# TECHNICAL MEMO

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## British Motor Group Show Room Acoustic Measurements (Søborg, Denmark)

Ramboll Acoustics have performed acoustic measurements before and after the installation of acoustic panels in the British Motor Group show room/sale offices in Søborg, Denmark (Dynamovej 12A, 2860). The primary purpose of the measurements was to quantify the improvement and compare the results to the Danish working environment acoustic requirements (Arbejdstilsynet, AT).

As well, a comparison 3D acoustic modelling was performed of the showroom with only an acoustic ceiling (without wall panels) to quantify and assess the difference if the show room only used an acoustic ceiling in the showroom to show the effectivity of using wall acoustics panels over ceiling acoustic panels.

The measurement/study included the following spaces:

- The Show room (car area)
- Service offices (back of show room)
- Lounge area (upstairs)
- The Canteen
- Large office/meeting room

Figure 1. BMG Showroom (Søborg, Denmark)

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## Acoustic requirements/recommendations

The Danish working environment authorities (AT) specifies acoustic limits (acoustic absorption area and reverberation time) for different working environments based on the space's volume (Akustik i arbejdsrum A.1.16 - 1. December 2008) and is listed for each of spaces of the in the following table. The canteen and meeting room do not have specific requirements, but we have listed 'good' acoustic comfort limits based on experience and different acoustic guidelines.

Table 1. Acoustic limits/recommendations

| **Space** | **Acoustic limit, Reverberation time (T) 250-4000 Hz.** |
|---|---|
| Show room/lounges | T ≤ 1.5 seconds |
| Rear office area | T ≤ 0.6 seconds |
| Canteen | T ≤ 0.8 seconds |
| Meeting room/Large office | T ≤ 0,7 seconds |

## Measurement results

As can be seen in the following table, the 'before' measured reverberation time greatly exceed the limits as expected. With the sound absorption panels installed, the 'AFTER' measured reverberation time are significantly reduced and all areas except for the rear office areas meet the Danish work environment authority's requirements.

Table 2. Before and After

| **Space** | **BEFORE Measured, Reverberation time (T) @ 500 Hz.** | **AFTER Measured, Reverberation time (T) @ 500 Hz.** |
|---|---|---|
| Show room/lounges | T = 2.8 seconds | T = 1.4 seconds |
| Rear office area | T = 1.6 seconds | T = 0.8 seconds |
| Canteen | T = 2.3 seconds | T = 0.9 seconds |
| Lounge Area (upstairs) | T = 2.8 seconds | T = 1.2 seconds |
| Large office room | T = 1.3 seconds | T = 0.7 seconds |

The shorter reverberation time has greatly improved the speech intelligibility (STI) and lowered the noise levels, greatly improving the acoustic comfort and promoting a much more amiable communication platform (sales culture). See section on acoustic parameters for descriptions.

## 3D acoustic modelling of the showroom with only an acoustic ceiling (without acoustic wall panels)

The ODEON 3D (https://odeon.dk/) acoustic model has been calibrated to the measured reverberation time and then applying acoustic material on the ceiling (45 mm thick, $\alpha < 0,8$).

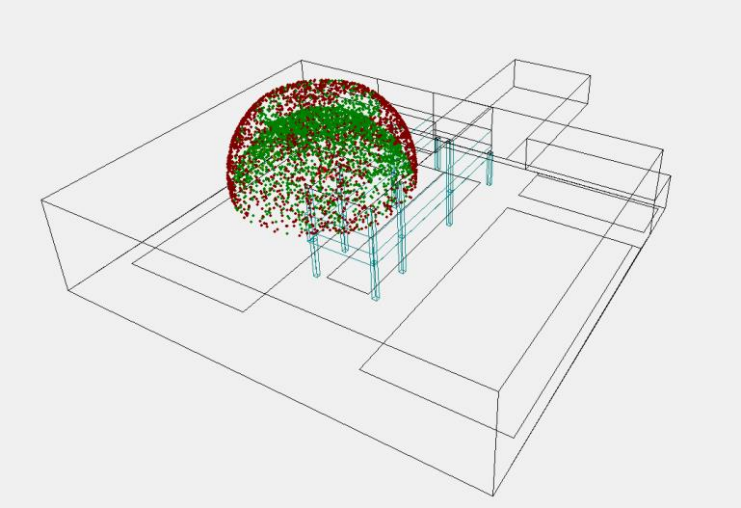

Figure 1. ODEON 3D acoustic model of the show room

Table 3. Calculated reverberation time (T) with only acoustic ceiling

| **Space** | **Reverberation time (T) 500 Hz.** |
|---|---|
| Show room/lounges | T = 1.6 seconds |
| Rear office area | T = 1.0 seconds |

The results show that by only using an acoustic ceiling, the reverberation times reduce almost, but not quite as much as using the acoustic wall panels. The surface area of an acoustic ceiling is more than double than the area of wall acoustic panels used, showing the effectivity per square meter of wall acoustic panels compared to an acoustic ceiling. This is due to the fact that the high ceiling/horizontal surface in a room with many parallel vertical surfaces will not absorb the reflecting sound as effectively as the wall panels do.

## Appendix: Applicable Acoustic Parameter Description

**Reverberation time** is the most important factor in all regulations, which is defined as the time it takes for the sound pressure level to drop 60 dB below its original level. In most cases, a low reverberation time improves the acoustical comfort and lower noise levels. In some situations, however, such as concerts or conference halls, a higher reverberation time can improve listening comfort. Reverberation time depends on the size and shape of the space along with the amount, quality and positioning of absorbing surfaces within the space. The more sound absorption in the room, the lower the reverberation time.

**Speech intelligibility** measures how well speech can be heard and understood in a room. It is closely linked to reverberation time. Many factors influence speech intelligibility. These include the strength of the speech signal, the direction of the source sound, the level of background noise, the reverberation time of the room and the shape of the room and can be calculated and measured. The common way of expressing speech intelligibility is the Speech Transmission Index (STI) value on a scale from 0 to 1. In a class room, for example, the level should preferably be above 0.6.