Room Acoustics Dictionary

When you talk about the space in which sound is played or recorded, you can call it a '***room'***. Doesn't matter whether it's a huge concert hall, or a small jazz club, or a 4'x4' sound booth. The acoustics of a room are a big part of the listening experience.

A room can be characterized by three things: Size, Shape, & Surfaces.

The ***size*** influences reverb time and predelay. A 10x10 recording booth will have a short reverb time and predelay. A 200x150 concert hall will have a long reverb time and predelay.

The ***shape*** influences frequency response. A square room will sound different than a rectangular room.

The ***surfaces*** influence both reverb time and frequency response. Hard surfaces may reflect more sound energy than soft surfaces, so the reverb reflections will retain their energies longer. Hard surfaces would also support high frequencies in the reverb.

There are lots of words you can use to talk about a room. Here are some of them.

Absorption.

When sound energy 'soaks' into a surface, and is lost. Many things are absorptive - padded materials, acoustic tiles, bass traps, water, human bodies.

Diffraction.

Diffraction is when a sound wave bends around an object. If a speaker is hidden behind a TV, the sound from the speaker is diffracted around the TV. Diffraction is why you can still hear someone calling even when they're hiding around a corner.

Diffusion.

Diffusion is the scattering of a sound wave's energy. Diffusive surfaces spread the reflective energy in all directions. One major benefit is that diffusion helps to flatten the frequency response of a room.

Refraction.

Refraction is when a sound wave changes speed and direction as it passes from one medium into another. For example, if a sound wave goes through a wall, it speeds up and changes direction.

Isolation.

When you disconnect a sound source like a speaker from the room, or from the surfaces it rests on or interacts with. A sound booth isolates the singer. Putting the guitarist in another room isolates them. One well-known principle of isolation is **decoupling**. You can decouple a room by building it with staggered studs or double-studded walls. You can decouple speakers by hanging them from chains.

Direct Sound.

The direct sound is the actual sound itself, coming from the sound source, without any reflections. The balance of direct sound and reflected sound that you hear depends on your distance from the sound source.

Early Reflection (ER).

Early Reflections are the first reflections to arrive just after the direct sound. They reach your ears within about the first 100 ms.

Predelay.

Predelay is a gap in time between the direct sound and the ER. A short predelay implies a small room; a long predelay implies a large room.

Reverberation, Reverb.

Reverb is the smooth blend of the many reflections that follow the ER. Reverb gives the listener audio cues about the physical design of a room. Reverb parameters include diffusion, early reflections, predelay time, reverb time, and HF damping.

RT60. Reverb Time.

RT60 is how long it takes for sound pressure of the reverb to decay by 60 dB after the direct sound finishes.

Damping.

Most rooms absorb some frequencies. This is called damping. The damped frequencies are usually high frequencies, because they have a small wavelength, and so are more easily absorbed by a variety of surfaces. So High Frequency (HF) Damping is a common option on digital reverbs.

Live.

A live room is highly reflective with strong ER. A gymnasium is a very 'live' room.

Warm.

A warm room has less ER than a live room. A warm room would probably exhibit some high frequency damping. Wood surfaces can contribute to warmth, as well as judicious treatment of mids and highs in the reverb.

Dead.

A dead room has significant absorption. A clothes closet would be pretty 'dead'. The clothing absorbs most of the sound energy. An *anechoic chamber* is an extremely 'dead' room.

Echo.

Echo is a reflection that has enough amplitude and delay time (more than 90 milliseconds) to sound distinct from the direct. Many people confuse echo with reverb, but they aren't the same. Echoes are distinct – reverb is fuzzy.

Flutter echo

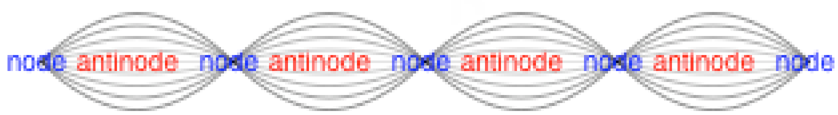
Fast repetitive echoes that happen between two parallel surfaces that are fairly far apart. A handclap in a large empty room will created flutter echo.

Room Modes.

The fundamental resonant frequencies of a room, based on its dimensions. The frequency that corresponds to any of the three dimensions, length, width or height, will be one half of whatever wavelength the dimension would match. If the room were 11.3 feet long, the corresponding frequency would be 100 Hz (1130 / 11.3 = 100). The fundamental resonant frequency will be one half, so 50 Hz.

Standing wave, nodes, and anti-nodes.

A standing wave is a "stationary" waveform created by reflections of the frequency that matches a room dimension. Standing waves don't go anywhere, but they do have regions where the disturbance of the wave is quite small, almost zero. These locations are called **nodes**. There are also regions where the disturbance is quite intense, greater than anywhere else in the medium, called **antinodes.**



The Parts of a Standing Wave

Proximity effect.

The exaggeration of low-frequency sounds when a microphone is closer to the sound source. If you move a mic closer to a singer, of course the sound of the voice will get louder, but it will also get bassier.

Boundary effect.

Bass response increases as you get close to a wall. Low frequencies may get more than 6dB louder, especially if you stand in a corner.

Precedence Effect.

The precedence effect is a psychoacoustic effect. If two identical sounds of the same amplitude arrive from two different directions, but one of them arrives a little later than the other (from 1 – 30 ms), the sound will seem to be coming from the direction of the earlier arrival. If you pan the vocal into the center of a stereo mix, and you move a little closer to one of the speakers, the vocal will seem panned in that direction.

Haas Effect.

The Haas effect is a psychoacoustic effect. If two identical or similar sounds arrive at the listener's ear within 5 – 30 ms, the listener's brain has difficulty separating them. ER usually arrives at the ear in about the same range of time (5 – 30 ms). The ER has an uneven frequency response, and the Haas effect makes it hard for the engineer to ignore the ER and just listen to the direct sound.

Masking.

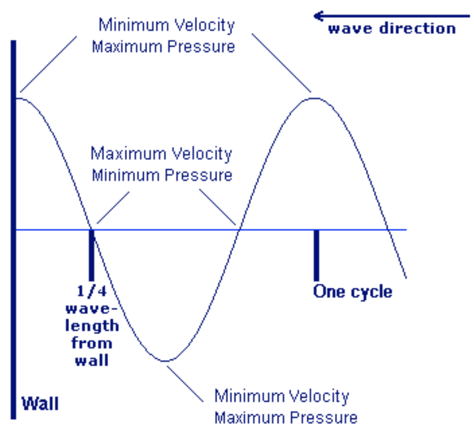
When one sound hides another sound, most notably if the two sounds are played at the same time. More intense sounds mask less intense ones. Brighter sounds mask darker sounds. Masking is a psychoacoustic effect (a bit of a brain trick).

Speed of Sound.

The speed of sound in the air is about **1130 feet per second**, but it depends upon the temperature of the air. It travels more slowly in cold air than in warm air. Sound travels very fast through solids. For example, the speed of sound in steel is 13,332 mph!

Velocity of Sound.

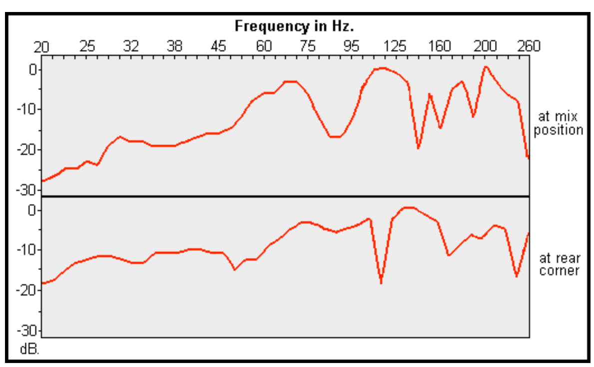
While the impulse of the soundwave travels at a steady rate (the speed of sound), the compression/decompression wave changes its velocity constantly. In the middle of compression or decompression, the wave is moving quickly. But as it nears maximum amplitude, the wave slows down and reverses direction. Right at the point where it turns around, the wave has no velocity at all.



Acoustic Interference.

When sound waves bounce off the floor, walls, and ceiling, and collide with each other, or with waves still coming from the speaker. This creates severe peaks and dips in the frequency response, and the peaks and dips change as you move around the room.

The figure below shows the frequency response in two different locations of an untreated 10' by 16' control room. It's very inconsistent between 75Hz and 260Hz.



Acoustic interference occurs in all rooms at all low frequencies - not just those related to the room's dimensions. The only thing that changes with frequency is where in the room the peaks and nulls occur.