Whether listening to a concert, or working in an open plan office, getting the acoustics right is important. The ISO 3382 series on Acoustics – Measurement of room acoustic parameters, is raising acoustic standards in performance spaces, open plan offices and other types of room.

The scientific approach to acoustics in rooms started in the 1890s, when Wallace C. Sabine, a young physics professor at Harvard University, established the concept of reverberation time. Sabine defined reverberation time, as the time for a decay of 60 decibels (dB) after a stationary sound source has been stopped.

However, around the year 1900 there were no microphones or other electronic devices that could be used for measurements. The telegraphophone, the first device for electromag- netic recording of sound, had recently been invented by the Danish engineer Valdemar Poulsen (patented 1898), but this was not used for acoustic measurements until the 1930s by Vilhelm Lassen Jordan at the Technical University of Denmark.

To measure the reverberation time of a room, Sabine used a method with a stopwatch and four identical sets or organ pipes (see Figure 1). Relying on his own ears, he measured the time from when the organ pipes were turned off to the moment the sound became inaudible. Repeating this with four organ pipes instead of one, Sabine could derive the time difference that would represent a decay of 6 dB (i.e. exactly 1/10 of the reverberation time that represents a decay of 60 dB).

The first step

ISO 3382:1975 stated, “At present, several methods exist for the measurement of reverberation time and there are some new ideas in this field. Each of these methods may give a different result for the same auditorium. The first step is to standardize a widely used method so that it is possible to compare the data obtained by this one method.”

Although a loudspeaker is the preferred sound source, other possible ones are mentioned: a pistol shot or, in churches and concert halls, an organ.

An orchestra may also be used: “Fortissimo passages of musical compositions followed by adequately long pauses are suitable.” Beethoven’s Coriolan Ouverture is often used for acoustical measurements as it has suitable interrupted chords at the start.

During the following decades, the technique for sound measurements developed, microphones and loudspeakers were used and the so-called level recorder became the preferred device for measuring reverberation.

Figure 1: Sabine’s setup for measuring reverberation time using four sets of organ pipes. (Ref. W. C. Sabine, 1922. Collected Papers on Acoustics, Harvard University Press, 1922 [reprint by Dover Publications, New York 1964]).
Today we have a three-part ISO standard covering ordinary rooms, performance spaces and open plan offices.

Making it better

In 1997, ISO 3382 was updated to resolve incomparable measurement methods. The direct analysis of a pistol shot or other impulse sources was abandoned; instead the integrated impulse response method was established as equivalent to the traditional method of interrupted noise.

As in the first edition of the standard, this second edition focused on auditoria and, in particular, concert halls for classical music. New annexes define a number of room acoustic parameters to describe the listening conditions in an auditorium. The idea is that reverberation time, though important as an overall descriptor of the acoustics of a room, is not sufficient to describe acoustic quality. Listening to music in a hall is a multi-dimensional perception.

The room acoustic parameters in ISO 3382:1997 have created a common reference that allows comparison of data measured around the world. The standard has also established a solid basis for discussion among researchers in the field. This has been demonstrated by international conferences in acoustics, in which special sessions have been devoted to the ISO 3382 parameters.

New measurement techniques

New measurement techniques have been recently developed to save time and improve the accuracy of reverberation time measurements. ISO 18233:2006, Acoustics – Application of new measurement methods in building and room acoustics, describes two such methods using advanced digital signal processing to derive the room impulse response.

The second method uses a sine-sweep, that is, a sine tone slowly changing the frequency from very low to very high, combined with a so-called de-convolution to derive the room impulse response.

Other fields of application

Reverberation time is widely used in a variety of rooms, not just auditoria. These include classrooms, meeting rooms, restaurants, sports halls, industrial halls, railway stations and airport terminals.

In addition, reverberation time has to be measured in connection with several other acoustic measurements, such as sound insulation between two rooms. In this case, the
Special Report

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From the second of these, two simple measures can be derived: the privacy distance and the distraction distance. The former is the distance from a source in which speech is not intelligible due to attenuation and background noise; and the latter is the distance as which speech is partly intelligible, but mostly contributes to background noise.

This recently published standard with new acoustical parameters may form a common basis for the research and development of better designed open plan offices. As we have seen in previous decades in relation to concert halls, it can be an important step forward to have measuring methods and parameters that are well defined, and allow comparison of data from different researchers and different cases.

The Euronoise international conference in June 2012 featured a session on the design of open plan offices, where delegates discussed the results of using the new ISO 3382-3.

It is hoped ISO 3382-3 will contribute to an improved understanding of problems in open plan offices, leading to better designs in the future.

World-class acoustics

Many recently built concert halls now claim to have “world-class acoustics”. Although this may not be entirely true in all cases, it seems that new halls generally have much better acoustics than before. ISO 3382 has helped to achieve this, in combination with improved prediction tools.

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Open plan offices

This could have been the end of the story, had it not been for the open plan or open-space offices becoming increasingly more common. There can be severe acoustic problems in open plan offices. Several research projects in this field have shown that reverberation time is not a sufficient descriptor of the acoustic properties in these rooms.

The most important parameters are the amount of sound absorption material, the possible use of screens between work stations, the level of background noise and speech and, more generally, the seating plan.

Following this, ISO 3382-3:2012, Acoustics – Measurement of room acoustic parameters – Part 3: Open plan offices, introduces some completely different acoustic parameters; spatial decay rate of noise with a typical speech spectrum as a measure of the sound propagation in the room and speech intelligibility as a function of distance.

About the author

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