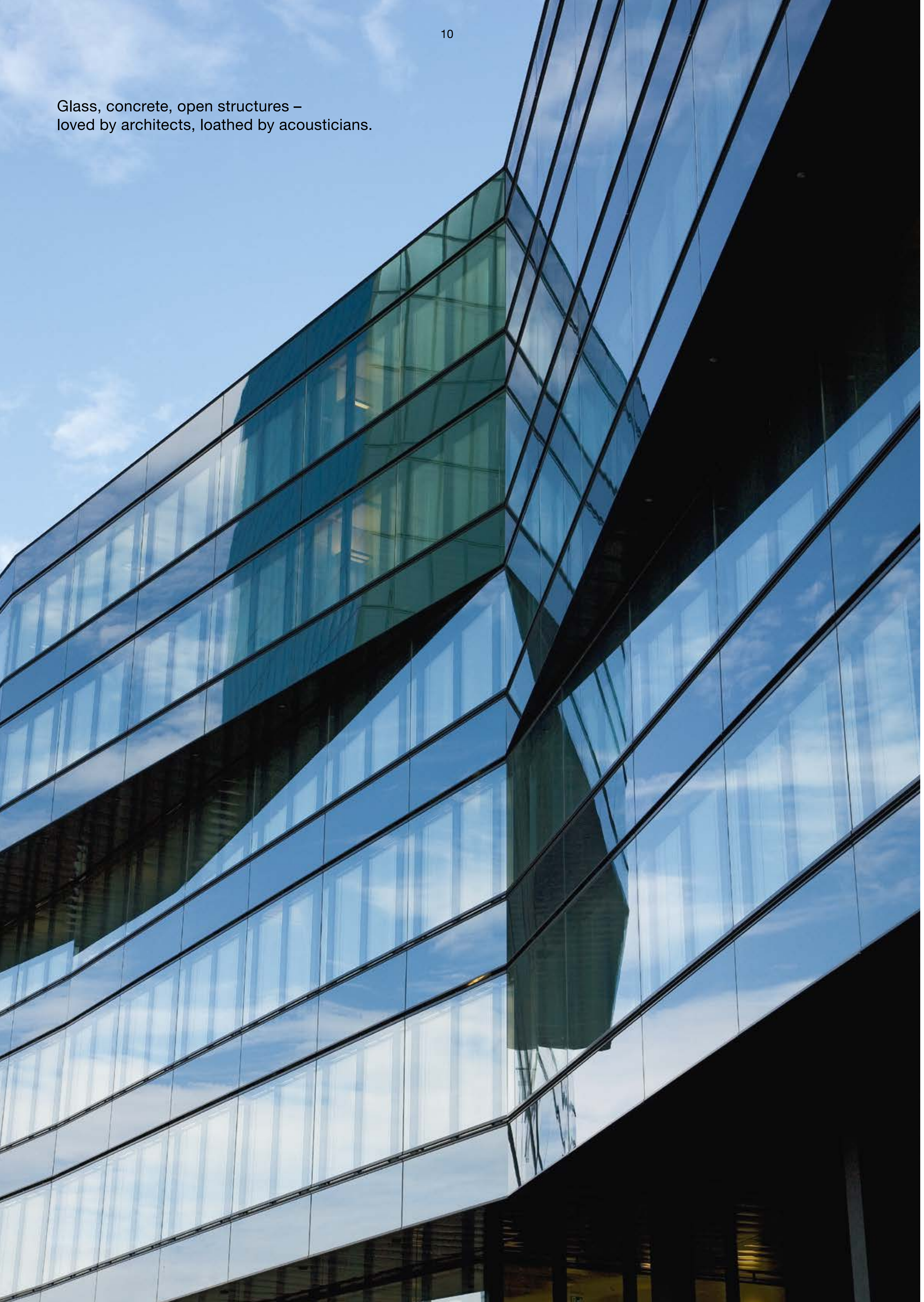
– If as an architect, I neglect to take acoustics into account during the design process, I will have to live with the fact that visible surfaces and room structures in the building may be subsequently changed.

– If as a builder or investor, I neglect to take acoustics into account during the design process, I may have to invest in additional structural measures at a later date to create a more comfortable ambience.

But good room acoustics is not just important for ensuring a comfortable office environment: Reducing noise levels also has a positive impact in other sensitive areas, such as large lobbies, libraries, hotels or canteens. Acoustic problems can also occur in private homes, especially ones with high ceilings and hard surfaces made from glass, exposed concrete or screed. Anyone who values good room acoustics in their private domain, for instance someone who genuinely appreciates listening to music and has a particularly high quality audio playback system, would not willingly give up acoustically enhanced surfaces having once experienced their effect.

Levels of effect of good room acoustics





Glass, concrete, open structures –
loved by architects, loathed by acousticians.

2

Why do buildings so often require retrofit treatment to improve room acoustics?

Contemporary energy concepts such as thermally active components are indispensable in modern architectural design. They ensure that resources are used responsibly, as well as providing a high level of comfort and a pleasant room environment for the users of the building.

The same applies to modern office concepts in new or old buildings: Open-plan, transparent working environments which encourage communication are becoming increasingly important. Many workplaces have moved completely away from rigid hierarchies and office structures to teamwork in flexible arrangements. It has now been proven that creativity arises far more from encounters and exchanges than by working in isolation in the ivory tower of a cellular office. Open-plan layouts make more efficient use of space and allow users to respond flexibly to changing team compositions. They can be made more enclosed, or airier, and it is easy to reconfigure space allocations and groupings.

Both these developments have given fresh impetus to architecture, creating new possibilities and prospects for architectural design. But they don't necessarily have a positive impact on room acoustics. Since it is extremely expensive to clad thermoactive concrete surfaces, the proportion of sound-absorbing surfaces in rooms is in decline. Many workers find the noise level in open-plan offices generally disturbing; it distracts them and makes them feel stressed. And it's not the volume of colleagues' conversations or telephone calls which is distracting so much as their content, which we are unable to ignore. When it comes to our awareness, speech always has priority; we can close our eyes, but not our ears.

3

Solutions from USM bring sound absorption
and screening into the room.

How can we overcome this problem?

Various measures can remedy the situation: Specially equipped furniture, flexible zoning modules, special plaster, certain textiles such as carpets or curtains, sound-absorbing partition walls, acoustic floating ceiling panels or other types of absorber. In simple terms, these sound-absorbing elements help convert sound energy into another energy form, thereby allowing it to be extracted from the room. By making the room audibly quieter, we find speech easier to understand.

USM solutions combine acoustically enhanced USM Modular Furniture Haller with USM Privacy Panels to provide sound absorption and sound screening – the two essential factors for good room acoustics. The use of these systems helps to effectively condition the room without the need for structural modifications. USM Haller provides ample storage space as well as sound-absorbing surfaces, whilst USM Privacy Panels create diverse zoning opportunities.

4

How does metal furniture improve room acoustics?

Non-specialists have some very wide-ranging and in some cases, rather inaccurate ideas of how sound is absorbed. For instance, it's not unreasonable to think that a perforated surface simply "swallows" sound through the holes. But what happens immediately behind the holes through which the sound passes unimpeded is more important. Acoustically enhanced USM Haller furniture has perforated doors and panels lined with special acoustic fleece which absorbs sound.

Still more important is the volume of the sound-absorbing element, in this case the storage space encased by the perforated doors, sides and back panels of an item of furniture. It is this enclosed space in an acoustically enhanced USM Haller filing cabinet or sideboard which increases the fleece's ability to absorb sound. The enclosed air volume acts like a resonating body in the same way as a musical instrument, except in this case it absorbs sound even when the furniture is full.

The perforated surface material in this set-up of the USM Haller furniture is less important due to its high degree of perforation – the acoustically enhanced USM elements are also effective when made from powder coated steel. These sound-absorbing elements reduce reverberation time, thereby increasing often crucial speech intelligibility – making them just as effective as wall or ceiling panels made e.g. from wood.

The acoustically enhanced USM elements act as sound absorbers
to reduce reverberation time and increase speech intelligibility
within the room.

5

How do USM Privacy Panels complement the USM Modular Furniture Haller?

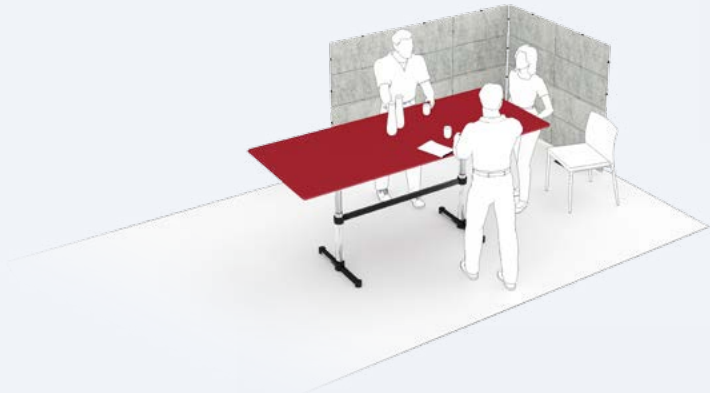
USM Privacy Panels are vertical room elements which, like USM Modular Furniture Haller, are also modular in design. This enables them to be configurated in a wide variety of ways, for example mounted on tables, or as freestanding panels for screening and zoning different areas of the room. They are based on a “leaf” principle and have a tubular structure like the USM Haller. USM Privacy Panels can be arranged linearly or in a corner configuration, flexibly extended and combined with USM Haller furniture. Their acoustically enhanced, textile surface with slightly overlapping individual panels creates an impression of softness. Unlike the perforated fleece absorbers, USM Privacy Panels are designed as classic, porous sound absorbers, the sound entering through their sound-permeable surface. The closed surface supports their shielding effect. Their low thickness results in sound absorption in the medium and high frequency range, perfectly complementing the absorption capacity of the USM Modular Furniture Haller, which achieves maximum absorption at low and medium frequencies. Here too, the benefits of modular design are apparent in the acoustic interaction between USM Privacy Panels and USM Haller.

6

The benefits of the USM Modular Furniture Haller are obvious – but what does modular absorption mean?

One of the outstanding strengths of USM products is their modularity. Within standard USM dimensions, they enable you to create custom-fit solutions and to respond flexibly to changing requirements. These strengths are directly transferable to sound absorption and sound shielding. Depending on the individual elements and their dimensions, using acoustic calculations and precise measurements it is possible to determine the ideal location for an item of furniture or USM Privacy Panels and how much acoustically optimised surface area is needed in a room.

In terms of furniture this means that perforated elements can be used simply in the back or side panels or in the doors as well, depending on the requirements and whether the furniture is free-standing or placed against a wall. In terms of USM Privacy Panels it means that you can respond to your specific needs by using the necessary surface areas and creating different spatial configurations. USM products thus provide modular – and acoustic – solutions tailored to the needs of every room.



7

Upgrading and retrofitting are the benefits of USM Modular Furniture Haller.

Can I simply upgrade my existing USM furniture?

Yes, the surface elements can easily be replaced, which in itself is enough to make the enclosed volume acoustically effective. And one advantage over other systems is that nothing has to be inserted or attached, the furniture does not get any bigger, nor is any storage space or other aspect of functionality lost. If a room needs more shielding, we recommend supplementing the furniture with USM Privacy Panels.

8

That sounds good, but it comes at a price. Is it worth making an investment of this kind?

Undoubtedly – because any investment in room acoustics is an investment in the wellbeing, health, ability to concentrate and thus the efficiency of your employees. Optimum room acoustics in the workplace reduce stress and increase wellbeing. It is possible to quantify the cost of every day of absence or every loss of concentration and interruption to work processes – there are numerous studies on this subject. An investment in carefully planned room acoustics or a later retrofit solution quickly pays for itself and makes a lasting impact.

Issues regarding room acoustics touch all aspects of life and affect our well-being at a fundamental level. In the office they have a major influence on employee satisfaction, productivity and health management. The modularity of the USM Haller system combined with the newly developed USM Privacy Panels enables you to create custom-fit solutions to improve room acoustics – not as a retrofit, but as an integral part of the overall room design.

Terms and parameters to gain a better understanding of room acoustics

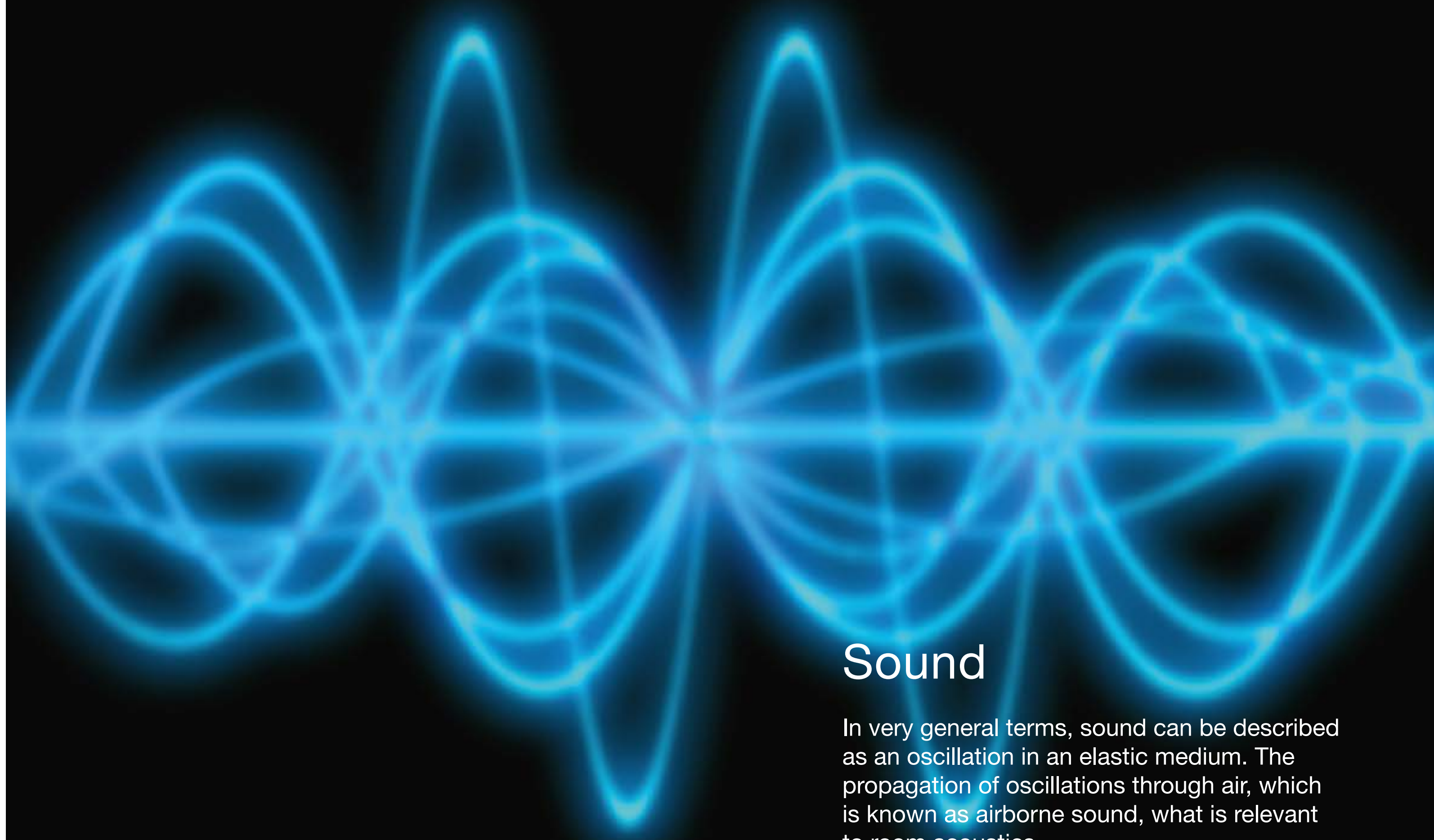
Building acoustics versus room acoustics

As an introduction to the topic, let's look at the small but significant difference between the terms "building acoustics" and "room acoustics", which are often used synonymously in the building industry. The fundamental question in building acoustics is: What proportion of the sound reaches the other side of the partition in question? Or even: How is sound transmitted from one room to another? The sound insulation of the component separating two rooms is crucial in this respect. Essentially, building acoustics is about the ability of components – walls, ceilings, doors, windows etc. – to minimise sound transmission.

In room acoustics, on the other hand, the question is: What surfaces should I use to create optimum listening and speaking conditions in the room? The crucial aspect in this case is the sound absorption, provided by the materials used in the room. Sound absorption describes the ability of materials to absorb sound i.e. to convert incident sound energy into other forms of energy.

Acoustic quality

DIN 18041 uses the term "acoustic quality" to describe the suitability of a room for presenting certain sounds, particularly for adequate verbal communication or musical performances. The acoustic quality of a room, in other words the prevailing speech and listening conditions, is influenced by many factors, such as the properties of the boundary surfaces, the fixtures and furnishings and the people present in the room. In simple terms, a room has a good acoustic quality if it makes us feel comfortable, allows us to communicate effortlessly and if we do not perceive it as being too loud or too quiet.



Sound

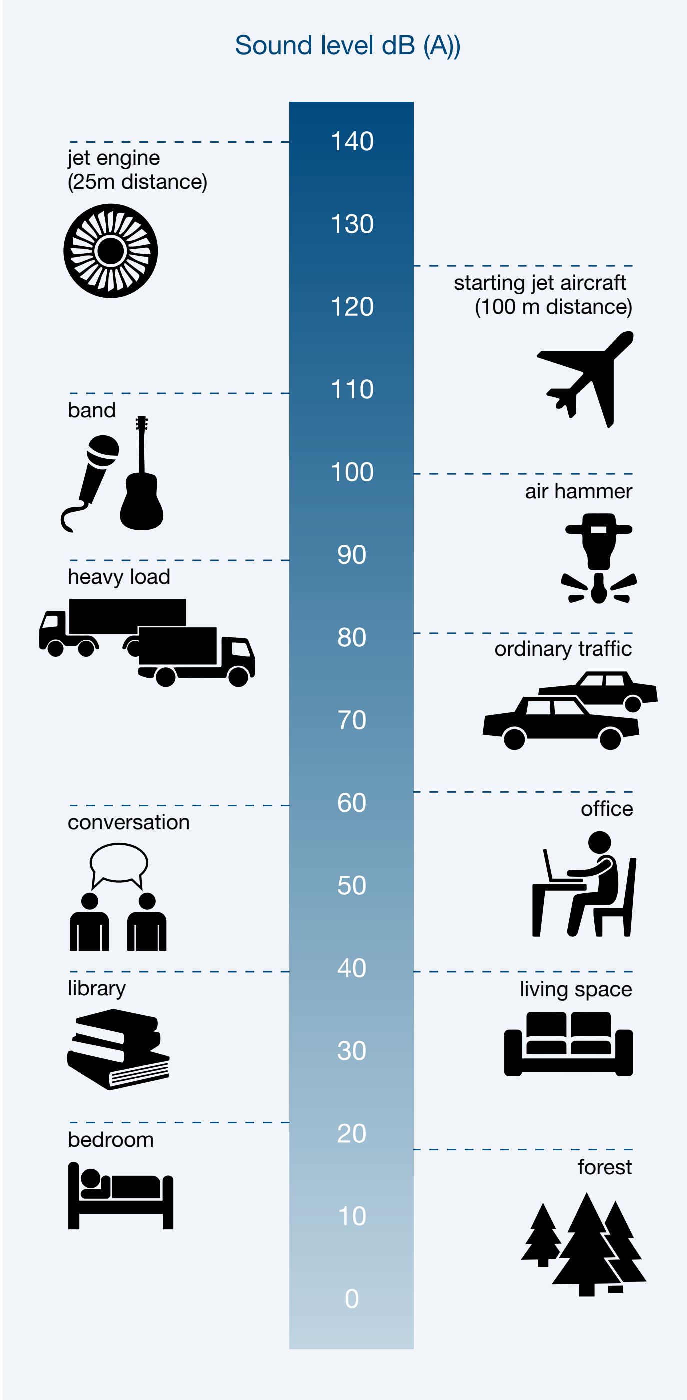
In very general terms, sound can be described as an oscillation in an elastic medium. The propagation of oscillations through air, which is known as airborne sound, what is relevant to room acoustics.

Sound events such as speech, music or noise from technical equipment cause a locally and temporally variable fluctuation in air pressure which propagates from its source into the surroundings. How each of us subjectively perceives an objective sound event – whether as a disturbing noise or a pleasant sound – does not depend initially on physically measurable sound values. Psychoacoustics differentiates between two types of sound; on the one hand we have desirable "useful sound", such as a musical performance or voices in a conversation. And then we have undesirable "noise". This may refer to distracting background noises, including speech you do not wish to hear, or music drifting across from your unpopular neighbour which, though not especially loud, is perceived as "annoying". And speech is not the only thing that can be perceived as both useful sound and nuisance sound, an aspect which is becoming increasingly relevant, especially in open-plan offices.

Sound level

The sound pressure level L, or simply sound level, is a physical parameter which is normally measured in decibels (dB). Humans can hear sounds ranging from around 0 dB to 140 dB. Continuous noises above 80 dBs or very short sound events such as loud bangs may cause permanent damage to our hearing. But even continuously too high sound levels below these values can be harmful.

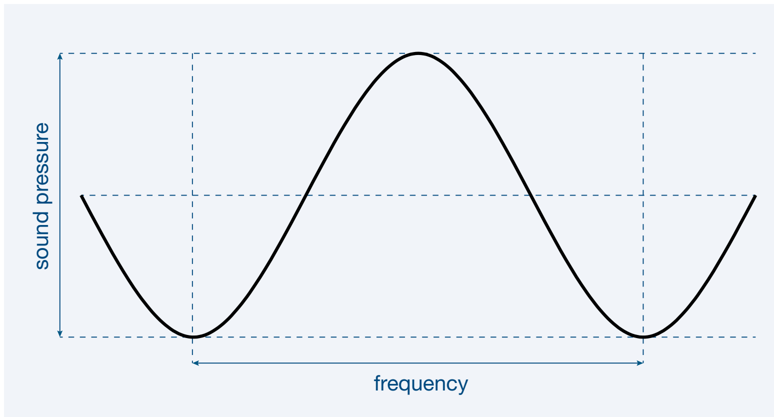
In Germany many things are governed by building regulations – but not room acoustics in buildings, surprisingly enough. Occupational health and safety requirements define safe limits relating to sound levels in the workplace. These provisions indirectly affect the installation of sound-absorbing or sound-shielding elements in rooms. The values stipulated in the German Workplace Ordinance and corresponding occupational health and safety regulations aim to prevent direct damage to hearing and health. However, sound levels of this order are not generally reached in an office environment. We perceive stress – demonstrably so – but as yet there is no statutory provision governing how this could be avoided. The sound level is not the only critical factor here; speech intelligibility also plays an important role. Experience suggests that intelligible speech is more distracting than unintelligible speech.



Frequency

Frequency indicates the number of sound pressure changes per second. High-frequency sound events are perceived by the human ear as high-pitched tones, whilst low-frequency sound events are perceived as low-pitched tones. Sounds such as the roaring of a waterfall or traffic noise generally comprise a large number of frequencies. Frequency is measured in Hertz. It indicates the number of oscillations per second, abbreviated to 1 Hz = 1/s. Humans have an audible range from 20 Hz to 20,000 Hz, although as we get older, our ability to hear high-frequency sounds deteriorates.

Human speech covers a frequency range of around 200 Hz to 1000 Hz in adults and up to 2000 Hz in children. Our hearing is particularly sensitive in this range. On the one hand, this makes it easy for us to communicate with other people, but at the same time, it makes us particularly susceptible to interference.



oscillations per second = Hertz

Sound propagation

As a rule, sound always propagates into all three directions of space. Even though sound radiation depends on the precise orientation of the source in many cases, it is helpful to assume that sound radiates more or less evenly in all directions. Sound sources of this type are referred to as omnidirectional sound sources.

At high frequencies, sound propagation can be compared to a ray of light, which is why the term “sound ray” is also used in this context. The idea of a sound ray helps us to understand how sound propagates within a room. What applies to optics also applies here: The angle of incidence is equal to the angle of reflection. This comparison with the geometrical behaviour of light is sufficient for many applications in room acoustics.

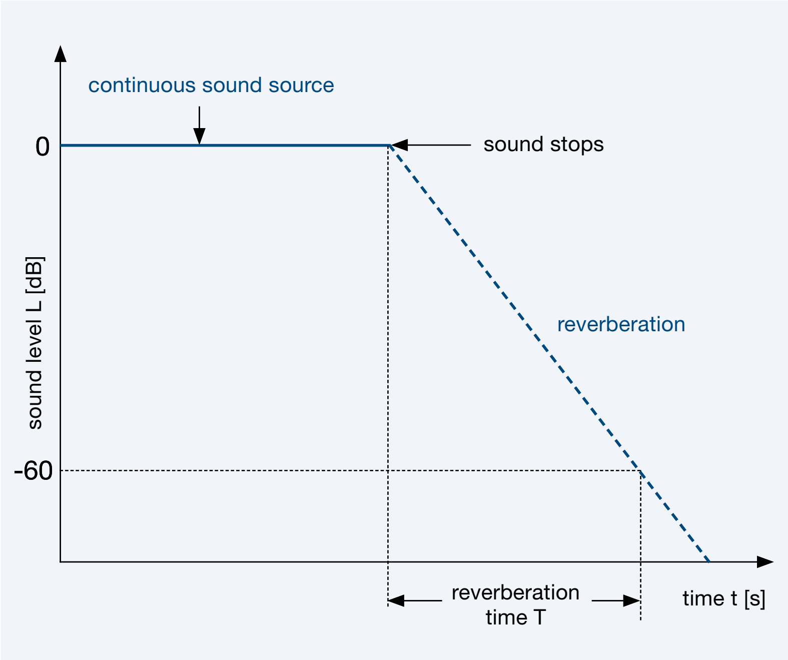
It is important to recognise the essential difference between direct sound and reflected sound. It then becomes clear that the acoustic quality of a room is influenced not merely by the shape of the room, but also by its boundary surfaces and furniture.

The speed of sound propagation (or speed of sound) basically depends on the material or medium. A sound wave propagates through air at a speed of approximately 343 m/s or 1200 km/h. All sound frequencies propagate through air at the same speed. Therefore it takes only a short time for sound to reach all areas of a small room. The larger the room, the more important the positioning of sound absorbers and sound screens within the room becomes. A carefully balanced interaction between absorption, reflection, sound screening and sound guidance makes for good room acoustics. Whilst sound propagation in a lecture theatre should be controlled with the aim of achieving good speech intelligibility, in an open-plan office sound propagation often has to be reduced by screening and absorption.

Reverberation time

Reverberation time is the oldest room acoustics parameter. It allows us to compare different rooms and to assess their acoustic quality. Put very simply again, the reverberation time indicates the time it takes for a sound event to become inaudible in a room. It was originally defined by acoustician Wallace Clement Sabine and measured using a stopwatch based on subjective auditory impressions in different rooms. Nowadays, of course, it is measured in a far more precise way. Technically, reverberation time T is defined as the period of time it takes for the sound level in a room to fall by 60 dB after a source stops emitting sound. The relationship that exists between reverberation time, room volume and amount of absorptive surface deduced by Sabine still holds true today.

The reverberation time of a room has a direct impact on speech intelligibility. Whilst a long reverberation time in a church can make organ music sound imposing, it is less desirable in the workplace or a conference room. Even though they are separate acoustic parameters, reverberation time and speech intelligibility are interdependent. It is generally the case that speech intelligibility within a room declines as reverberation time increases.



Spatial decay

How loud a sound source is perceived to be from a greater distance depends amongst other things on the room geometry and reverberation time, and in offices in particular on sound screens positioned between the source and the receiver.

The effect of sound screens on room acoustics can be described by different room acoustic parameters, especially the average sound level decay per doubling of distance and the sound level of an average speaker at a distance of four metres.

Screening

The term “sound screen” generally refers to a barrier which interrupts or reduces the direct propagation of sound from its source to a receiver. This function can be performed by a desk-mounted panel, a dividing wall, a cabinet or any other fixture or item of furniture. The closer a sound screen is to the sound source, the more effective it is. Similarly, a sound screen arranged as a corner which partially “wraps around” the sound source is more effective than a screen which is purely linear in shape. The greater the detour the sound has to make as a result of the sound screen, the more effectively sound propagation is impeded.

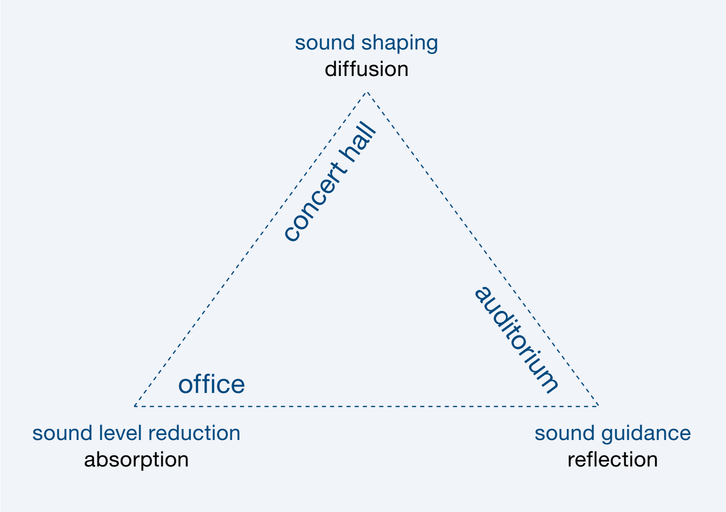
If sound screens have an absorbent surface, sound propagation is further reduced throughout the room, as well as immediately in front of and behind the screen. In this case a sound screen can also increase absorption in the room.

Speech intelligibility

Measuring or calculating the speech intelligibility of an entire room is not possible because it depends on the position of the respective listener in relation to the sound source. The traditional, but very time-consuming method of measuring speech intelligibility in a room is to systematically survey a sufficiently large number of people using standardised lists of syllables and phrases. The Speech Transmission Index (STI) is a physical measurement parameter which has been developed on the basis of such subjective studies to describe speech intelligibility. In simple terms, the more transmission is affected by the influence of the room, for instance by reverberation, echoes or other sound sources, the lower the speech intelligibility and thus the smaller the STI value.

The effect of surfaces – three dimensions of acoustic properties

The acoustic effect of surfaces in a room is essentially described by the absorption, reflection and diffusion (scattering) of sound waves at the surfaces. Absorption generally serves to lower the sound level in the room and reduce reflection, thereby shortening the reverberation time. Reflective surfaces are needed in rooms to direct sound to certain areas within the room. To prevent the localisation of individual sound reflections, surfaces are often also designed to produce a diffuse scattering effect. Sound diffusion generally serves to shape the sound, in rooms where especially high quality acoustics are important. In everyday rooms such as living rooms and workrooms, it is generally sufficient to consider the absorption characteristics of surfaces.



Model: Peter D'Antonio, USA

Diffusion: Distribution of sound within the room
Absorption: Reduction of sound within the room
Reflection: Guidance of sound within the room

Sound absorbers

The capability of materials and surfaces to absorb sound is an all-important factor from the point of view of room acoustics. Sound absorbers are used to convert the sound energy in a room to another form of energy and thus extract it from the room. They make the room quieter and optimise sound propagation by changing the reflections.

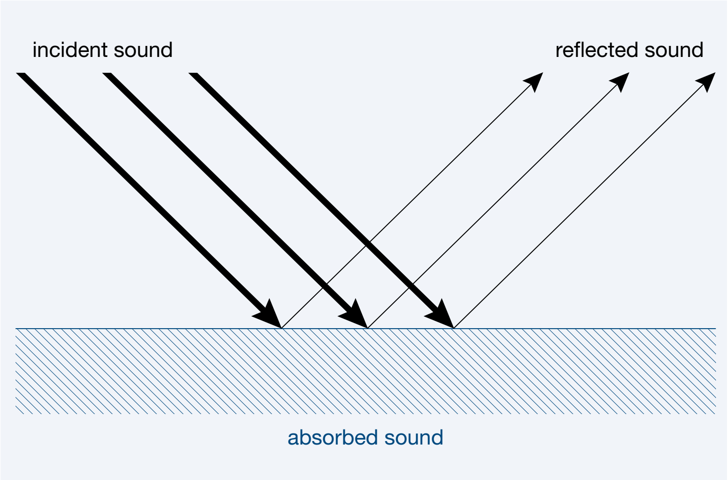
The effect of sound absorbers is generally frequency-dependent. It can be said that high frequencies are attenuated by sound absorbers with small construction height, whilst sound absorbers of larger construction height or size are required to attenuate lower frequencies.

The sound absorption of two-dimensional flat structures, such as ceiling, wall or floor coverings and sound screens, is described by the sound absorption coefficient.
For elements such as tables, chairs and cabinets where the surface cannot be determined unambiguously the so-called equivalent sound absorption area is indicated directly. The sound absorption coefficient and equivalent sound absorption area are directly comparable if the surface area of the absorber is known.

Sound absorption coefficient

The indication of the sound absorption coefficient of the materials used forms the fundamental basis for the room acoustic design. It describes the property of a material to convert incident sound into another form of energy and thus absorb it. An ideal sound absorber which "swallows" 100 percent of the incident sound has a sound absorption coefficient of 1. A fully reflective surface, on the other hand, has a sound absorption coefficient of 0.

The reverberation room method is used to determine the sound absorption coefficient α of a material. For this test, a sample of the material being tested is placed in a laboratory room whose reverberation time has been determined previously. From the change in the reverberation time with the sample present in the room, the sound absorption coefficient α_S can be determined and the extent to which the material absorbs sound and at which frequencies can be described exactly.
The sound absorption coefficient indicates the absorption capability of a material based on one square metre of material. However, it is not only the sound absorption coefficient α of the material which has a bearing on the sound-absorbing effect of the room, but also the size of the absorber surface present in the room. The effective or equivalent sound absorption area is defined as the product of the absorption coefficient α and the geometric absorption area S, in other words $\alpha \times S$. A small area S with a high absorption coefficient α is therefore just as effective as a large area S with a low absorption coefficient α. It is important to be aware that the equivalent sound absorption area which is responsible for the acoustic effect on the room varies at different frequencies as well.



The absorption coefficient describes the proportion of absorbed sound relative to the incident sound.

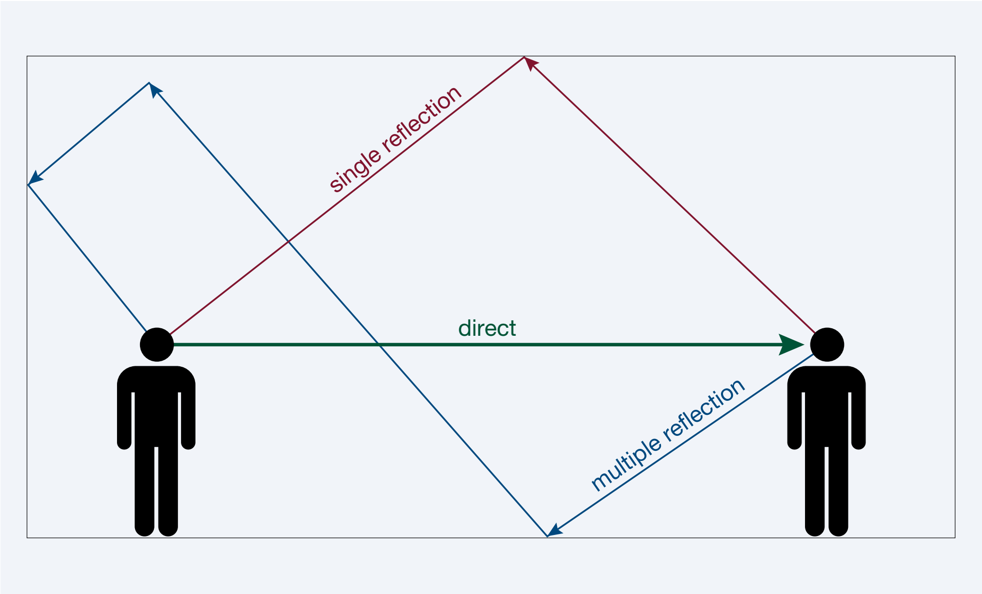
Equivalent sound absorption area

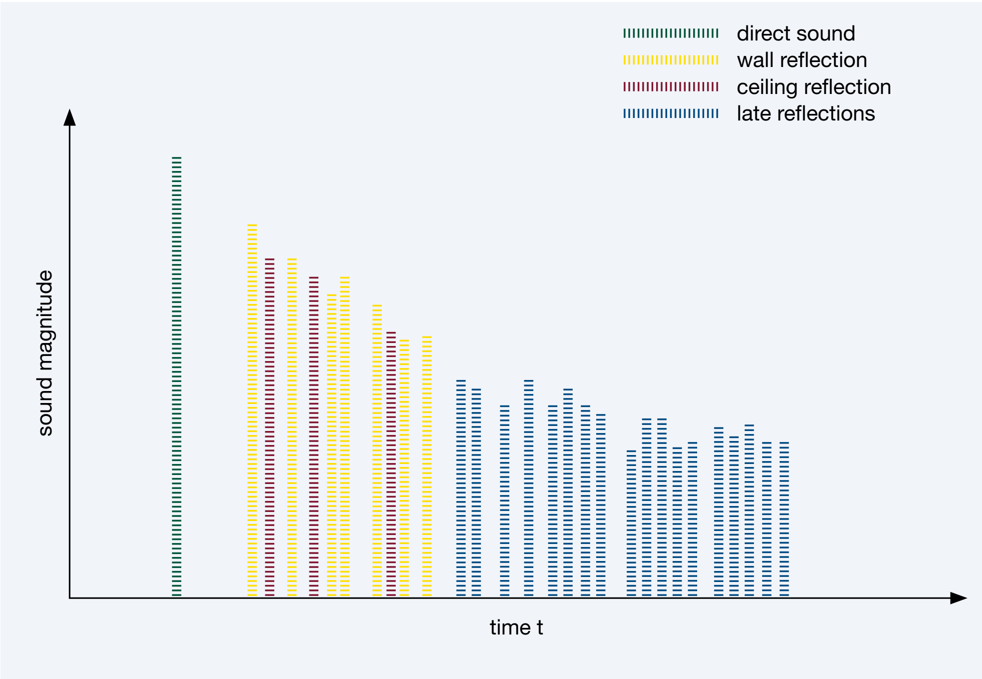
For elements which are not two-dimensional, the equivalent sound absorption area can be calculated by direct comparison of the measurement with and without the sample present in the reverberation room. This equivalent sound absorption area of an element or object is described by A_{obj}. Thus the acoustic effect of a cabinet is described by the associated equivalent sound absorption area, which is also frequency-dependent. The effect is added if a room contains several cabinets. Accordingly, two cabinets have double the absorption of a single cabinet. USM has taken extensive measurements of different configurations of the USM Modular Furniture Haller.

In a fully furnished room with different surfaces, for example, each material (e.g. carpets, plaster, acoustic ceiling, curtains, windows, shelves etc.) can be allocated a sound absorption coefficient and by multiplying this coefficient by the surface area of the material, the equivalent sound absorption area A_{eq} can be calculated. The number of objects multiplied by the equivalent sound absorption area of the object gives the equivalent sound absorption area of objects in the room. The equivalent sound absorption areas of all the materials and objects are then added to determine the total equivalent sound absorption area of the room. The reverberation time of the room is derived from this equivalent sound absorption area of the room, or A.

Sound propagation in a room

We can visualise how sound propagates by modelling it as sound rays. After direct sound is emitted, sound is transmitted to the listener by reflections from the floors, ceilings and walls. Multiple reflections with longer pathways also occur. The reflections define the reverberation time of a room and are thus the key factor in characterising the impression of the sound quality of a room.





Source: Christian Nocke - Raumakustik im Alltag, Fraunhofer IRB Verlag

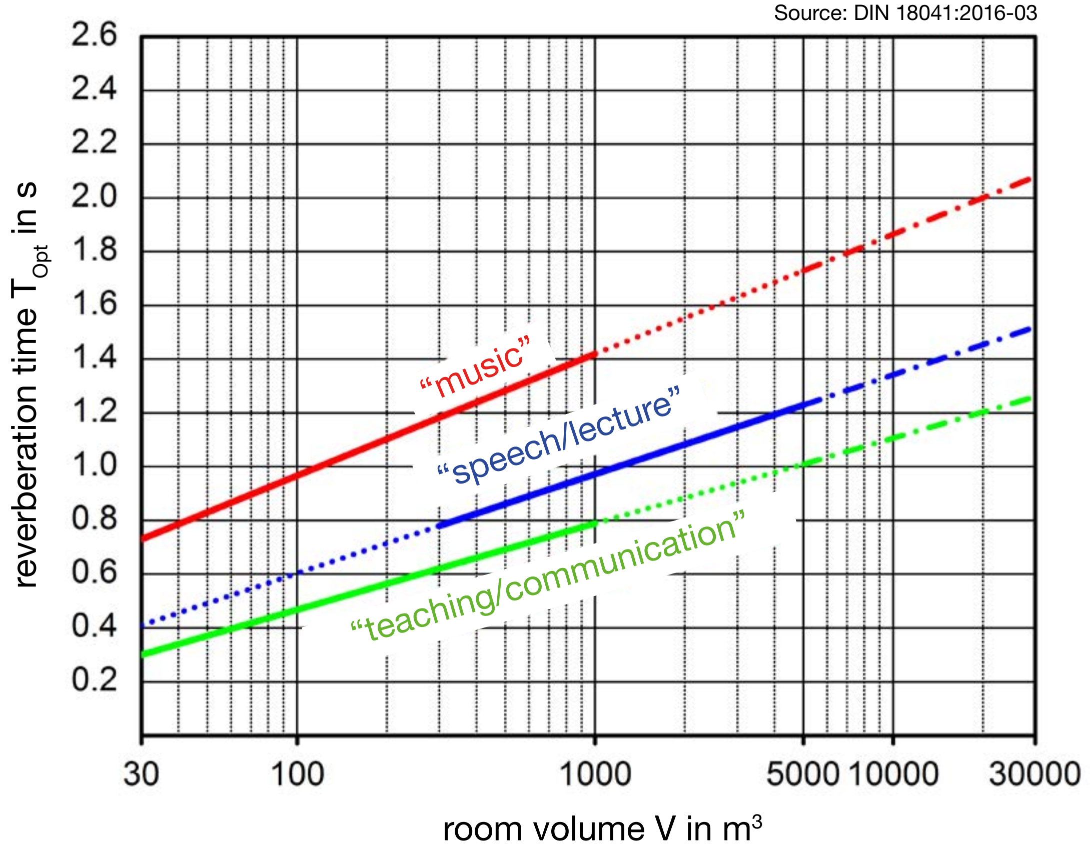
Requirements for rooms

The German standard DIN 18041 “Acoustic quality in rooms – Specifications and instructions for the room acoustic design” defines three different room categories based on usage: “music”, “speech/lecture” and “teaching/communication”. It indicates an optimum value for the reverberation time T_{Opt} for each usage type as a function of room volume V.

Example:
1. A lecture theatre with V = 1000 m³ (usage type: “speech/lecture”) should have a reverberation time of T_{Opt} = 1.0 seconds.

2. A conference room with V = 250 m³ (usage type: “teaching/communication”) should have a reverberation time of T_{Opt} = 0.6 seconds.

Source: DIN 18041:2016-03



DIN 18041 recommendations for the reverberation time T_{Opt} of rooms with different uses as a function of room volume V.

USM's solutions: benefits and comparisons

Modular absorption and screening – general acoustic properties of USM products

USM Modular Furniture Haller
USM Privacy Panels

Absorption and screening in symphony


DELL

Technical explanations of the terms sound absorber and sound absorption coefficient

The sound absorption coefficient α_S indicates the ability of two-dimensional sound absorbers to absorb sound, whilst for objects such as furniture this is indicated by the equivalent sound absorption area A_{obj}. Both these parameters are frequency-dependent; ISO 354 specifies a frequency range of 100 Hz to 5000 Hz. A more detailed evaluation of sound absorption can be made on the basis of the sound absorption coefficient.

Measuring sound absorption as per ISO 354

The reverberation room method is the traditional method of determining sound absorption for room acoustic applications. The method is described in standard DIN EN ISO 354 “Acoustics – Measurement of sound absorption in a reverberation room” and thus available internationally.

In the reverberation chamber method, a test object is placed in a special room with a known, very long reverberation time to determine the extent to which the test object reduces the reverberation time.
This capacity to reduce the reverberation time is a property of the test object which is indicated by the equivalent sound absorption area A_{obj} (for individual objects such as cabinets) and A_{eq} (for two-dimensional absorbers) and also has an effect in other rooms.
The sound absorption capacity can be used in the acoustic design of rooms. It reduces the reverberation time irrespective of whether the object is an item of furniture, ceiling or wall material.

Evaluating sound absorption as per ISO 11654 and ASTM 423

ISO 11654 introduced a method which describes sound absorption as a single value based on a measurement of the sound absorption coefficient α_s as per ISO 354. This multi-step process ultimately gives a weighted sound absorption coefficient α_w. The weighted sound absorption coefficient α α_w can be used to describe two-dimensional absorbers such as ceiling materials or sound screens, but not objects such as items of furniture.

In the US the NRC (noise reduction coefficient) as per ASTM 423 is normally used instead of the weighted sound absorption coefficient α_w since this alternative single value rating is widely used internationally to describe sound absorption.

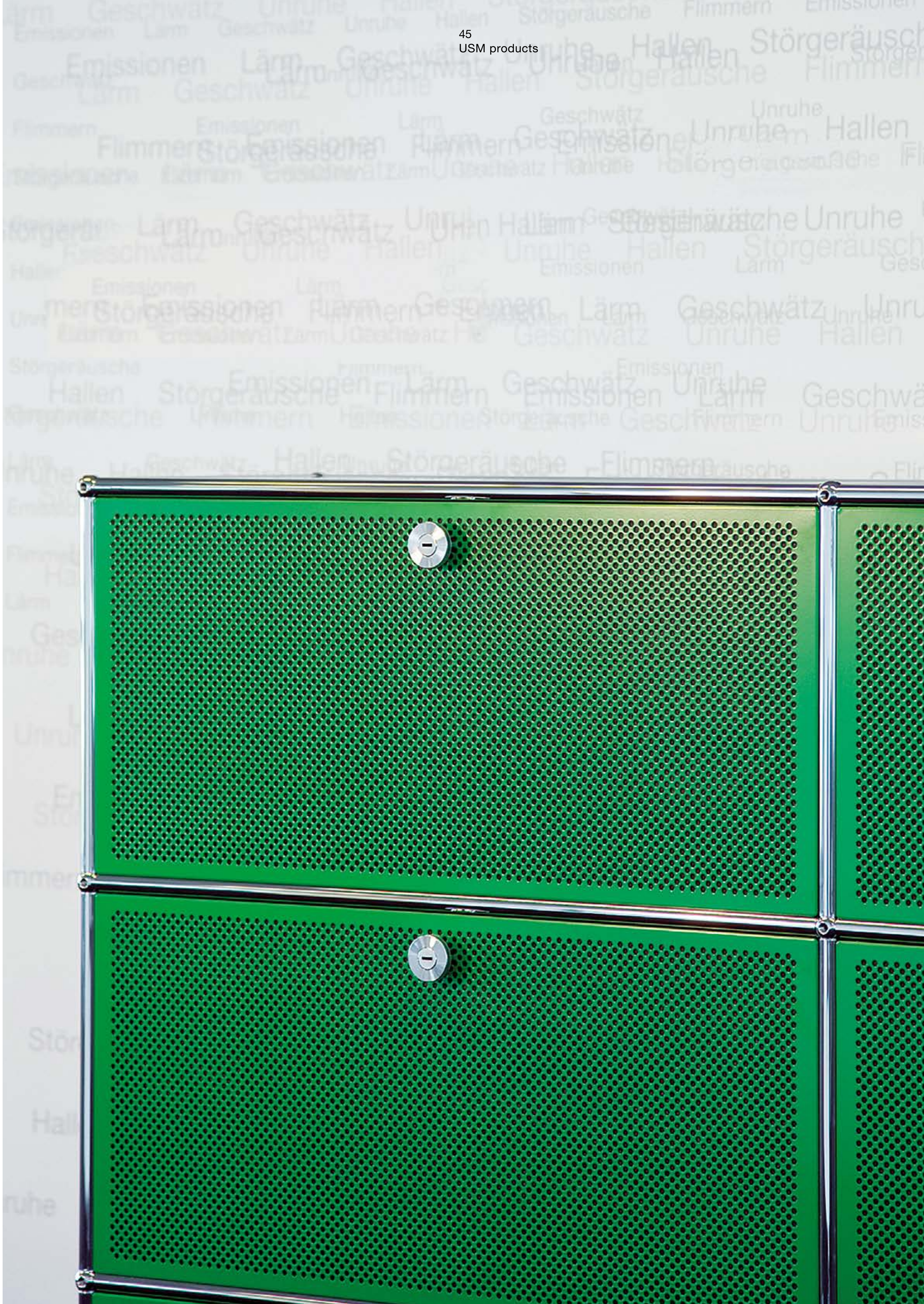
USM modular furniture Haller

Modular absorption

In acoustically enhanced USM Haller furniture, the volume of the furniture carcass acts as a resonating body in a similar way to a musical instrument. Even the plain (unperforated) furniture is able to absorb sound in the low frequency range. When used in conjunction with a traditional porous absorber (fleece) inserted behind a perforated panel, the furniture acts as a broadband absorber. Its capacity for absorption can be modified by swapping plain panels for perforated ones. This property is described as modular absorption.

Due to its solid construction, the furniture also acts as a sound screen. This means that coating the surface to produce a sound barrier effect is less of a priority initially. Ideally, however, sound screens should be designed to absorb sound in the direction of a sound source to minimise irritating back reflections. This is easy to achieve with USM Modular Furniture Haller by simply switching from plane to perforated panels.

Solutions for improving room acoustics using USM elements (USM Modular Furniture Haller and USM Privacy Panels) based on simple calculations are illustrated below. Equivalent sound absorption areas are indicated in these examples as a function of frequency.

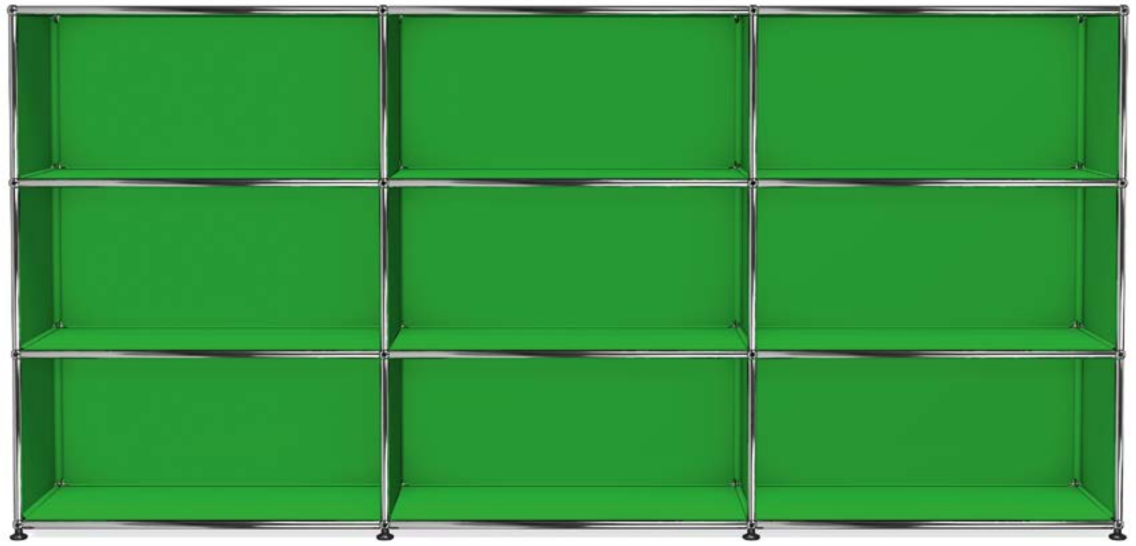


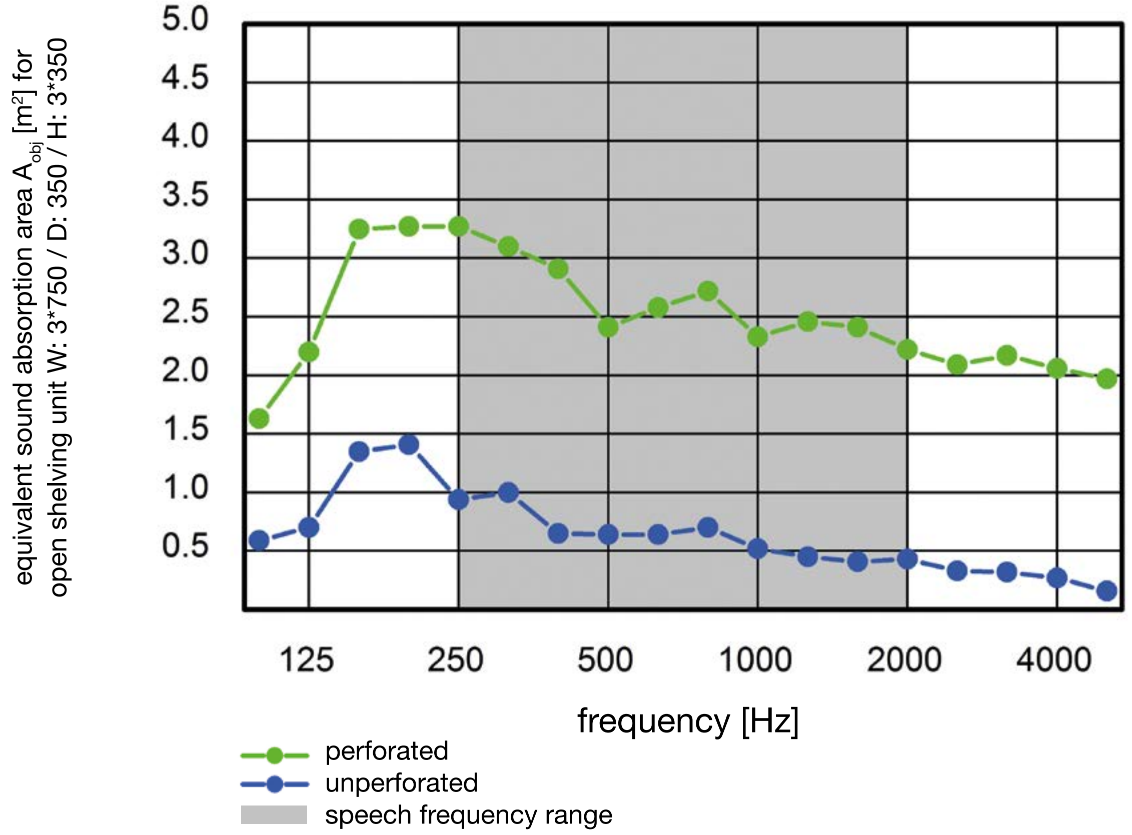
Comparison

1

An open shelving unit, 3 shelves high (3 × 350 mm) and 3 shelves wide (3 × 750 mm) with metal acoustic panels and an identical shelving unit with standard panels were measured.

The graph compares the equivalent sound absorption areas of an un-perforated (blue) and a perforated (green), empty shelving unit. It is quite clear that the perforations more than double the sound-absorbing effect in all frequencies. (See test report on page 52).





The equivalent sound absorption area of a shelving unit in the frequency range 100 to 5000 Hz is indicated in each case. Sound absorption was tested in accordance with DIN EN ISO 354. More detailed test reports are available from USM.

Conclusion

When the shelving unit is fitted with metal acoustic panels, the perforated, fleece-backed surface acts as a remarkably effective absorber.

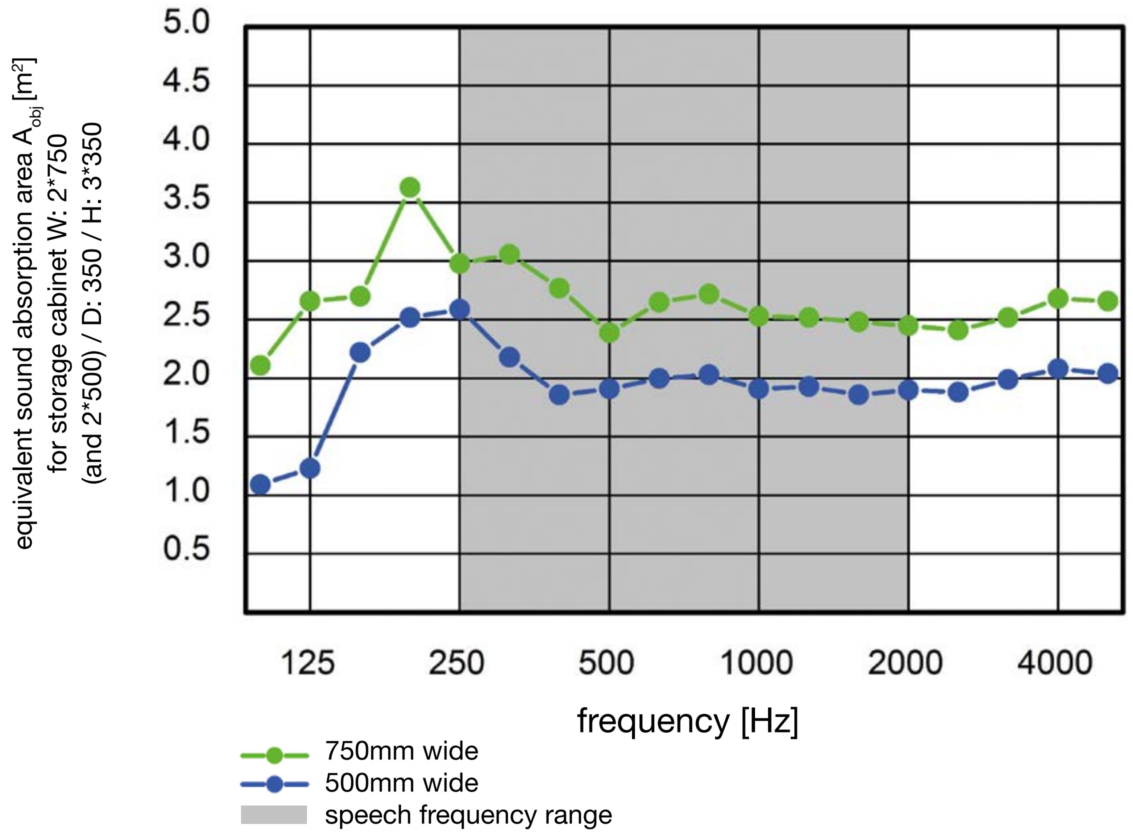
Modular absorption therefore means that acoustically enhanced furniture can be adapted to meet specific room requirements using precise calculations.

Comparison

2

Two storage cabinets with metal acoustic panels with the following dimensions were tested:
3 shelves high (3 × 350 mm), 2 shelves wide (2 × 750 mm) and
3 shelves high (3 × 350 mm), 2 shelves wide (2 × 500 mm)

The following comparison shows that the width of the furniture also has an impact on its capacity to absorb sound; the equivalent sound absorption area depends on the width of the furniture. The graph shows that sound absorption in all frequencies increases by at least 0.5 m² when the width of the furniture increases from 500 mm to 750 mm. (See test report on page 52).



The equivalent sound absorption area of an object in the frequency range 100 to 5000 Hz is indicated in each case. Sound absorption was tested in accordance with DIN EN ISO 354. More detailed test reports are available from USM.

Conclusion

The narrower unit has a good sound-absorbing effect when combined with a perforated surface. When the width of the furniture increases, this effects increases correspondingly.

The same effect is achieved by varying the height of an item of USM Haller furniture. Even a low height with a perforated surface provides very good absorption, and this can be further enhanced by increasing the height of the cabinet.

Modular absorption therefore means that acoustically enhanced furniture can be adapted to meet specific room requirements using precise calculations.

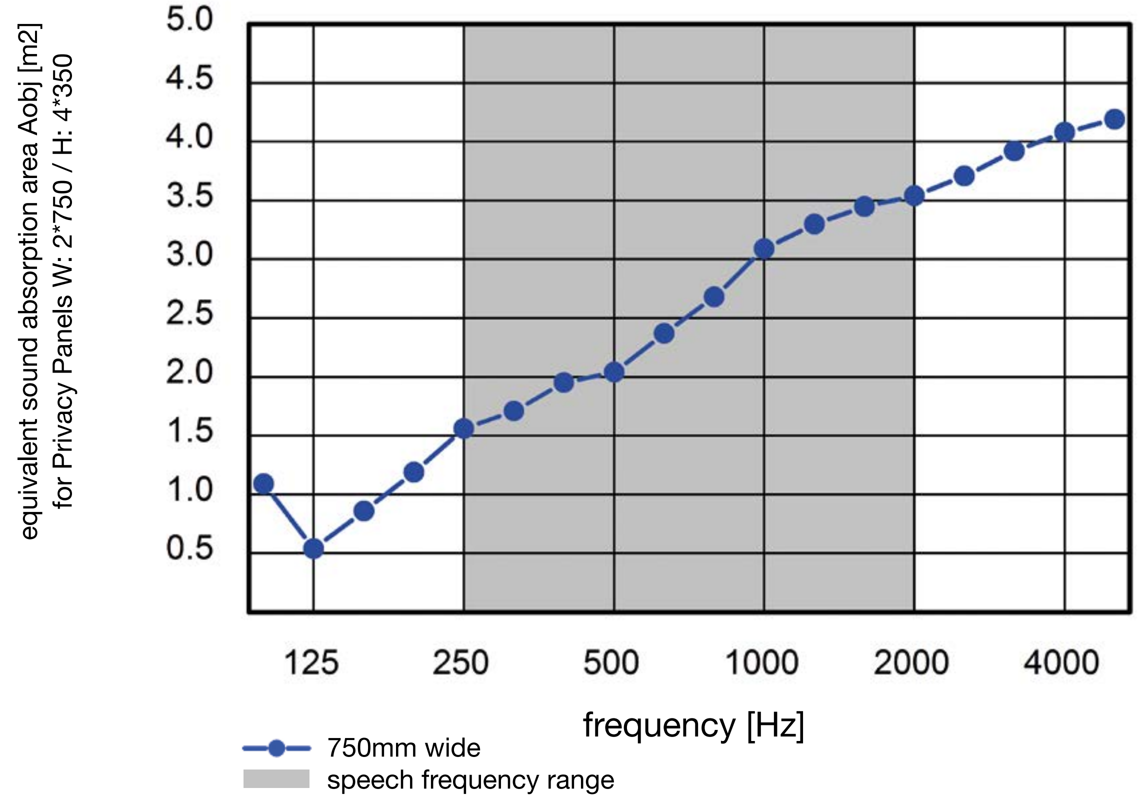
USM Privacy Panels
Modular screening

USM Privacy Panels are designed to effectively combine two different capabilities; the absorbing effect of the material reduces reverberation time, whilst the shielding effect optimises acoustic design in open-plan offices, for example. Privacy Panels can also be used to versatile effect in the home – especially in open plan, loft-style spaces where reducing reverberation combined with careful zoning can help enhance the quality of life.

Sample measurements for free-standing USM Privacy Panels

The equivalent sound absorption area for a combination of 2 × 750 mm wide and 4 × 350 mm high USM Privacy Panels with a total surface area of 2 × 2.1 m².

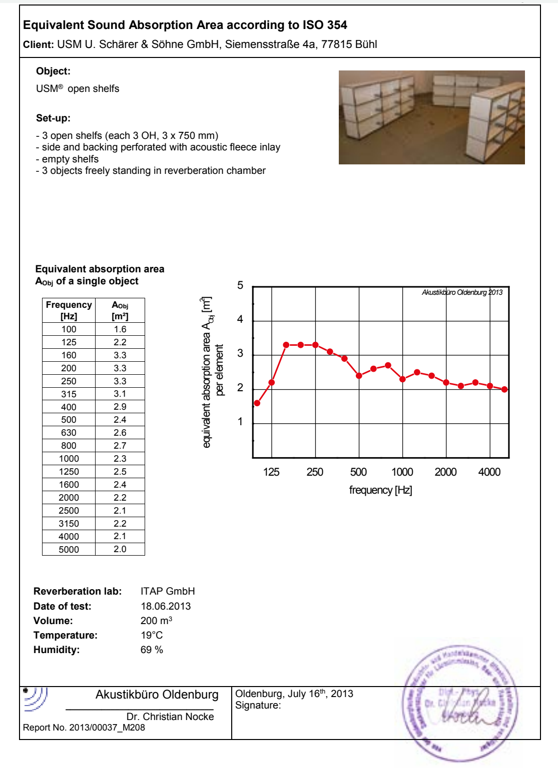
The graph shows the equivalent sound absorption area A_{obj} of a panel in the frequency range of 100 Hz to 5000 Hz. It is clear that the USM Privacy Panels effectively absorb high frequency sound. (See test report on page 53).



The equivalent sound absorption area for an object in the frequency range 100 to 5000 Hz is indicated in each case. Sound absorption was tested and calculated in accordance with DIN EN ISO 354 and DIN EN ISO 11654. More detailed test reports are available from USM.

Test reports for the USM modular furniture Haller

Test reports for Comparison 1



Equivalent Sound Absorption Area according to ISO 354
Client: USM U. Schärer & Söhne GmbH, Siemensstraße 4a, 77815 Bühl

Object:
USM® open shelfs

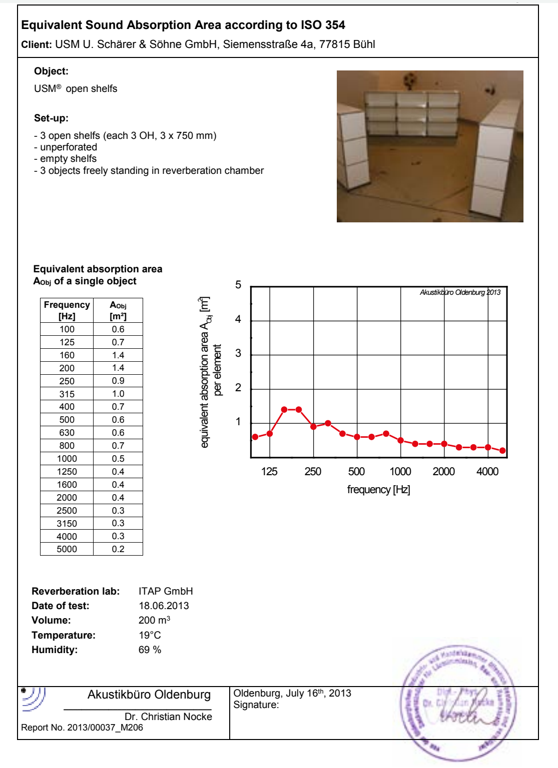
Set-up:
- 3 open shelfs (each 3 OH, 3 x 750 mm)
- side and backing perforated with acoustic fleece inlay
- empty shelfs
- 3 objects freely standing in reverberation chamber

Equivalent absorption area A_{Obj} of a single object

Frequency [Hz]	A_{Obj} [m²]
100	1.6
125	2.2
160	3.3
200	3.3
250	3.3
315	3.1
400	2.9
500	2.4
630	2.6
800	2.7
1000	2.3
1250	2.5
1600	2.4
2000	2.2
2500	2.1
3150	2.2
4000	2.1
5000	2.0

Reverberation lab: ITAP GmbH
Date of test: 18.06.2013
Volume: 200 m³
Temperature: 19°C
Humidity: 69 %

Akustikbüro Oldenburg
Dr. Christian Nocke
Report No. 2013/00037_M208
Oldenburg, July 16th, 2013
Signature:



Equivalent Sound Absorption Area according to ISO 354
Client: USM U. Schärer & Söhne GmbH, Siemensstraße 4a, 77815 Bühl

Object:
USM® open shelfs

Set-up:
- 3 open shelfs (each 3 OH, 3 x 750 mm)
- unperforated
- empty shelfs
- 3 objects freely standing in reverberation chamber

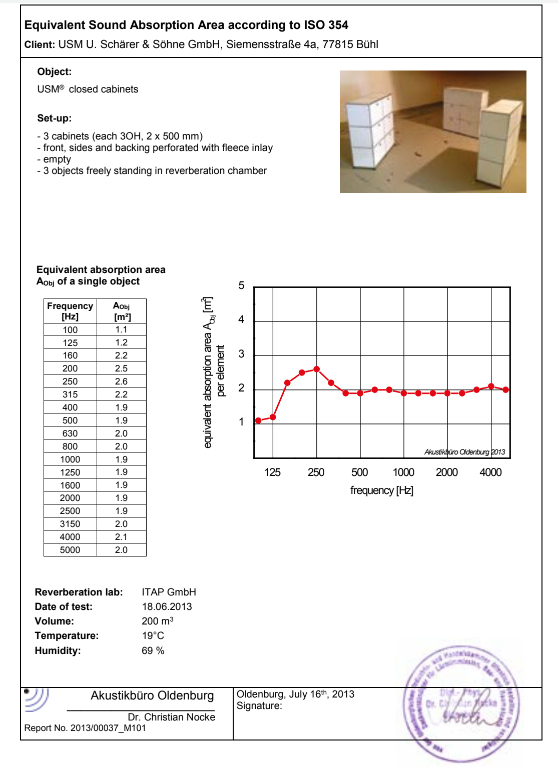
Equivalent absorption area A_{Obj} of a single object

Frequency [Hz]	A_{Obj} [m²]
100	0.6
125	0.7
160	1.4
200	1.4
250	0.9
315	1.0
400	0.7
500	0.6
630	0.6
800	0.7
1000	0.5
1250	0.4
1600	0.4
2000	0.4
2500	0.3
3150	0.3
4000	0.3
5000	0.2

Reverberation lab: ITAP GmbH
Date of test: 18.06.2013
Volume: 200 m³
Temperature: 19°C
Humidity: 69 %

Akustikbüro Oldenburg
Dr. Christian Nocke
Report No. 2013/00037_M206
Oldenburg, July 16th, 2013
Signature:

Test reports for Comparison 2



Equivalent Sound Absorption Area according to ISO 354
Client: USM U. Schärer & Söhne GmbH, Siemensstraße 4a, 77815 Bühl

Object:
USM® closed cabinets

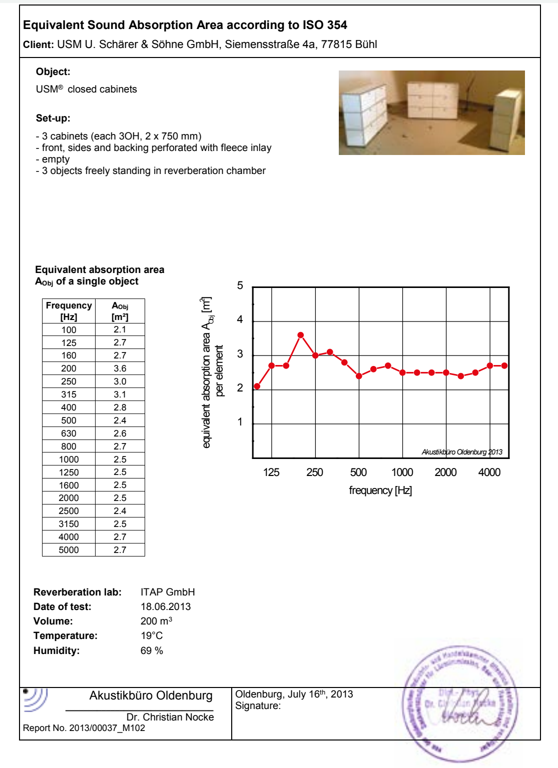
Set-up:
- 3 cabinets (each 3OH, 2 x 500 mm)
- front, sides and backing perforated with fleece inlay
- empty
- 3 objects freely standing in reverberation chamber

Equivalent absorption area A_{Obj} of a single object

Frequency [Hz]	A_{Obj} [m²]
100	1.1
125	1.2
160	2.2
200	2.5
250	2.6
315	2.2
400	1.9
500	1.9
630	2.0
800	2.0
1000	1.9
1250	1.9
1600	1.9
2000	1.9
2500	1.9
3150	2.0
4000	2.1
5000	2.0

Reverberation lab: ITAP GmbH
Date of test: 18.06.2013
Volume: 200 m³
Temperature: 19°C
Humidity: 69 %

Akustikbüro Oldenburg
Dr. Christian Nocke
Report No. 2013/00037_M101
Oldenburg, July 16th, 2013
Signature:



Equivalent Sound Absorption Area according to ISO 354
Client: USM U. Schärer & Söhne GmbH, Siemensstraße 4a, 77815 Bühl

Object:
USM® closed cabinets

Set-up:
- 3 cabinets (each 3OH, 2 x 750 mm)
- front, sides and backing perforated with fleece inlay
- empty
- 3 objects freely standing in reverberation chamber

Equivalent absorption area A_{Obj} of a single object

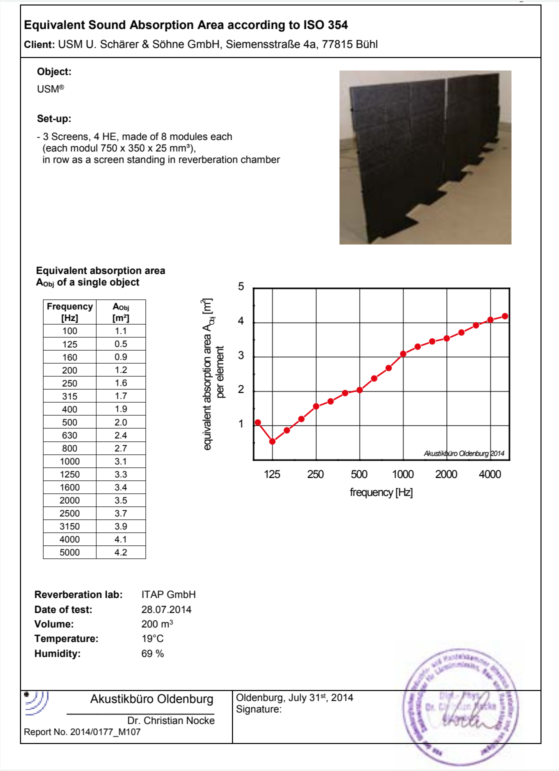
Frequency [Hz]	A_{Obj} [m²]
100	2.1
125	2.7
160	2.7
200	3.6
250	3.0
315	3.1
400	2.8
500	2.4
630	2.6
800	2.7
1000	2.5
1250	2.5
1600	2.5
2000	2.5
2500	2.4
3150	2.5
4000	2.7
5000	2.7

Reverberation lab: ITAP GmbH
Date of test: 18.06.2013
Volume: 200 m³
Temperature: 19°C
Humidity: 69 %

Akustikbüro Oldenburg
Dr. Christian Nocke
Report No. 2013/00037_M102
Oldenburg, July 16th, 2013
Signature:

Test report for USM Privacy Panels

Test report on sample measurements of free-standing USM Privacy Panels



Equivalent Sound Absorption Area according to ISO 354
Client: USM U. Schärer & Söhne GmbH, Siemensstraße 4a, 77815 Bühl

Object:
USM®

Set-up:
- 3 Screens, 4 HE, made of 8 modules each (each modul 750 x 350 x 25 mm³), in row as a screen standing in reverberation chamber

Equivalent absorption area A_{Obj} of a single object

Frequency [Hz]	A_{Obj} [m²]
100	1.1
125	0.5
160	0.9
200	1.2
250	1.6
315	1.7
400	1.9
500	2.0
630	2.4
800	2.7
1000	3.1
1250	3.3
1600	3.4
2000	3.5
2500	3.7
3150	3.9
4000	4.1
5000	4.2

Reverberation lab: ITAP GmbH
Date of test: 28.07.2014
Volume: 200 m³
Temperature: 19°C
Humidity: 69 %

Akustikbüro Oldenburg
Dr. Christian Nocke
Report No. 2014/0177_M107
Oldenburg, July 31st, 2014
Signature:

The test reports are available from USM on request for use with USM projects.

Persuasive values

USM Modular Furniture Haller and USM Privacy Panels can replace absorber surfaces on ceilings and walls – individually or ideally in combination.

The following examples show which acoustic materials are needed to supplement or even replace conventional walls, floors and furnishings to achieve the required optimum reverberation time as per DIN 18041. They show how the use of USM products instead of furnishings which are not acoustically effective can reduce the size of these surfaces.

Open-plan office

Room width:
21.90 m

Room length:
15.00 m

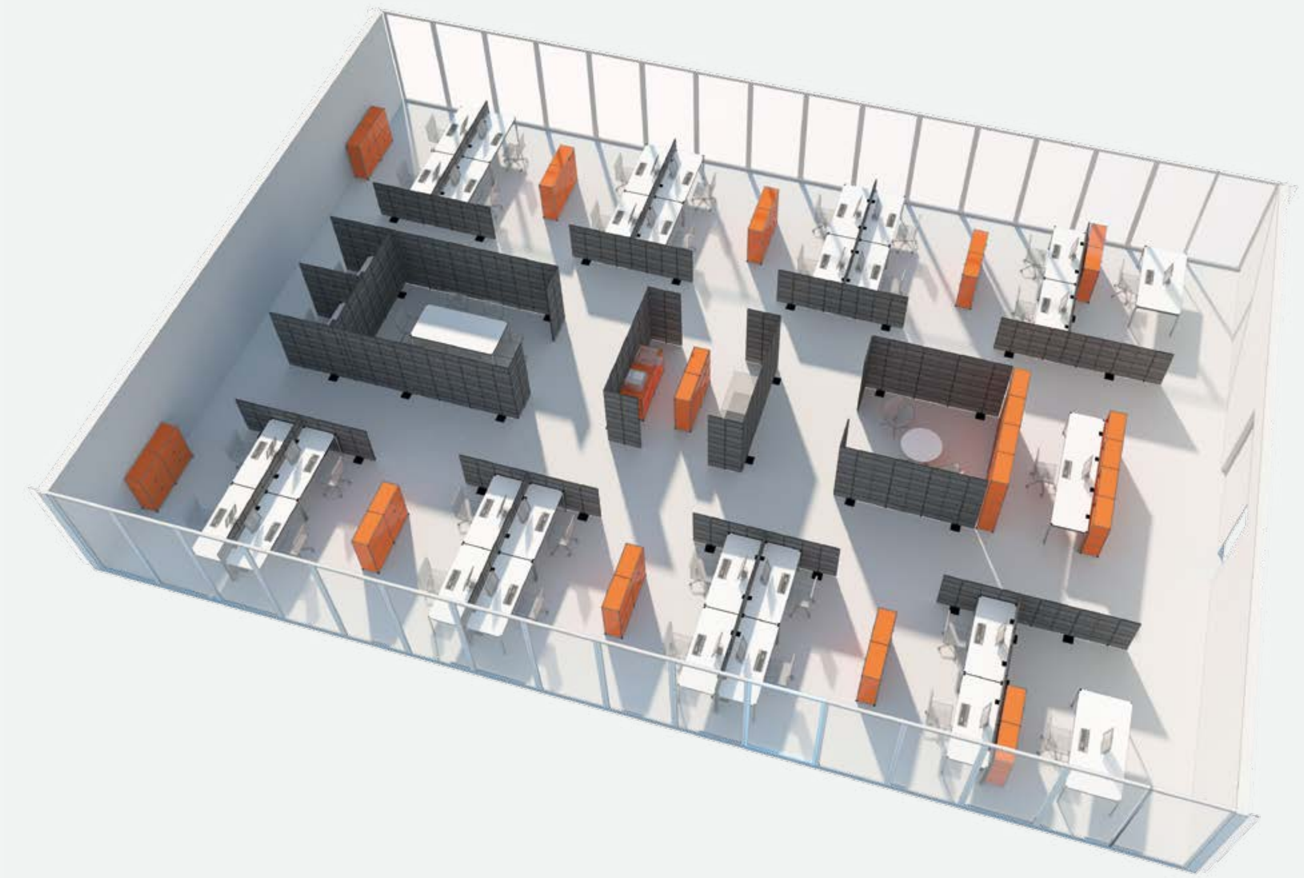
Room height:
approx. 2.75 m

In an open-plan office measuring approx. 330 m² with 30 workstations and two meeting areas, an optimum reverberation time of 0.78 s ± 20% can be obtained across the entire frequency range by:

Option 1	Option 2
Conventional furnishings 21 m² wall absorbers 100% acoustic ceiling	USM Haller furniture with acoustic panels USM Privacy Panels 20% acoustic ceiling

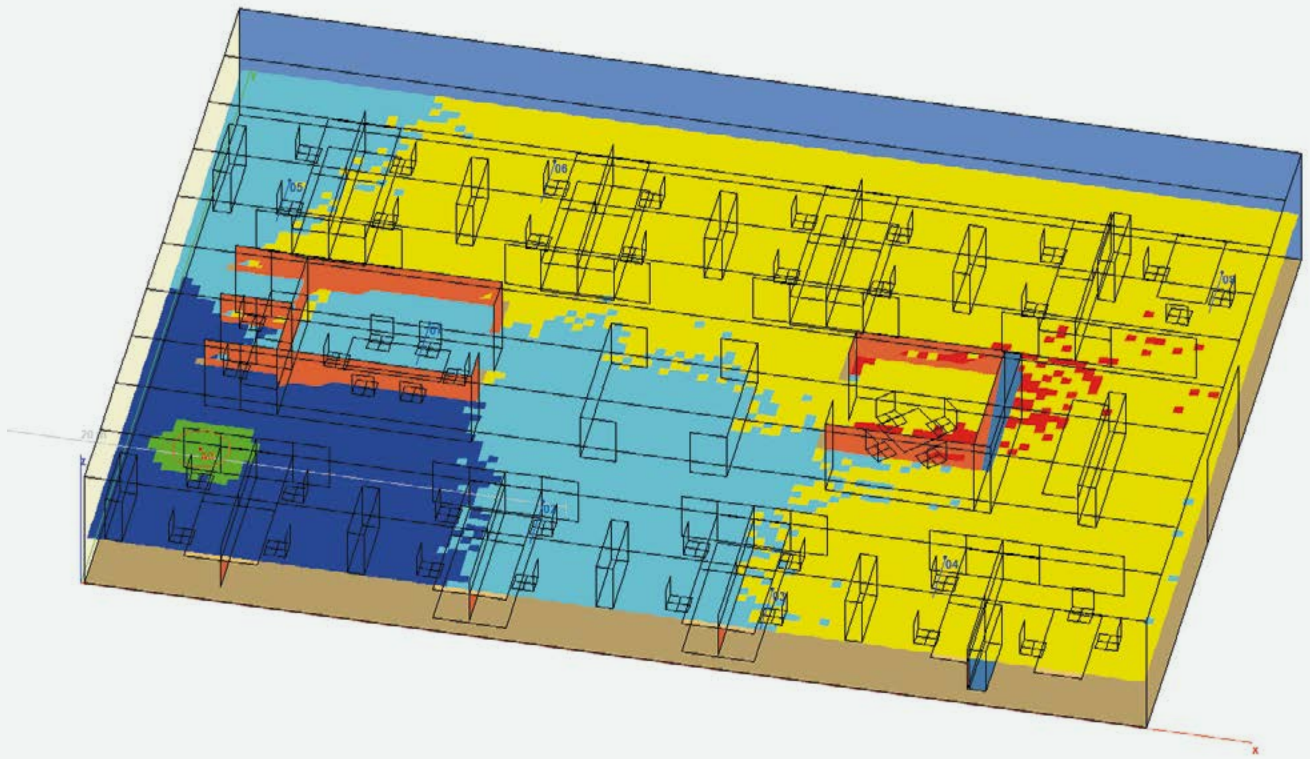
Conclusion

USM Haller furniture with acoustic panels on all four sides reduces the required absorber area on the ceiling by 80%. In addition, USM Privacy Panels provide the screening between workstations which is essential for good room acoustics.



acoustically enhanced USM Haller furniture

acoustically enhanced USM Privacy Panels



Simulation carried out by Akustikbüro Oldenburg

Conference meeting room

Room width:
5.40 m

Room length:
4.10 m

Room height:
approx. 2.75 m

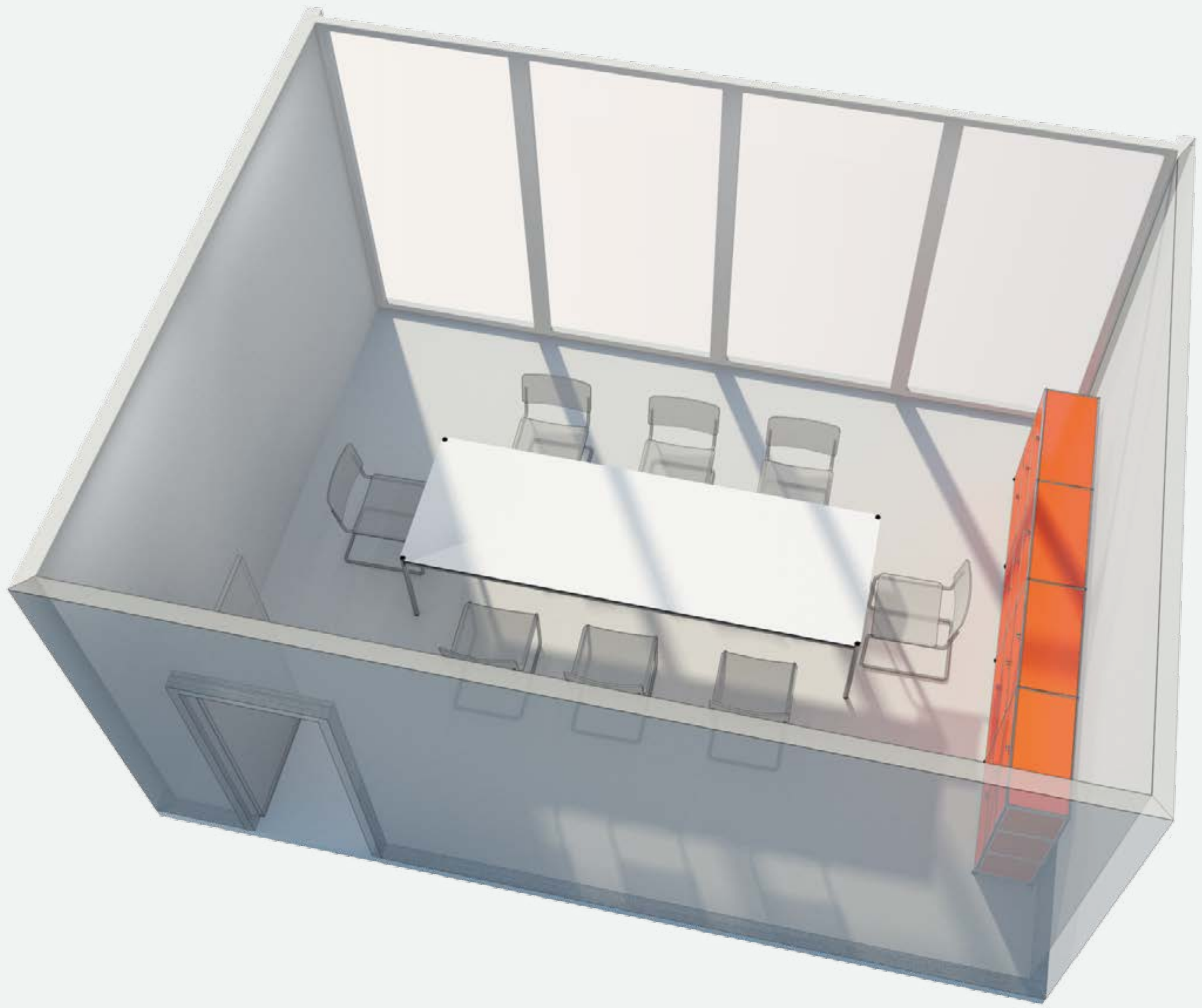
In a conference room measuring approximately 22 m² an optimum reverberation time of 0.5 s ± 20% can be achieved across the entire frequency range by:

Option 1	Option 2
Conventional furnishings	USM Haller furniture with acoustic panels
90% acoustic ceiling	60% acoustic ceiling

A very high degree of speech intelligibility is required in meeting rooms and video-conferencing rooms. This is achieved by a short reverberation time.

Conclusion

USM Haller furniture with metal acoustic panels on all four sides reduces the absorber area required on the ceiling by 30%.



acoustically enhanced USM Haller furniture

Breakout area / living space

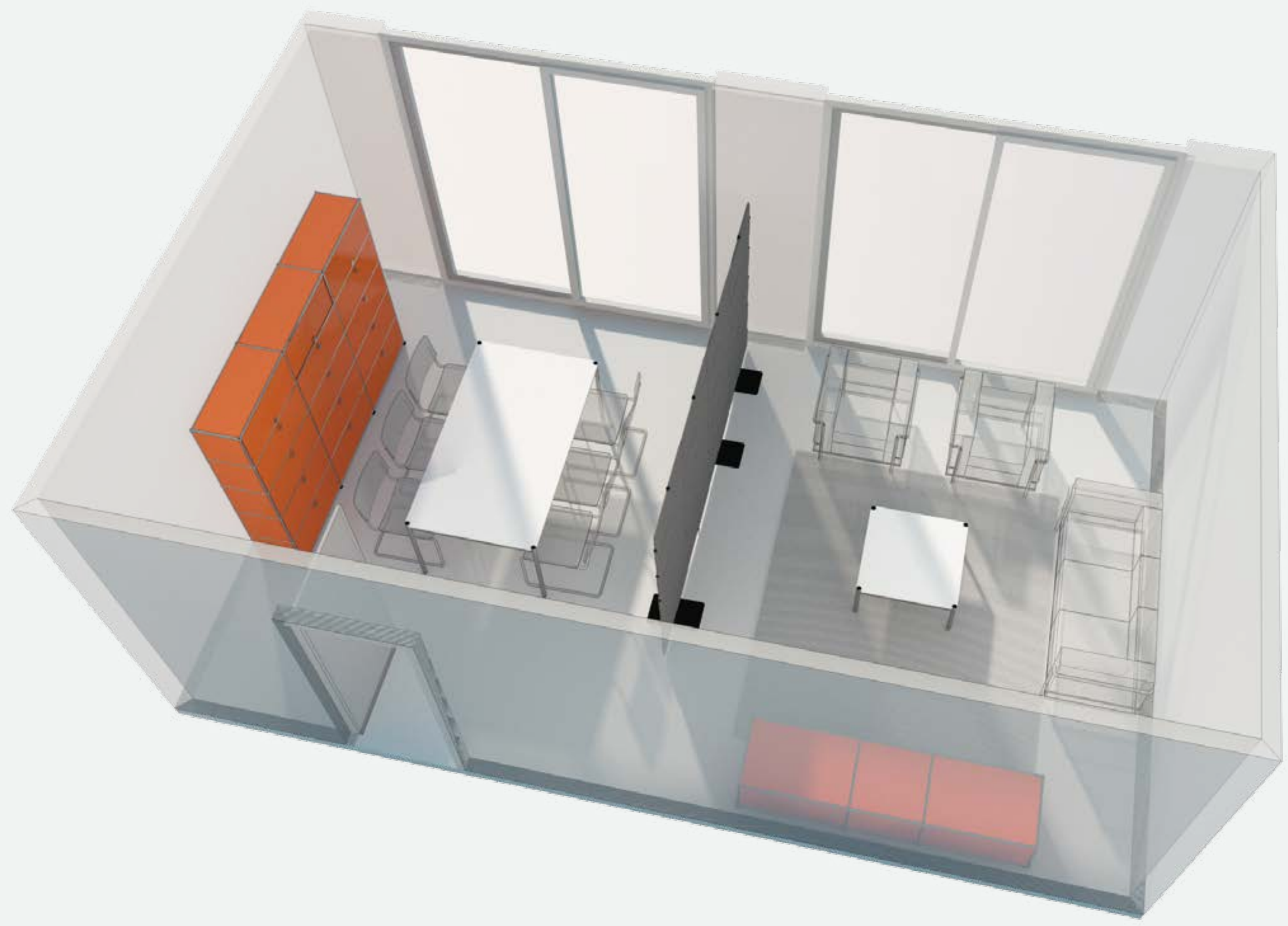
Room width:	Room length:	Room height:
5.40 m	4.10 m	approx. 2.75 m

In a breakout area or living space measuring approximately 22 m², an optimum reverberation time of 0.5 s ± 20% can be achieved across the entire frequency range by:

Option 1	Option 2	Option 3
Conventional furnishings	USM Haller furniture with acoustic panels	USM Haller furniture with acoustic panels
100% acoustic ceiling	40% acoustic ceiling	10 m² USM Privacy Panels

Conclusion

The acoustic ceiling can be dispensed with entirely (100%) by using acoustic USM Haller furniture in conjunction with USM Privacy Panels.

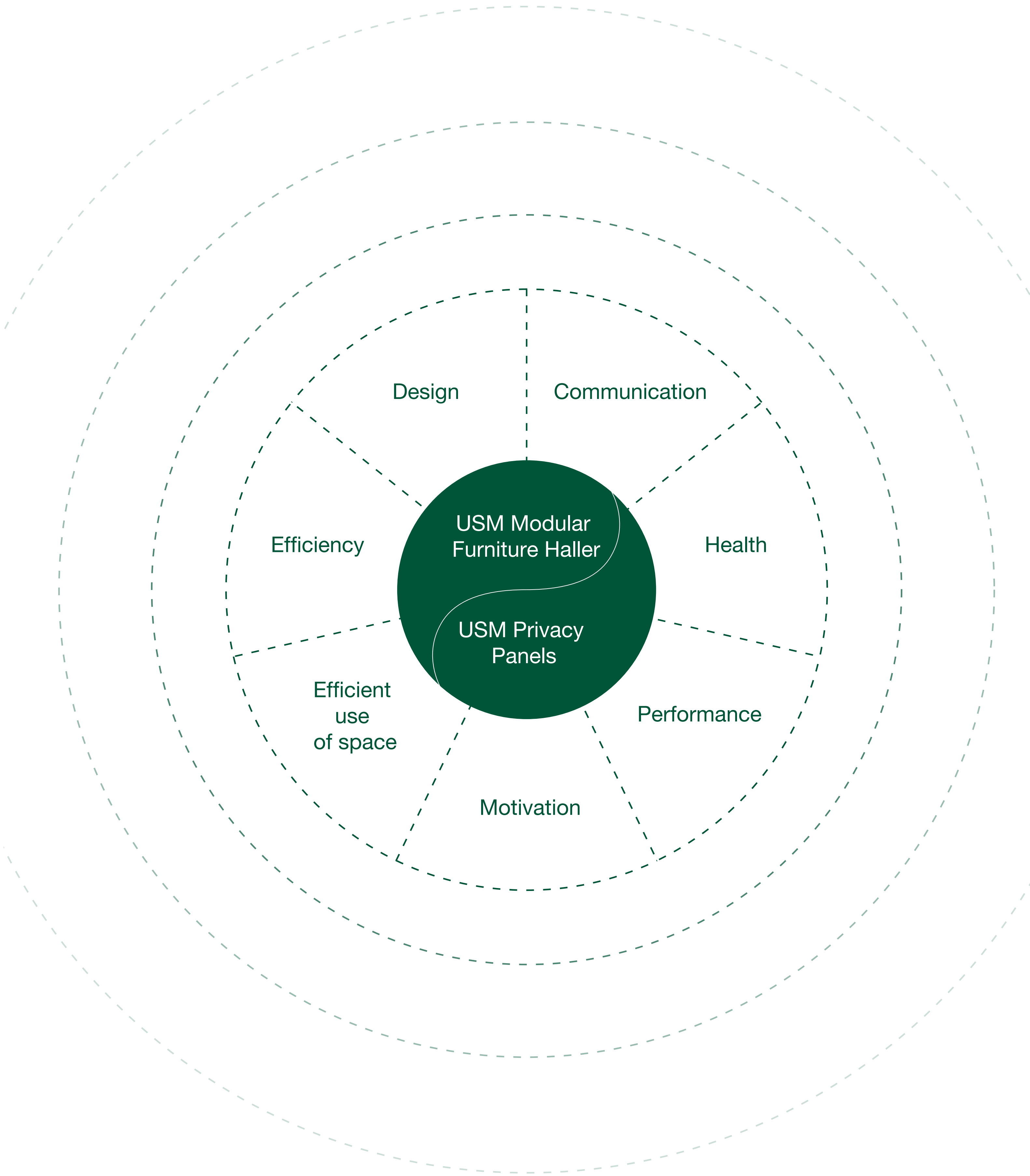


acoustically enhanced USM Haller furniture

acoustically enhanced USM Privacy Panels

What surfaces should I use to create optimum listening conditions in a room?

Benefits of good room acoustics



Sample projects

CTP offices – a cargo ship comes ashore

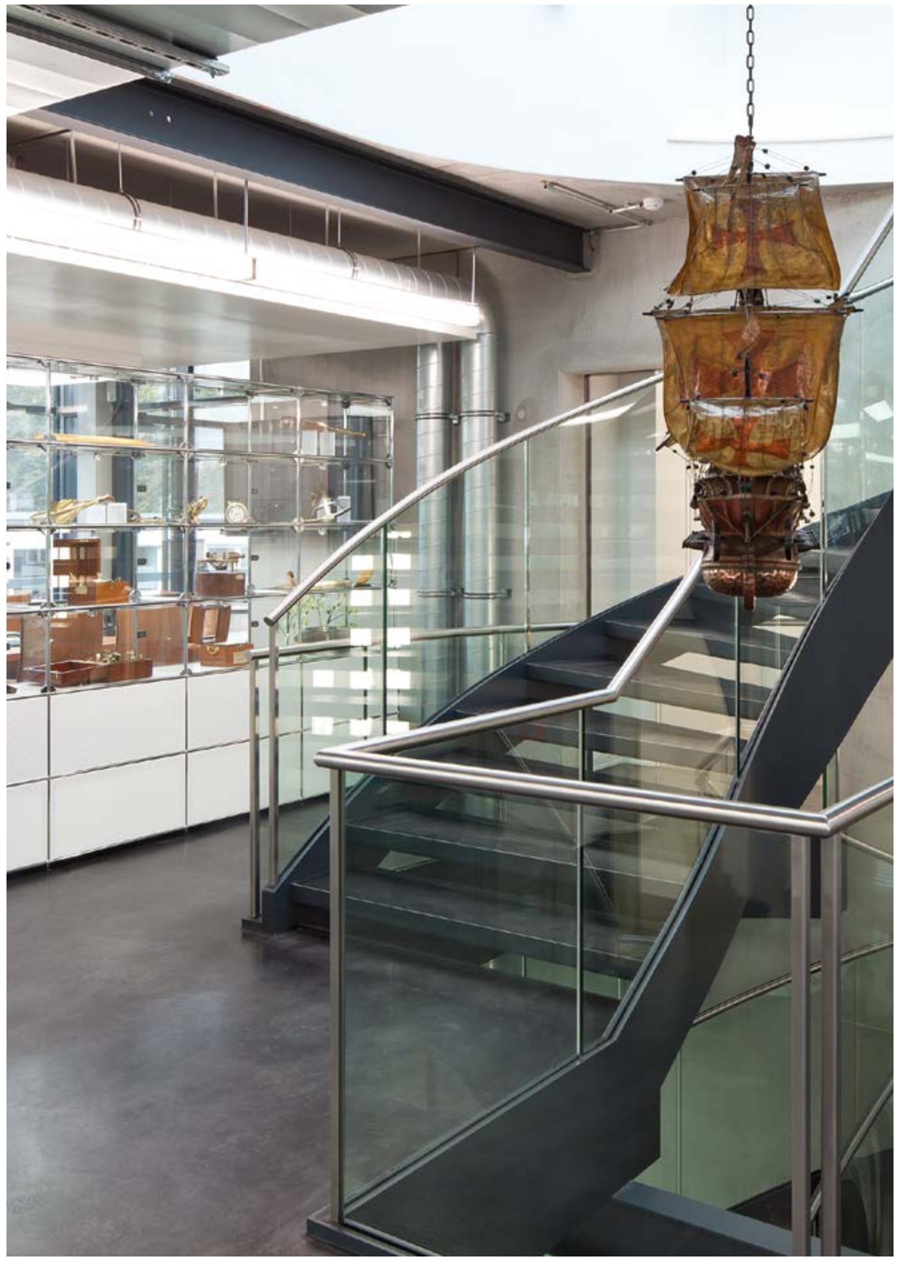
Sometimes architecture tells a story – and that's certainly true of this symbolic office building near Hamburg. Architect Jürgen Waskow's design is packed with allusions to the core business of CTP Service GmbH, a traditional shipping and logistics company, and its managing director Captain Thomas Pötzsch.

Old and new

The headquarters of CTP Service GmbH is an ensemble comprising two distinct parts. An historic villa at the front of the property was remodelled on contemporary lines to accommodate social and recreational rooms, a kitchen and a canteen for staff. Cast an eye over the new extension (see photo), and you could almost imagine that a modern cargo ship had moored alongside it.
Shapes and materials inspired by maritime motifs play with the observer's associations. A navigation bridge, a chimney, which is in fact an outlet, portholes for windows, and open railings. In the interior, too, the principal materials are visible as you would expect on a cargo ship; nothing is hidden, functions are recognisable. The rooms are characterised by exposed concrete, steel, glass and a dark screed floor, supply lines and cable trays are open-routed. Green and red original container doors flank the entrance to the new building.

Open-plan offices

The architect's declared goal was to reflect the cosmopolitan openness and genuine transparency of the company. The aim was to create short routes and maximise communication. On the open-plan office floors of the new building, unobstructed visual links exist between all workstations, including those of senior staff. No fittings or installations disrupt or impede work processes. The ground and first floor merge almost seamlessly via two huge airy stairwells with glass balustrades.



Acoustically enhanced office furniture

In view of the architectural design which incorporates so many sound-reflecting boundary surfaces, it quickly became clear that very carefully attention would have to be paid to room acoustics. So Dr. Christian Nocke from Akustikbüro Oldenburg became involved at an early stage of the extension project. Used in conjunction with individual ceiling panels above the work stations, the acoustically optimised USM Modular Furniture Haller ensures all round acoustic comfort and thus optimum working conditions. Unlike the classic USM Modular Furniture Haller, the acoustic doors and metal panels have perforated surfaces. Sound is absorbed by a highly effective acoustic fleece inserted in the panels as well as by the volume of the furniture itself. With detailed acoustic planning it was possible to calculate the number of perforated metal panels required and the optimum position of the furniture in the room. A measurement on completion clearly demonstrated how effectively the office furniture has improved the room acoustics without having to modify visible surfaces or desired room layouts by adding partition walls or other retrofit installations.

Schöck administrative building – a relaxed working environment

Schöck ISOKORB is a well-known prefabricated structural component. For over 40 years Schöck's site in Steinbach, a district of Baden-Baden, has been expanding brick by brick as new production and administration buildings are added. This is the headquarters of the global manufacturer of standardised prefabricated structural components which serve primarily to prevent thermal bridges or impact noise.

Transparency and permeability

Innovation and customer focus are essential components of Schöck's corporate philosophy – as is the creation of optimum working conditions for employees. One of the company's key aims is to remove compartmentalised room structures wherever possible and replace them with large, open-plan office areas which conform to their guiding principle of open and direct internal communications. The restoration and remodelling of all administrative buildings, including a five-story building dating from the 1970s, offered the perfect opportunity to implement this idea of transparency and permeability in a creative way.

Highest standards of energy efficiency and office design

Architects Herzog and Wolz were keen to upgrade the building to meet current standards of energy efficiency. The old roof structure was replaced with a new, flat green roof with high levels of thermal insulation which incorporates a photovoltaic module. The facade also received additional insulation and high-quality triple glazing.

Inside, the architects completely stripped out the existing room structure, leaving only the exterior walls and steel supporting columns. Within this space they constructed a contemporary workspace for 170 employees with open-plan, clearly zoned office areas and meeting rooms and kitchenettes separated by glass walls. The architects consciously used bright ceilings and walls, concealed wiring and warm, solid oak parquet flooring to create a relaxed and comfortable environment.

Two steps to high-quality room acoustics

Two measures ensured optimum room acoustics in the open-plan offices: acoustically activated ceilings and wall surfaces on the one hand, and acoustically optimised USM Modular Furniture Haller with perforated metal panels backed with high-performance acoustic fleece on the other. With the help of renowned acoustician Dr. Christian Nocke from the Akustikbüro Oldenburg, the furniture was tailored specifically to the spatial conditions and their effectiveness was verified by precise measurements. In addition to USM Haller furniture, which plays an important role in floor zoning, the offices at Schöck are also equipped with electric height-adjustable USM Kitos desks which allow people to work while either sitting or standing.

Switzerland
USM U. Schärer Söhne AG
Thunstrasse 55, 3110 Münsingen
Phone +41 31 720 72 72, info.ch@usm.com

Germany
USM U. Schärer Söhne GmbH
Siemensstraße 4a, 77815 Bühl
Phone +49 72 23 80 94 0, info.de@usm.com

France
USM U. Schärer Fils SA, Showroom
23, rue de Bourgogne, 75007 Paris
Phone +33 1 53 59 30 37, info.fr@usm.com

United Kingdom
USM U. Schaerer Sons ltd., London Showroom
Ground Floor, 49–51 Central St., London, EC1V 8AB
Phone +44 207 183 3470, info.uk@usm.com

USA
USM U. Schaerer Sons Inc., New York Showroom
28–30 Greene Street, New York, NY 10013
Phone +1 212 371 1230, info.us@usm.com

Japan
USM U. Schaerer Sons K.K., Tokyo Showroom
Marunouchi MY PLAZA 1 · 2F
2-1-1 Marunouchi, Chiyoda-ku, Tokyo 100-0005
Phone +81 3 5220 2221, info.jp@usm.com

All other countries
contact USM Switzerland.

www.usm.com