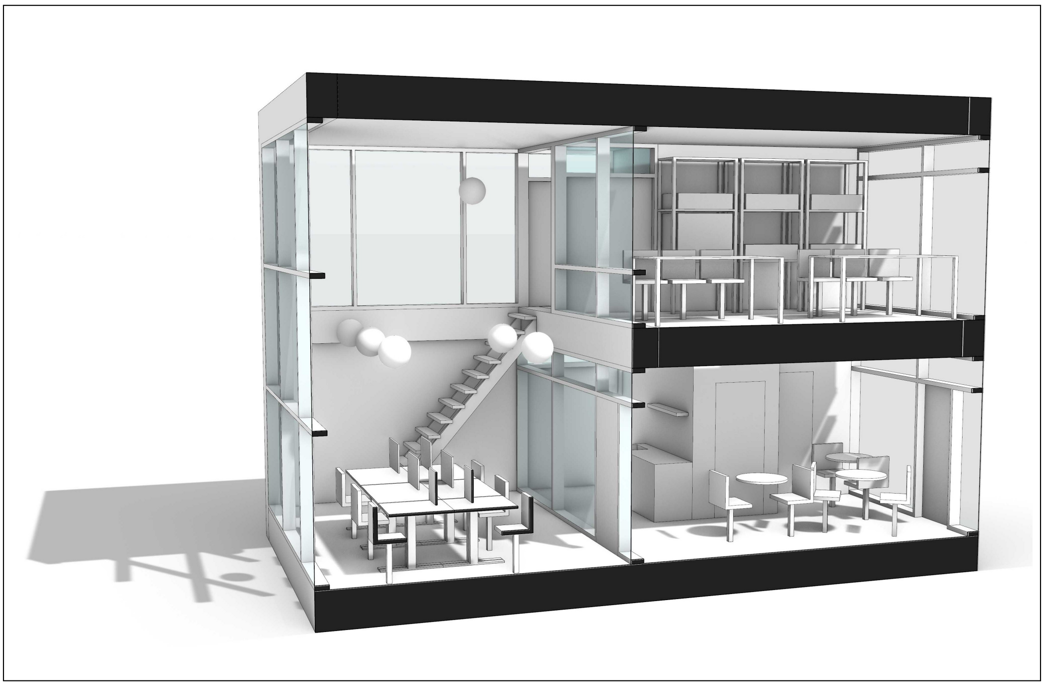
Acoustic Conditions at BIOSIS



Architectural Acoustics - 31240

Oliver Hvidtfeldt
Alexander Kittel
Diego Ratia

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Contents

1 Introduction

1.1 Project description

The purpose of this project is to provide acoustic consultancy for an architecture company called BIOSIS. The aim is to gather the first impressions of the client and their concerns, analyse the current acoustic situation and propose measures that will improve the acoustic conditions.
BIOSIS provides architectural services in Denmark, Sweden, Faroe Islands and Greenland. The company has 11 employees and an office space located in Baldersgade 4, 2200 København. The contacts for this project are the company founding partners and architects, Mikkel Thams Olsen and Morten Vedelsbøl, and they will be referred to as the client.

Figure 1: *Building of interest (Left) and the space occupied by BIOSIS architects (Right)*

1.2 Building description

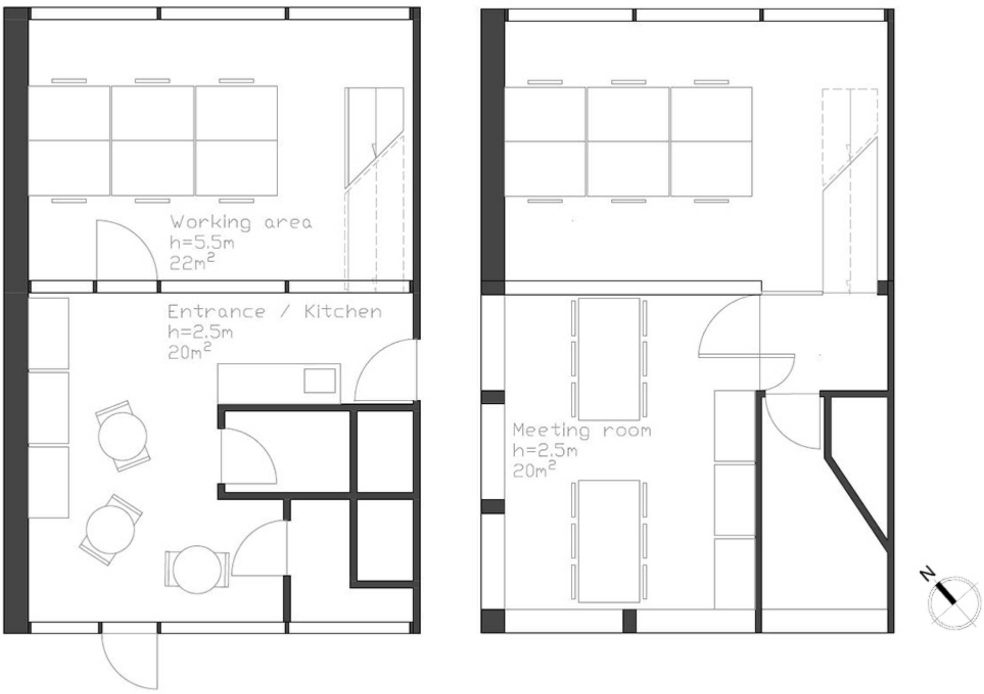


Figure 2: *Office drawings. Ground floor (Left) and first floor (Right)*

The office is located in a seven-storey building occupied by multiple companies. The building has a curtain wall facade and steel structure, and the client rents 85 m2 distributed on the ground floor and first floor. The space is divided into three main areas: entrance, working area, and meeting room. A complete analysis of the space was carried out during the first visit together with a detailed measurement of each of the areas to later build a 3D model.

Figure 3: *Render of the 3D model*

1.2.1 Entrance

Figure 4: *Entrance to the office*

Located on the ground floor, it serves as a multipurpose space. There is a small kitchenette / hallway and a larger space with a toilet, wardrobe room, lunch tables and three metal shelves where regular printers and a 3D printer are placed.
The external wall present in this area is a curtain wall with metal frames and double-glazed facade and a perpendicular solid wall. Internal partitions limiting with the toilet and the wardrobe are painted gypsum walls while the partition connecting to the working area is a curtain wall that matches the external curtain wall characteristics. The floor is made up of concrete with acrylic finish and the ceiling is gypsum.
The furniture in this area is a kitchenette with a wooden shelf, three metal shelves, three metal tables and two metal chairs per table.

1.2.2 Working area

Figure 5: *Working area*

The working area is a double-height space that limits with the entrance on the ground floor and with the meeting room in the first floor, connecting with the latter through wooden stairs.
External partitions in this room are the characteristic curtain wall of the building and the concrete brick wall present on the ground floor. Internal partitions are also solved with the curtain wall except for one gypsum wall.
The working area contains six office desks with their office chairs, an A0 plotter and a wooden vertical lamella covering the brick wall which already plays a role in the acoustic conditions.

1.2.3 Meeting room

Figure 6: *Meeting room*

Located on the first floor, the space serves as a meeting room for the whole team as well as the office space for the client.
The room has the curtain wall on three of the sides, and gypsum wall limiting with the workshop room next to it. The floor is finished in epoxy and the ceiling is a gypsum board.
Furniture present in this room are two meeting tables, several chairs and three metal shelves.

1.3 Goals

1.3.1 Client expectations

BIOSIS is a danish architecture company with a special interest in sustainability and climate. One of their core competences is to provide architectural spaces that feel integrated with the nature and the surroundings, creating comfortable buildings for their clients. In this context the client states their intention to communicate this idea to anybody that enters the office space, and that includes comfortable acoustic conditions.
Being located next to Nørrebrogade, BIOSIS wants for the clients to feel as good as possible when entering the office, and to avoid any uncomfortable noise. The entrance is the first impression for the guests when visiting the architecture studio, and the client stated that the acoustic conditions could be improved, and they state their wish to be assessed in this regard.
The working area is described by the client as a generally comfortable room acoustically speaking. However, they mention that sound and conversation coming from the meeting room above is noticeable, and they would be willing to fix this detail.
The acoustic situation in the meeting room is closely related to the one in the working area, since the client reaffirms the need of avoiding noises leaking to the working area. Furthermore, there is a need of privacy in the room and a reduction of sound distractions would be beneficial for the space.

1.3.2 Project goals

Taking in mind the client perspective and goals, each of the rooms have been individually assessed in terms of room acoustics. The office space was carefully analyzed room by room and all of them were tested in a preliminary way, with physical simulations and easy to make sounds and conversations that would replicate the normal use.
By doing so, and together with a visual inspection, different facts were extracted:

1. The entrance has not been treated acoustically speaking. There are no carpets and the ceiling is bare as well. First impressions are high reverberation and high background noise levels. Given the first impression importance, it seems to be the most problematic space at the moment.

2. The working area appears to be comfortable although it is acoustically untreated. Considering the shape and materials of the room, it may be difficult to improve the general acoustics. One of the walls is covered with vertical wooden lamella (10m2) and several architectural models that are hanging from it. These materials and shapes are already creating certain improvement in the acoustic conditions.

3. The meeting room surfaces are also untreated. The room is inadequately isolated and at first glance the pivoting door closing the space is identified as one of the causes, since it does not close airtight and it is the cause of acoustic leaks.

In conclusion, none of the rooms have been treated acoustically and some of the building elements like doors, materials and finishes are playing an important role in the final acoustic perception. The measurement of the room acoustic parameters has been done according to the standards DS/EN ISO 3382 [1] and the sound transmission between rooms according to the DS/EN ISO 140-4 [2]. According to the building regulations in Denmark, BR18, where they aim for *sound and comfort-satisfactory sound conditions in relation to the use of the space*, the aim in terms of design values for the sound insulation follows in the tables below:

Office construction - Table 5.1 Sound insulation - Proposed design values	
Airborne Sound Insulation - Horizontal	**R'w**
Between offices and other offices (with door connection)	$\geq 35dB$

Table 1: *Proposed target for airborne transmission loss.*

Office construction - Table 5.4 Room acoustics - Proposed design values		
Reverberation time	**T**	**Frequency range**
Offices (1-4 people) and meeting rooms	T $\leq 0.6s$	125-4000Hz

Table 2: *Proposed target for T30 reverberation time.*

2 Measurements

In order to align our measurements with our goals and the expectations of the client, we have opted for characterizing the acoustics of each of the three rooms of the office, as well as evaluating the airborne sound insulation, specifically with the ground floor office space as receiver.

2.1 Acoustics (ISO 3382)

30 dB decay times (T30) are measured as the time it takes for the sound pressure level (SPL) in a room to drop 30 dB (after the initial 5 dB drop from the onset). Early decay times (EDT) are very similar, but cover only the first 10 dB of decay. Both of these quantities are measured using the B&K Dirac Acoustic Software according to the ISO 33082 standard. We used a laptop for controlling the source signal, as well as the input from the microphone. The output of the computer was fed into a power amplifier driving an omnidirectional speaker (dodecahedron construction, supplied by DTU Acoustics). The signal was picked up by a B&K 4192 1/2" microphone driven by a Nexus preamplifier, and fed back into the laptop. An exponential sine sweep of 2.73 s from 125 to 8000 Hz is used as source signal, preaveraged 12 times for each source / receiver combination.

2.1.1 Entrance and kitchen area

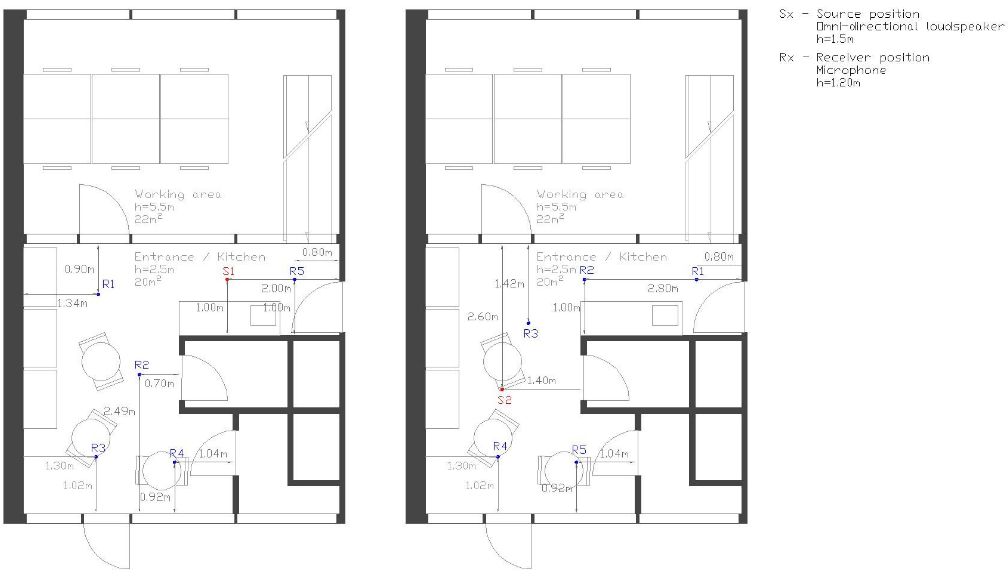


Figure 7: *Source and receiver positions for the entrance / kitchen area.*

Source and receiver locations are presented in Figure 7 and are marked in relation to the nearest wall. Figure 8 shows the averaged ISO 3382 parameters for the kitchen and entrance area, along with error bars corresponding to the standard deviation between the source and receiver position combinations. This room is an odd shape (essentially two coupled near rectangular rooms), and the inherent geometry may be a part of the reason for the large deviations in reverberation times for low frequencies, as each section may have modes of its own. These values aren't particularly worrisome at first glance, but the uneven decay times across the frequency range and the large early decay time in relation to T30 could explain the particular sound profile of the room, which felt loud and ringing [3].

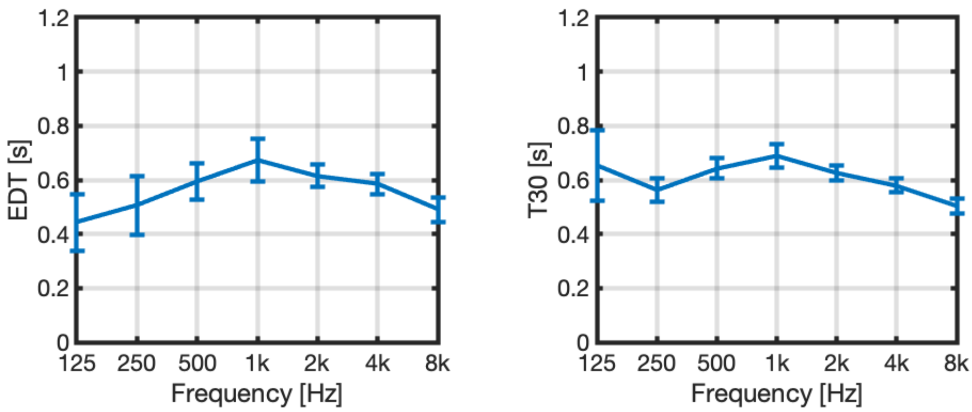


Figure 8: *ISO 3382 parameters with standard deviation for the entrance / kitchen area.*

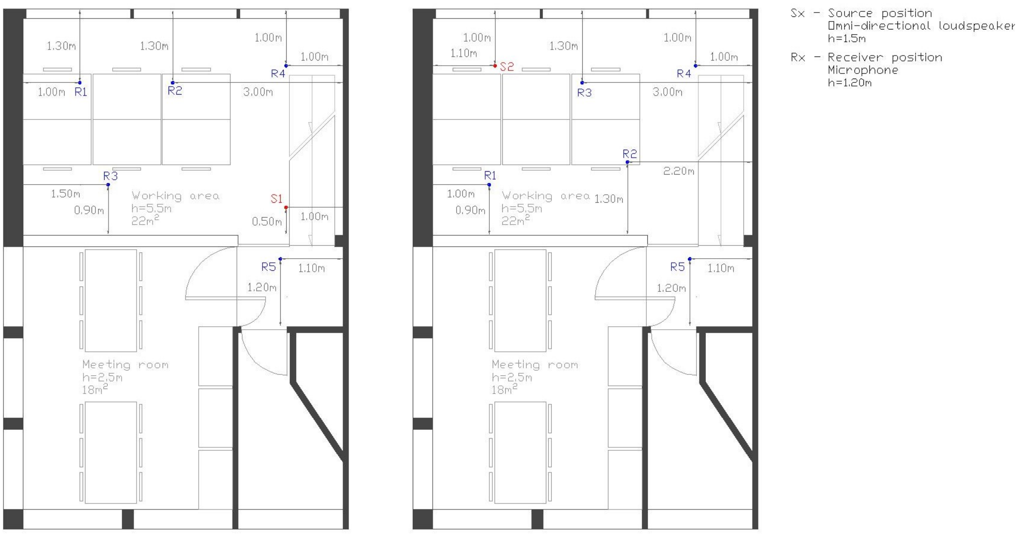


Figure 9: *Source and receiver positions for the ground floor open office area.*

2.1.2 Ground floor open office area

The ground floor office area has the largest volume of any room, and is also where we have the most requirements from our client. Source and receiver locations are presented in Figure 9. Figure 10 shows the ISO 3382 parameters plotted for this space. As we expected (and experienced), the T30 times and EDT are quite long. Even if these values are larger than for the kitchen area (Figure 8), the acoustics are perceived better in this room. The shape of the decay times across frequencies being similar between EDT and T30, along with the fact that the EDT is consistently shorter, may be a representation of this discrepancy [3].

2.1.3 Upstairs meeting room

The upstairs meeting room is the smallest room, with the least ceiling height. Due to the size of this room, only 4 receiver positions were used for each source position, as opposed to 5 for the two other rooms. Locations for two sources and the receiver positions are presented in Figure 11. The ISO 3382 parameters are shown in Figure 12. These results are expected for an untreated room of this size, with decay times exceeding 0.65 s. We see the same behaviour here as in the kitchen area, where the EDT is quite long in relation to the T30, attributable to the fact there is little energy lost in each reflection surface. In alignment with client expectations, this room will need special attention.

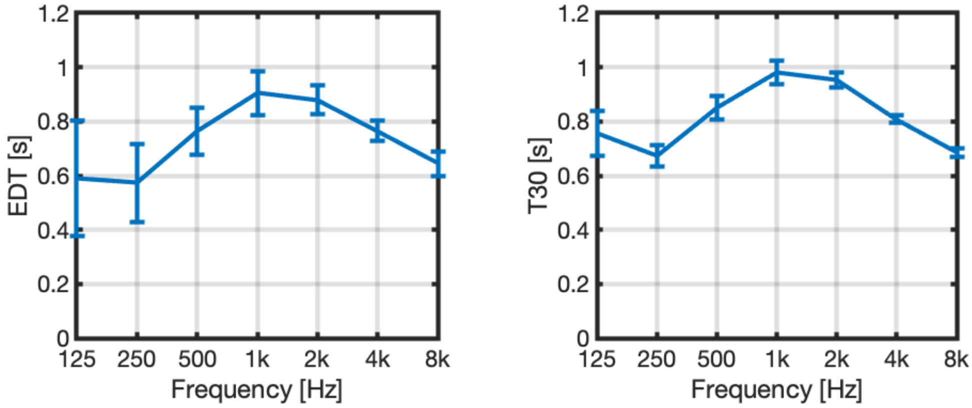


Figure 10: *ISO 3382 parameters with standard deviation for the open office area*

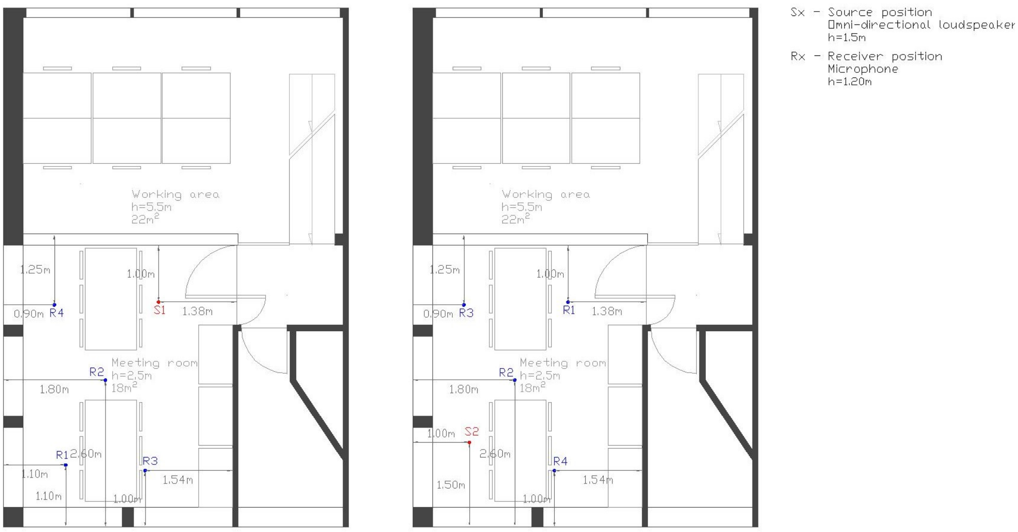


Figure 11: *Source and receiver positions for the meeting room upstairs.*

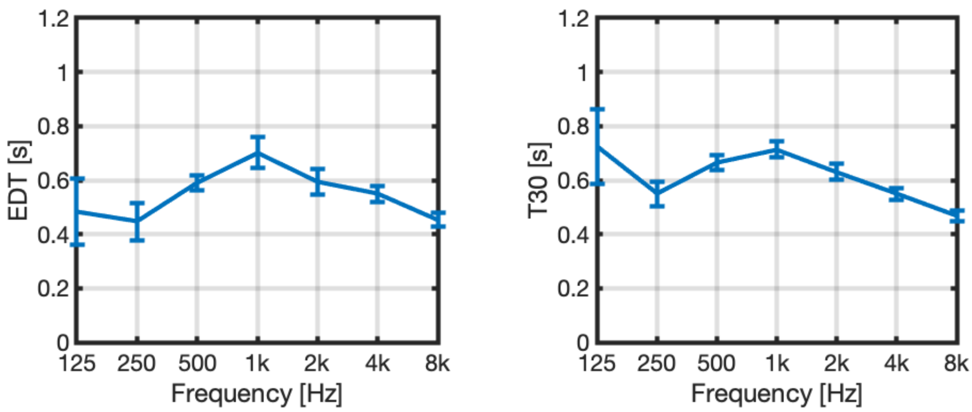


Figure 12: *ISO 3382 parameters with standard deviation for the upstairs meeting room.*

2.2 Airborne sound transmission (ISO 140-4)

A large part of client expectations were around the sound transmission from the entrance area and the upstairs office to the open office space. For this reason, we conducted airborne sound insulation tests in accordance to the ISO 140-4 standard, using the B&K 2250 analyzer and the omnidirectional dodecahedron speaker from the room acoustics measurement. The power amplifier driving the omnidirectional speaker was used to generate pink noise at very high sound pressure levels, with the 2250 acting as source for measuring the reverberation time. The sound reduction index and weighted transmission loss are calculated for frequencies between 50 and 5 kHz, such that

$$R' = L_1 - L_2 + 10\log\left(\frac{S}{A}\right), \tag{1}$$

for SPL in source room L_1, SPL in receiver room L_2, transmitting surface area S and equivalent absorption area A, given by Sabine's equation for receiver room volume V and reverberation time T_{30}:

$$A = 0.16\frac{V}{T_{30}} \quad . \tag{2}$$

First, the average sound pressure in the source room was measured for two source positions and three receiver positions. The speaker was left on, and the average sound pressure was measured for the same two source positions at three microphone positions in the receiver room. The background noise and average reverberation time is then measured in the receiver room with three microphone positions. This was done with both the kitchen / entrance area and the upstairs room acting as source rooms and the open office area as receiver room. The receiving room has a volume of $122\,\mathrm{m}^3$, with a transmission surface of $14\,\mathrm{m}^2$ to the kitchen and $10\,\mathrm{m}^2$ to the upstairs office. For both cases, the partitions are mainly double pane glass, though the space between panes is quite small ($\leq 1\,\mathrm{cm}$). Between the receiving room and the upstairs office, there is a large swivel door that we spotted as a focus area to improve. There is no effort made to create a seal, partly because there is no gasket, and partly because the design of the door and frame make sealing it very difficult.

2.2.1 Kitchen to open office area

Figure 13 shows the R' sound transmission loss from the kitchen to the open office space as function of frequency. The transmitting surface is $14\,\mathrm{m}^2$, and the weighted averaged index is 26 dB, which is worse than recommendations [4], and far below our target of 35 dB (Table 1).

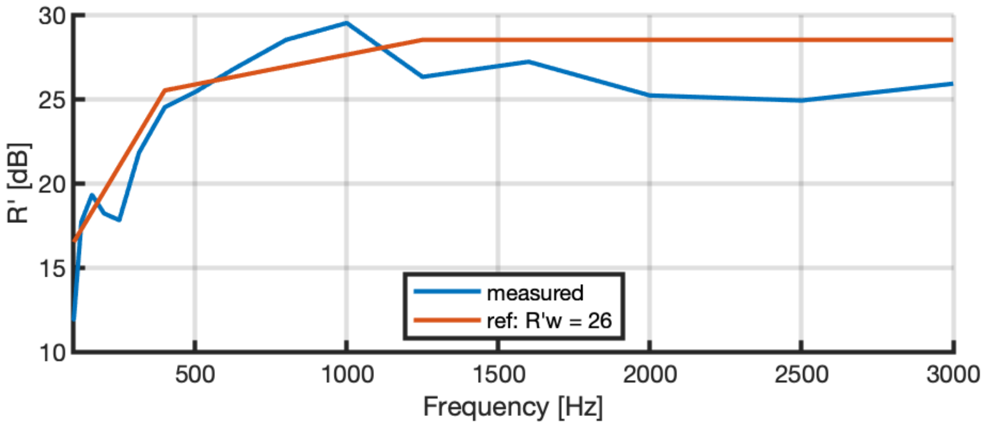


Figure 13: *Sound reduction index, kitchen to open office area. Reference curve for* $R'w = 26\,\mathrm{dB}$.

2.2.2 Upstairs meeting room to open office area

Figure 14 shows the sound transmission loss between the meeting room and the open office area. This measurement concerns our main acoustic issue to rectify, which is understandable considering how low the weighted transmission loss is for this configuration, with $R'w = 22\,\mathrm{dB}$. We suspect most of this is due to the swiveling door. The leak is also observable in the sharp decrease in high frequency when comparing the transmission loss to the 22 dB weighted reference curve.

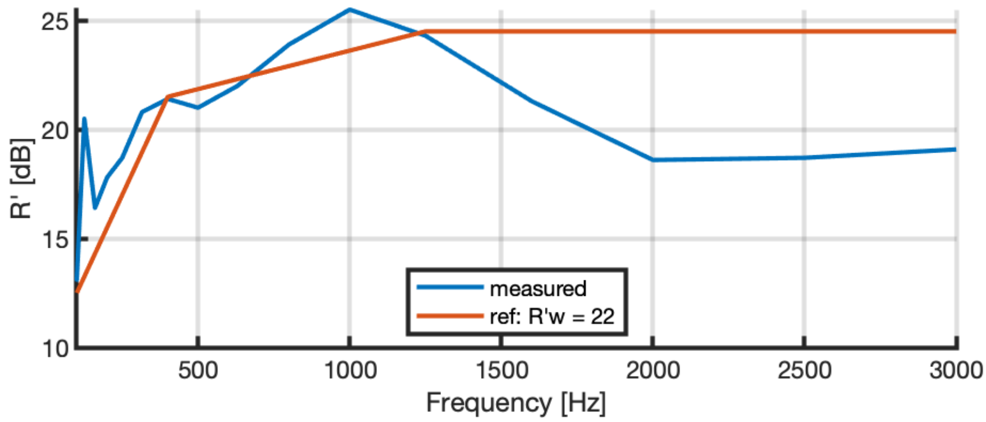


Figure 14: *Sound reduction index, upstairs office to open office area. Reference curve for $R'w =$* 22 dB.

3 ODEON simulation

This section will focus on the ODEON setup and on matching the simulation results to our measurements. In order to argue for our proposed solutions, we need to be able to rely on a well fitted model to test on.

3.1 Geometry

The initial geometry was created using Rhino with material layers predefined before import to ease material allocation. The CAD model was exported using the 2007 solids export scheme and imported as a .dwg file into ODEON. The model geometry in ODEON can be seen on figure 15 depicting two elevation views.

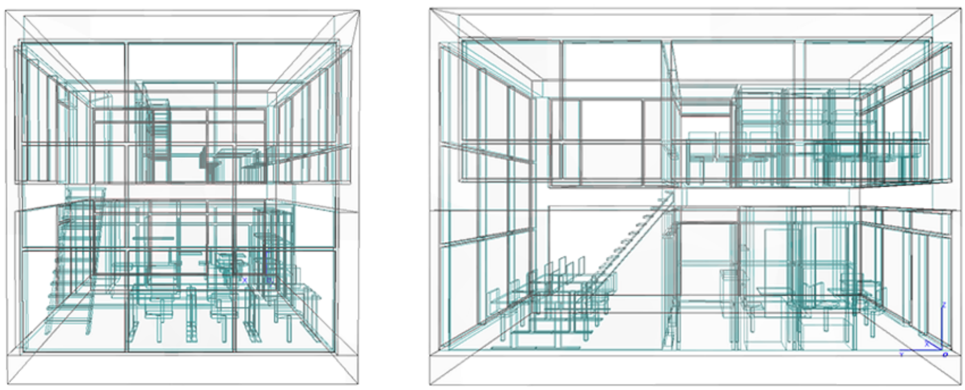


Figure 15: *ODEON room of the office - front (Left) and side (Right)*

The interior was modelled to capture the variation in surfaces, and also remain simple in geometry. The model has in total 716 surfaces, and 13000 late rays in the room setup for higher precision.

3.2 Calibration

In order to document realistic design proposals using ODEON, the model has to produce results for acoustic parameters similar to the real measurements. To achieve this, the building elements have to be examined and defined within ODEON from the global material library available. Figure 16 describes the material specifications chosen for each surface, their global library ID, and the initial optimization search area.
The selection of materials and corresponding absorption coefficients might not match entirely with real conditions, unless the material properties are explicitly known. In this case, the model was

Surface	Material specification	ID	63	125	250	500	1000	2000	4000	8000 Hz	a(w)
Office chair	Empty chairs, upholstered with cloth cover	11006	0.555	0.395	0.645	0.781	0.908	0.768	0.705	0.761	0.85
External wall	Smooth concrete, painted or glazed	102	0.105	0.058	0.132	0.103	0.079	0.09	0.128	0.05	0.1
Glass	Double glazing, 2-3 mm glass, 10 mm gap	10003	0.188	0.094	0.144	0.07	0.01	0.032	0.022	0.024	0.05
Interior wall, ceilin	Plaster, gypsum, or lime, smooth finish on lath	4036	0.121	0.223	0.279	0.136	0.15	0.041	0.132	0.144	0.1
Door	Solid wooden door	10007	0.083	0.128	0.136	0.064	0.058	0.078	0.086	0.105	0.1
Cabinet	Thin plywood paneling	3063	0.305	0.406	0.197	0.074	0.053	0.102	0.039	0.033	0.1
Lamella	Plywood paneling, 1 cm thick	3068	0.432	0.427	0.292	0.099	0.058	0.147	0.162	0.07	0.1
Staircase	Floating wooden floor	3001	0.088	0.091	0.093	0.028	0.083	0.036	0.055	0.025	0.05
Floor	Linoleum or vinyl stuck to concrete	6000	0.02	0.038	0.027	0.052	0.041	0.052	0.048	0.034	0.05
Other chair	20% absorption	-	0.219	0.199	0.253	0.266	0.216	0.267	0.269	0.289	0.25
Structural system	30% absorption	-	0.541	0.173	0.528	0.388	0.359	0.509	0.16	0.15	0.35
Shelf	10% absorption	-	0.24	0.222	0.07	0.176	0.236	0.243	0.148	0.075	0.25
Window Frames	20% absorption	-	0.443	0.421	0.106	0.156	0.239	0.188	0.239	0.169	0.2
Computer	30% absorption	-	0.401	0.225	0.242	0.377	0.209	0.146	0.183	0.248	0.2
Table	20% absorption	-	0.23	0.112	0.162	0.207	0.3	0.194	0.102	0.256	0.2
Search area 30%	Search area 50-60%										

Surface	Material specification	ID	63	125	250	500	1000	2000	4000	8000 Hz	a(w)
Curtains	Curtains, densly woven window curtains	8014	0.06	0.06	0.1	0.38	0.63	0.7	0.73	0.73	0.35
Wall panel	Topakustik Type 12/4 M	-	0	0.35	0.79	0.9	0.89	0.84	0.73	0	0.85
Ceiling baffle	Topakustik Topperfo Type M	-	0	0.2	0.41	0.95	0.95	0.75	0.59	0	0.7
Panel / divider	Bencore Lightben Acoustic	-	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
MPP	Barrisol Microsorber	-	0	0.09	0.4	0.75	0.77	0.73	0.62	0	0.7

Figure 16: *Specification of optimized global library materials and acoustic surfaces*

calibrated in ODEON using the measured acoustic parameters for eg. T20, T30, EDT and C50, C80 per recommendations from the ODEON manual. The function in ODEON optimizes the absorption coefficients within a specified search area in an iterative process altering the materials to produce a more realistic model. The comparison between the simulated and measured T30 parameter can be seen for all rooms in Figure 17.

ODEON simulates acoustics by modelling rooms like reflectors, and calculating rays for sound propagation. The frequency range below which a room with volume V acts as a resonator is determined by the Schroeder frequency:

$$f_S = 2000\sqrt{\frac{T_{30}}{V}} \quad . \tag{3}$$

Below this, ODEON is unsuited for simulating acoustic parameters, as the uncertainties associated are large and essentially unknown. Fitting the model must therefore be done mostly on frequencies above.

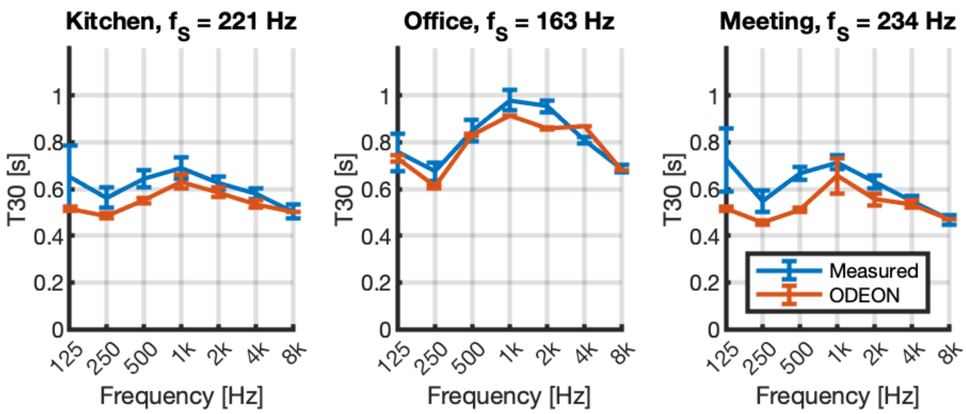


Figure 17: *Comparison of simulated and measured T30 values, along with the corresponding Schroeder frequency (Equation 3). From the left: kitchen and entrance area, shared office space and upstairs meeting room. Our model slightly underestimates T30, but remains within acceptable margins for our usage. The general shape of the curves is also replicated. Discrepancies in low frequencies (especially for the meeting room) are attributed to the large deviations associated with simulating room parameters below the Schroeder frequency in ODEON.*

4 Solutions

There are a number of measures that could be taken in order to improve the acoustic conditions in the office space. The list of proposals that can be found below is sensitive with the context of this project, the client profession, the company core concept, and of course efficiency and economical viability.

4.1 Entrance

- Ceiling absorbers (1): Topperfo Type M 49mm (https://www.topakustik.uk.com/)
- Furniture (2): Cover metal shelves in translucent composite "Bencore Lightben Acoustic"
- Wall absorber (3): Topakustik wood planks similar to the existing lamela in the working area

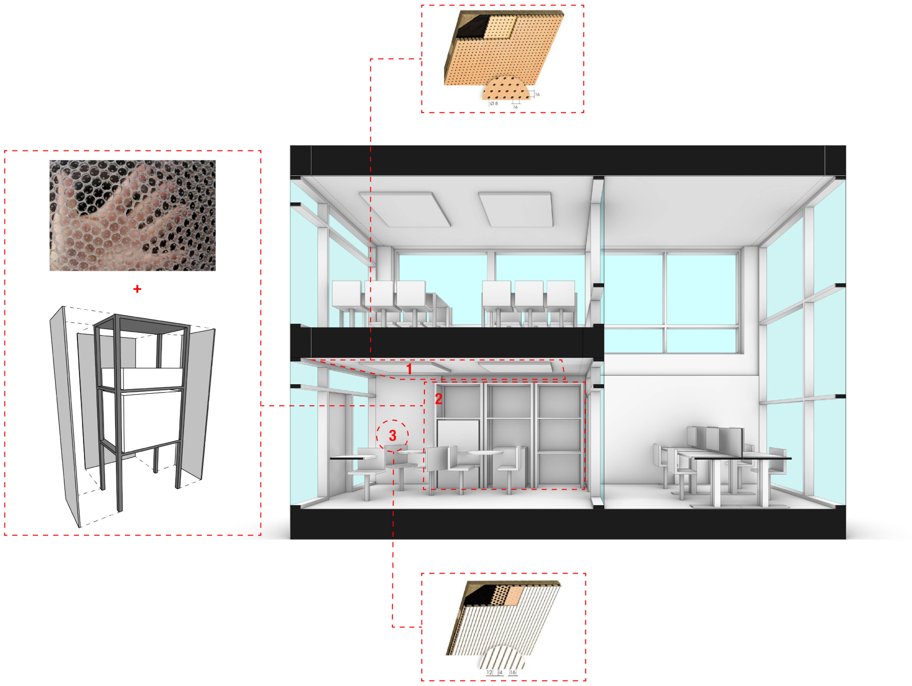


Figure 18: *Proposed acoustic measures for the entrance*

4.2 Working area

- Wall absorbers (1): Topakustik planks similar to the existing lamela in the opposite side of the room
- Furniture (2): Use of translucent composite "Bencore Lightben Acoustic" as desk separator
- Curtains (3): Medium weave curtains are recommended. These will have better effect than curtains with a weave too loose or too dense
- Micro perforated plastic (MPP) (4): micro perforated plastics (MPP) for windows: variety of transparent, translucent and printed foils and acrylic glass panels which reduce reflected sound and reverberation time in buildings. This could also tackle a non-acoustic issue that the client states which is the glare in the working area, or additional privacy in the meeting room.

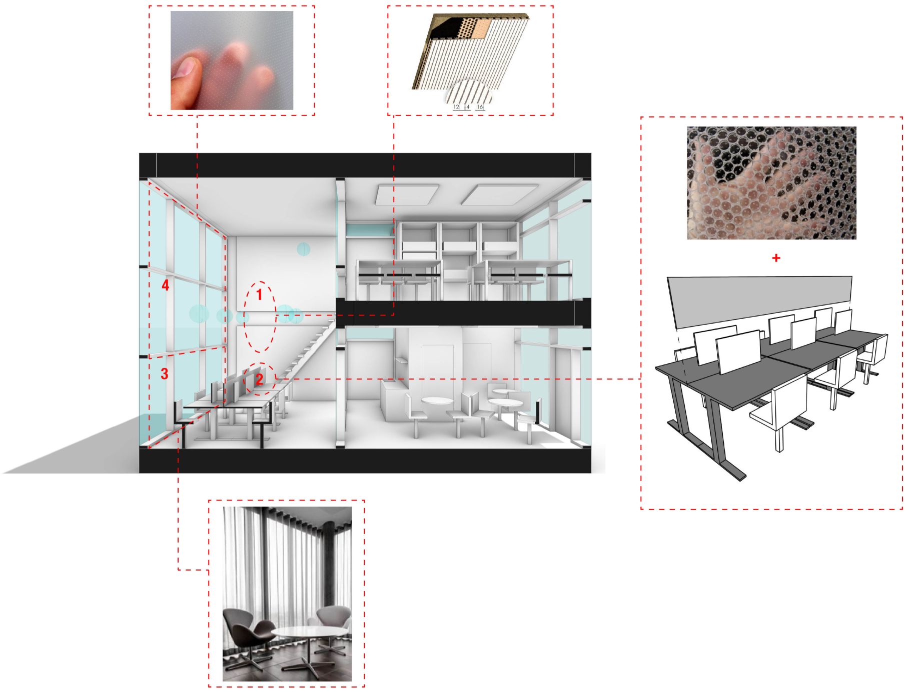


Figure 19: *Proposed acoustic measures for the shared office area.*

4.3 Meeting room

- Ceiling absorbers (1): Topperfo Type M 49mm (https://www.topakustik.uk.com/)
- Furniture (2): Cover metal shelves in translucent composite ”Bencore Lightben Acoustic”
- Fixed pivot door (3): It is recommended to replace the pivot door as a priority

Figure 20: *Proposed acoustic measures for the upstairs meeting room.*

4.4 Additional / Optional measures

There is a wide variety of possibilities in regard of the acoustic measures that could be taken. After prioritizing the measures listed above, there are several additional options that would improve the acoustic conditions, however due to economical aspects, aesthetics or efficiency, among others, the following was omitted as client choices:

- carpets: aesthetically complex to implement, but it is an effective and economical solution.
- furniture: acquiring new furniture with good acoustical properties or plants.
- hanging absorbers in the open office space: This may alleviate the issues arising from the larger volume of the room

5 Simulation results with acoustic treatment

In Figure 21 the T30 times for each room for the untreated ODEON model and the aforementioned treatment are shown. The effect of the micro-perforated plastic treatment on the office space windows is noticeable, with a 0.1 s reduction in T30 for sounds within the 250 Hz to 8 kHz. This effect is perhaps exaggerated, which may be due to limited information available about the acoustic benefits of MPP.

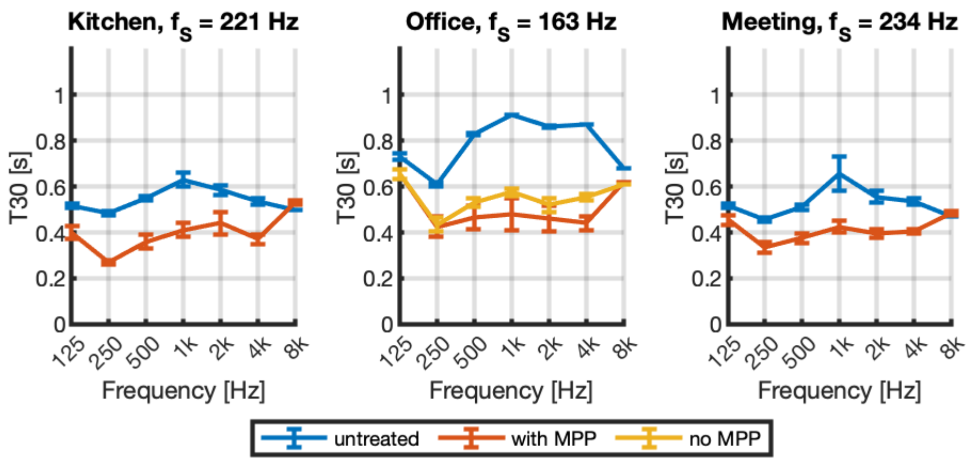


Figure 21: *Reverberation times for each room with solutions implemented in ODEON model.*

The simulated airborne transmission with the office space as receiver is shown in Figure 22. In this model, the swivel door is modelled as a sealing surface, in addition to the aforementioned acoustic treatment to the rest of the office. We can see a very big improvement in the weighted transmission loss, which is now roughly 32 dB for both cases. This is still below our initial goal of 35 dB, but further improvements may be unrealistic to the client: new window panes, a total replacement of the door and so on.

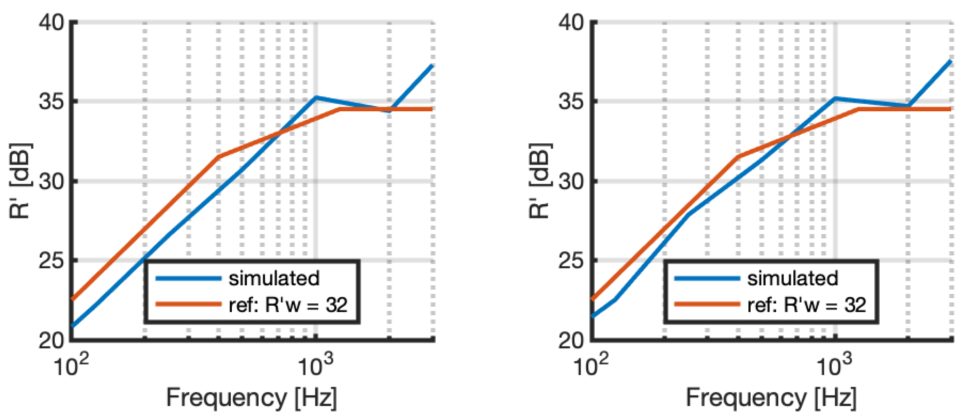


Figure 22: *Simulated apparent sound reduction index R' for the shared office space as receiver room. Top: kitchen as source, bottom: upstairs meeting room as source.*

6 Summary

The conducted experiments (in accordance with ISO 3382 and 140-4) were aligned with the requirements of the goals we set with the client. The results reflected our own experience in the spaces, and our initial concerns (notably the swivel door and the poor acoustics of the kitchen area) were indeed issues to be corrected in the acoustics of the office. Our recommended solution: a general acoustic treatment of the rooms along with an airtight door to the above room produced more than adequate results in terms of reverberation time: we were able to show T30 could be reduced to 0.4 s across most of the frequency range for all rooms with treatment. Our simulated airborne sound transmission index results ultimately fall short of our goal of $R'w \leq 35\,\mathrm{dB}$ though, but were still improved upon massively when compared to the initial results. As stated, further improvement may prove too cumbersome, expensive or intrusive for the client.
The client has been offered auralizations of the ODEON simulation with and without acoustic treatment, and a (less technical) presentation of our findings is planned.

References

[1] DS/EN ISO 3382-3:2012. *Acoustics – Measurement of room acoustic parameters – Part 3: Open plan offices*. en. Standard DS/EN ISO 3382-3:2012. Geneva, CH: International Organization for Standardization, 2012. URL: `https://www.iso.org/standard/62711.html`.

[2] DS/EN ISO 140-4:1998. *Acoustics – Measurement of sound insulation in buildings and of building elements – Part 4: Field measurement of airborne sound insulation between rooms*. en. Standard DS/EN ISO 140-4:1998. Geneva, CH: International Organization for Standardization, 2000. URL: `https://www.iso.org/standard/62711.html`.

[3] Pat Brown and Peter Mapp. *Early Decay Time as a System Performance Benchmark*. 2010. URL: `https://www.prosoundtraining.com/2010/03/17/early-decay-time-as-a-system-performance-benchmark` (visited on 05/06/2021).

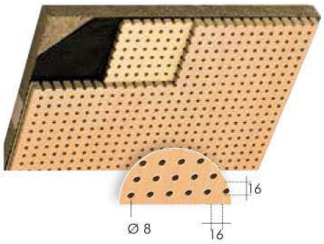
[4] Birgit Rasmussen and Jens Holger Rindel. "Sound insulation between dwellings – Descriptors applied in building regulations in Europe". In: *Applied Acoustics* 71.3 (2010), pp. 171–180. DOI: `10.1016/j.apacoust.2009.05.002`.

A Appendix

TOP AKUSTIK

TOPPERFO® type M Series - data sheet

TOPPERFO® type M series - In tried and tested form
Acoustic panel in its tried and tested form, as well as in all materials and surfaces, non-perforated borders and areas for cutouts according to your requirements.



Dimensions and Materials

Core Panel	Fire category B2 (CH 4.3) / D-s2, d0			Fire category B1 (CH 5.3) / B-s2, d0			Fire Category A2 (CH 6q.3)	
Surface/ thickness	Paint 16 mm	Wood Veneer 17 mm	Melamine 16 mm eco	Paint 16 mm	Wood Veneer 17 mm	Melamine 16 mm eco	Paint 16 mm	Wood Veneer 17 mm
Panels	max. in mm 3648 x 1216	max. in mm 3648 x 1216	max. in mm 3648 x 1216	max. in mm 3648 x 1216	max. in mm 3648 x 1216	max. in mm 3648 x 1216	max. in mm 3080 x 1216	max. in mm 3080 x 1216
	ideal: in mm 2032 x 992	ideal: in mm 2032 x 992	ideal: in mm 2032 x 992	ideal: in mm 2032 x 992	ideal: in mm 2032 x 992	ideal: in mm 2032 x 992	ideal: in mm 1540 x 608	ideal: in mm 1540 x 608
	2780 x 992	2780 x 992	2780 x 992	2780 x 992	2780 x 992	2780 x 992	3080 x 608	3080 x 608
	3648 x 640	3648 x 640			3640 x 640			

idel means optimal use of MDF core - custom legths are also available

symbols

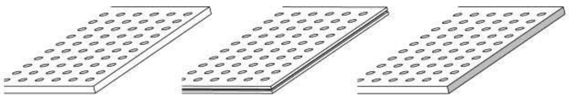
eco

Paint

Wood Veneer

Melamine

Edges



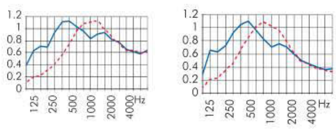
clean cut

with surrounding groove and tongue

visible edge

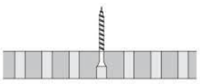
or according to your specifications

sound absorption values

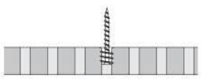


Graphics: Sound absorption in suspension height 215 mm and 55 mm.

Mounting



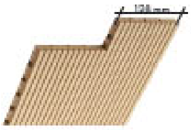
TOPPERFO® type-M, Ø 6 mm
Special screws: in half depth «dummy» perforations



TOPPERFO® type-M, Ø 8 mm
Using sleeve inserts, screwed

note:
Type 20/20/8+ Type 20/20/6 see product catalog

TOPAKUSTIK® type 12/4 M

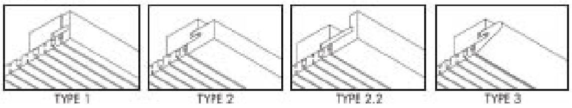


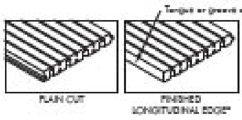
Planks

Thanks to the precise tongue and groove connection, TOPAKUSTIK planks result in a monolithic surface with a joint-free appearance, because the connecting joint matches the dimension of the grooves. The planks allow simple and flexible assembly. They can be installed by stapling to a wood batten or clamping to a T-bar with TOPAKUSTIK clips.

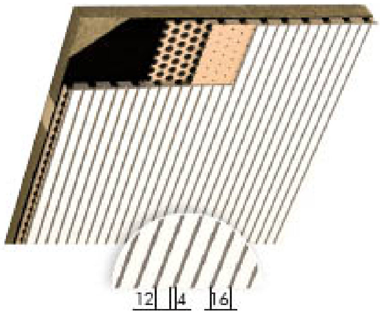
Class C Fire Rated			Class A Fire Rated		
Paint 16 mm (0.63")	Wood Veneer 17 mm (0.67")	Melamine 16 mm (0.63")	Paint 16 mm (0.63")	Wood Veneer 17 mm (0.67")	Melamine 16 mm (0.63")
Standard					
2780 x 128 (109.45" x 5.04")	2780 x 128 (109.45" x 5.04")	2780 x 128 (109.45" x 5.04")	2780 x 128 (109.45" x 5.04")	2780 x 128 (109.45" x 5.04")	2780 x 128 (109.45" x 5.04")
-	3640 x 128 (143.3" x 5.04")	-	-	3640 x 128 (143.3" x 5.04")	-
4080 x 128 (160.63" x 5.04")	-	4080 x 128 (160.63" x 5.04")	4080 x 128 (160.63" x 5.04")	-	4080 x 128 (160.63" x 5.04")
custom lengths are also available - waste charges may apply					

Finishing Options





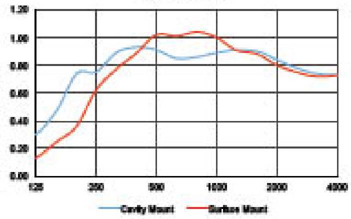
*AVAILABLE UPON REQUEST



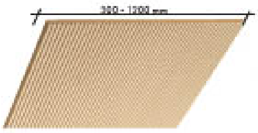
12 mm flat area - 4 mm groove
16 mm center to center spacing

Sound Absorption Values

12/4 M 12%



	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
1" Insulation 6" Cavity Behind	0.35	0.79	0.90	0.89	0.84	0.73	0.85
1" Insulation Surface Mount	0.16	0.58	0.97	0.98	0.81	0.74	0.85

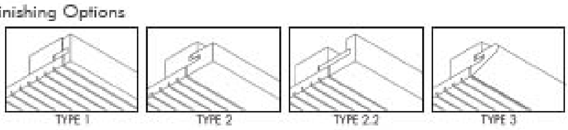


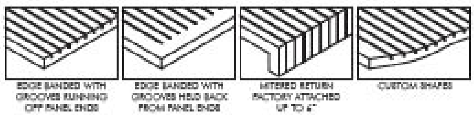
Panels

Panels are used for removable or fixed ceilings and walls and will have visible joints. Panels can be provided with a number of different edge conditions and are also suited for cabinet fronts and room dividers. They can also be provided with ungrooved borders or grooves running off the edge.

Class C Fire Rated			Class A Fire Rated		
Paint 16 mm (0.63")	Wood Veneer 17 mm (0.67")	Melamine 17 mm (0.67")	Paint 16 mm (0.63")	Wood Veneer 17 mm (0.67")	Melamine 16 mm (0.63")
max.					
3640 x 1216 (143.3" x 47.875")	3640 x 1216 (143.3" x 47.875")	3640 x 1216 (143.3" x 47.875")	3640 x 1216 (143.3" x 47.875")	3640 x 1216 (143.3" x 47.875")	3640 x 1216 (143.3" x 47.875")
ideal = means optimal use of MDF core - custom lengths are also available					
2040 x 992 / 640 (80.3" x 39"/25.2") 2780 x 992 / 640 (109.45 x 39"/25.2") 3640 x 640 (143.3" x 25.2")	2040 x 992 / 640 (80.3" x 39"/25.2") 2780 x 992 / 640 (109.45 x 39"/25.2") 3640 x 640 (143.3" x 25.2")	2040 x 992 (80.3" x 39") 2780 x 992 (109.45" x 39")	2040 x 992 (80.3" x 39") 2780 x 992 (109.45" x 39")	2040 x 992 (80.3" x 39") 2780 x 992 (109.45" x 39") 3640 x 640 (143.3" x 25.2")	2040 x 992 (80.3" x 39") 2780 x 992 (109.45" x 39")

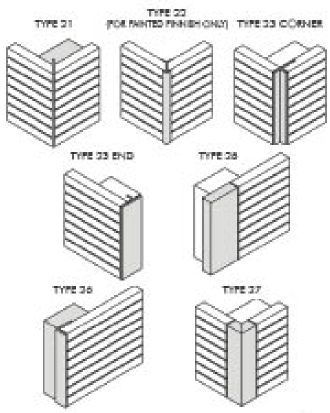
Finishing Options





Corner Trims and Finishing

Types 21, 22, 23 & 26 are anodized aluminum



SGB ACOUSTICS LLC
1123 STATE ROUTE 3 N #279
GAMBRILLS, MD 21054

(410) 849-4333
INFO@TOPAKUSTIKUSA.COM
WWW.TOPAKUSTIKUSA.COM

LIGHTBEN Acoustic™

bencore
COMPOSITE PANELS FOR ARCHITECTURE

LIGHTBEN Acoustic™ è un pannello composito traslucido per l'architettura di interni con anima alveolare in policarbonato a celle cilindriche, laminato con resina co-poliestere da 1 mm micro-forato. LIGHTBEN Acoustic™ è stato studiato appositamente per migliorare l'acustica degli ambienti. I principali impieghi del LIGHTBEN Acoustic™ sono:

- Elementi per progettazione acustica;
- Controsoffitti acustici retro-illuminati;
- Pareti divisorie traslucide con prestazioni acustiche;
- Rivestimenti per pareti per incrementare le prestazioni acustiche;

__LIGHTBEN Acoustic™__ is a composite translucent panel for interior architecture designed to enhance acoustic performance in interiors. Made with clear polycarbonate cylindrical-cells core, laminated on both sides with micro-perforated co-polyester resin 1mm thick. The main applications of LIGHTBEN Acoustic™ are:

- *Acoustic elements to correct acoustic performances of interiors;*
- *Backlit acoustic false-ceilings;*
- *Translucent partition walls with acoustic performances;*
- *Wall claddings with improved acoustic performances;*

TECHNICAL DATA SHEET	LIGHTBEN Acoustic™
ANIMA ALVEOLARE / HONEYCOMB CORE	Policarbonato / Polycarbonate
PELLI DI RIVESTIMENTO / EXTERNAL SKINS	PETG
SPESSORE / THICKNESS [mm]	**17 ±0,5mm**
LUNGHEZZA / LENGTH [mm]	3015 ±2
LARGHEZZA / WIDTH [mm]	1000 ±2
PESO UNITARIO / UNIT WEIGHT [KG/m²]	3,90
CLASSE DI REAZIONE AL FUOCO / FIRE RATE	Classe 1 * / Class B1 ** / Cs2d0 *** / M2 ***
COEF. DILATAZIONE TERMICA / COEF. THERMAL EXPANSION [mm/m°K]	0,067
TEMPERATURA DI SERVIZIO / SERVICE TEMPERATURE [°C]	-10 / +50
ISOLAMENTO TERMICO / THERMAL INSULATION (UNI–EN 674) [W/m²°K]	-
ISOLAMENTO ACUSTICO Rw / SOUND INSULATION Rw (UNI-En ISO 354) [db]	20
ASSORBIMENTO ACUSTICO αw / SOUND ABSORPTION αw (ISO 11654) [db]	0,40
MOD. DI ELASTCITA' APPARENTE / MOD. OF ELASTCITY (UNI-EN 310) [N/mm²]	-
CARICO DI ROTTURA A FLESSIONE / BENDING STRENGHT (UNI-EN 310) [N/mm²]	-
RIGIDEZZA A FLESSIONE / BENDING STIFFNESS [N·m2]	-
RESISTENZA A COMPRESSIONE / COMPRESSIVE STENGHT [N/mm²]	-

TSET-VALUE (TOTAL ENERGY SOLAR TRANSMITTANCE) (UNI-EN ISO 1217)	ANGOLO DI INCIDENZA LUCE SOLARE / SUN ELEVANTION ANGLE				
	0°	15°	30°	45°	60°
LIGHTBEN Acoustic™	78%	71%	68%	63%	53%

** UNI 9177 | ** DIN 4102-1 | *** EU Norm SBI test Cs2d0 (M2 France) informal test.*

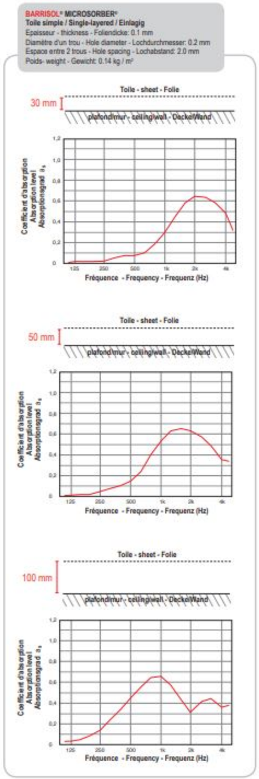
BENCORE SRL | Via Provinciale Nazzano, 20 | 54033 Carrara MS | Tel. +39 0858 830129 | bencore.it. | info@bencore.it

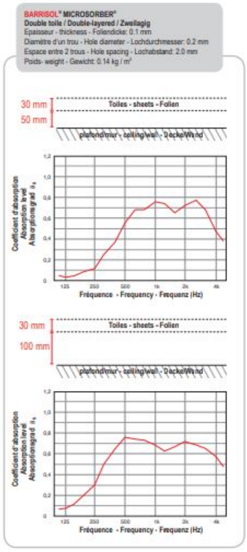
MICROSORBER® by BARRISOL® MCBR 1

Epaisseur : 0.096 to 0.175 mm	Thickness: 0.096 to 0.175 mm	Foliendicke: 0.096 to 0.175 mm
Perforation: diamètre approx. : 0.2 mm, distance entre 2 trous : 2 mm	Perforation: hole diameter approx.: 0.2 mm distance between holes : 2 mm	Perforation: Lochdurchmesser ca.: 0.2 mm Lochabstand : 2 mm
Finitions: - transparent - translucide - imprimé	Finishes: - transparent - translucent - imprimé	Ausfuhrungsart: - transparent - transluzent - bedruckt
Propriétés: **- classé au feu B-S1, d0 (DIN EN 13501-1) - stabilisé UV - antistatique** *si l'humidité relative est supérieure à 40 %*	Properties: **- fire rated B-S1, d0 (DIN EN 13501-1) - UV-stabilised - antistatic** *if relative humidity exceeds 40 %*	Eigenschaften: **- schwerentflammbar B-S1, d0 (DIN EN 13501-1) - UV-stabilisiert - neutrales Verhalten gegen statische Aufladung** *oberhalb einer relativen Luftfeuchtigkeit von 40 %*
Largeur max. : 1250 mm	Max. width: 1250 mm	max. Folienbreite: 1250 mm

MICROSORBER® by BARRISOL® MCBR - ETFE

Epaisseur : 0,1 mm	Thickness: 0,1 mm	Foliendicke: 0,1 mm
Perforation: diamètre approx. : 0.2 mm, distance entre 2 trous : 2 mm	Perforation: hole diameter approx.: 0.2 mm distance between holes : 2 mm	Perforation: Lochdurchmesser ca.: 0.2 mm Lochabstand : 2 mm
Finitions: - transparent - imprimé	Finishes: - transparent - imprimé	Ausfuhrungsart: - transparent - bedruckt
Propriétés: **- classé au feu B-S1, d0 (DIN EN 13501-1) - stabilisé UV - antistatique** *si l'humidité relative est supérieure à 40 %*	Properties: **- fire rated B-S1, d0 (DIN EN 13501-1) - UV-stabilised - antistatic** *if relative humidity exceeds 40 %*	Eigenschaften: **- schwerentflammbar B-S1, d0 (DIN EN 13501-1) - UV-stabilisiert - neutrales Verhalten gegen statische Aufladung** *oberhalb einer relativen Luftfeuchtigkeit von 40 %*
Largeur max. : 1500 mm	Max. width: 1500 mm	max. Folienbreite: 1500 mm





QuietSwing

EZ OPEN™ DOOR

The Compression Seal is a Custom Designed Seal for use on the frame in conjunction with a magnetic seal on the door leaf.

Features & Benefits:

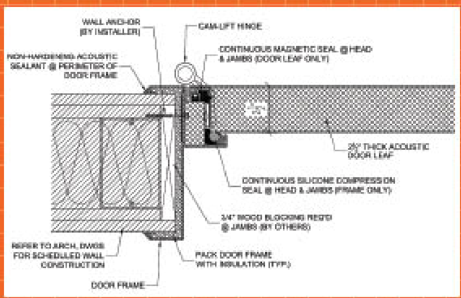
- Reduces required force to disengage seals
- Guaranteed acoustic performance
- EZ Open™ Compression Seal is compatible with 2-1/2" and 3-1/2" door thicknesses and designed to work with standard building hardware
- All hardware, seals and cam-lift hinges are factory supplied and installed
- Wood veneer finish available
- Split-frame assembly allows installation into existing openings
- All doors with vision panels are delivered factory glazed
- All doors are tested at independent NVLAP approved testing facilities

How Does it work?

When the hardware latch is retracted the compression seal overcomes the force of the magnetic seal so the door can be opened easily with minimal push/pull force.

Single Leaf and Double Leaf Applications:

- Studios
- Performance Halls
- Classrooms
- Music Practice Rooms
- Jury Rooms
- Hospitals
- Assisted Living Facilities
- Conference Rooms
- Secure Areas
- Auditoriums
- Audiometric Rooms
- Sensitive Compartmented Information Facilities (SCIFs)



EZ Open™ is compatible with Noise Barriers' QuietSwing™ STC 45, 49, 50 and 51 Doors!

Acoustic Performance Data

1/3 Octave Band Data

Frequency, Hz	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	STC
Sound Transmission Loss Data, dB																		
QS-51	35	37	41	43	46	45	47	48	48	47	48	51	51	54	57	56	55	51
EZ OPEN™ QS-51	35	37	41	43	46	45	47	48	48	47	48	51	52	54	57	56	55	51

All tests performed by an independent NVLAP accredited acoustical testing facility.
The test method conforms with ASTM Designations E90-09 and E413-87

NOISE BARRIERS

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