# Pro Note

## Why the best pistonic speakers in the worst room can still sound unsatisfactory.

Traditional (pistonic) loudspeakers are "indoor hostile".

Ok, maybe that's a bit of clickbait, but you'll see what I mean by the end of this somewhat deep dive.

When we say the word "speaker" or "loudspeaker" in the context of sound reproduction, we are referring most often to a diaphragm being moved by an electromagnetic coil. Though refined many times since, the basic design from the late 1800's remains. These "old school" speakers produce sound by moving air with a piston-like motion. This pistonic design remains the most common speaker technology employed around the globe.

Just as common is an inherent flaw bedeviling pistonic loudspeakers since their inception: when sound waves launched by pistonic action reach flat, reflective surfaces, they bounce back degrading the original sound. Combatting the degradation caused by pistonic speakers interacting with reflective surfaces has spurred a multimillion dollar global industry.

While many a PhD thesis has explored this phenomenon, we can keep it simple:

When sound emanates from a pistonic loudspeaker the first arrival to reach the listener should sound about as good as the particular speaker's ability to reproduce the source sound accurately.

Unfortunately, that direct sound is not all that the listener hears—the sound from the speaker also bounces off all of the surfaces in the room, eventually finding its path to the listener's ear as well—ending up with multiple paths of sound for the brain to process. Each of these paths take a different length of time to arrive. Now, Houston, we have a problem—these multiple paths of sound combine with, and degrade, the original sound. We refer to such conflicting sound waves as being "out of phase". Why does that sound bad?

When your brain combines out-of-phase sound waves, the original source material becomes altered, and no longer sounds like the original content. Worse, even the slightest change in listening position changes the mix of all of these combined sound paths in the brain, resulting in things sounding differently (sometimes drastically) at different positions in the room.

So, just to go back to our clickbait title, a pistonic speaker that is placed outdoor has no walls to interact with—the problem comes with the introduction of the walls, and so we could say,"traditional (pistonic) loudspeakers don't work very well indoors". Ok, ok, we know that the ground is flat as well, and heat can affect sound outdoors, but just for illustration, there's generally less flat surfaces outside to cause the issue.

So the amazing engineering benefits of even the clearest sounding, most amazing pistonic loudspeaker can be immediately negated when that speaker is introduced into a room with flat surfaces (aka walls). Because of this, pistonic loudspeakers in performance spaces (theaters, houses of worship) often go hand in hand with acoustic treatment of the room, to minimize the destructive interactions (reflections) creating multiple arrivals of sound at the listener.

You've seen this type of thing before, right? We all know of the guitar player that is $5,000 away from the perfect electric guitar tone, but in truth could really use some lessons from a professional to improve technique. This is chasing the 1% and neglecting the 99%. Unfortunately, we see it all too often in room audio design as well, where folks will choose the most amazing pistonic loudspeakers, with the most amazing signal path (console) driven by the most amazing amplifiers known to man (that last 1% in quality) and place all of that into a completely untreated room. And sadly, the out-of-control reflections destroy all of that work (and expense) of architecting that perfect signal.

Acoustic treatments and acoustical design in a space help to minimize the destructive interactions of the reflections with the original, direct sound from the loudspeaker. However acoustic treatments cost money—and to the defense of those of us who design and install sound systems, it's often not our fault that treatment doesn't happen—acoustic modeling and the resulting treatment of a room can often cost as much as the audio system itself, and is often '86'ed from the proposal quick and early in the process.

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# Pro Note

## Addressing the coverage limitations of point source loudspeakers with DML technology

Decades ago, the UK Ministry of Defense was exploring the use of composite materials in aircraft construction. In that process, it was empirically observed that the composite materials very faithfully turned vibrations in the aircraft's airframe into sound. This discovery has since been refined by very brilliant people into what we now call a "Distributed Mode Loudspeaker" or DML. Where a pistonic loudspeaker moves large volumes of air to create sound, a DML resonates.

Where your ear attempts to re-assemble the many sound arrivals from a pistonic source into one sound (including the resulting artifacts) a DML's sound is not correlated (i.e., emanating from a single source like in a piston mic speaker.) Instead, the sound from a DML is said to be un-correlated in that different frequencies emanate from different locations on the DML panel—making it difficult for the ear to re-assemble all of the multiple sound arrivals—so the ear sticks with the first, direct sound, and discards the reflections. The result is that what arrives at the ear is much more faithful to the original source.

Or, as we like to say, "a DML's  room interactions are (much) less destructive than a pistonic loudspeaker's room interaction". The resulting un-correlated sound arrivals (the surface reflections) that get to the ear just appear as natural reverb in the room, while leaving the original, direct sound extremely faithful to the original, and extremely intelligible, even within a highly reverberant, un-treated room. And it is because of that, we can say that a DML-based audio solution can work very well in a room, even without acoustic treatments in that room.[1]

What we endeavored to explain in this document was that pistonic loudspeakers are subject to destructive interactions with rooms, if the rooms are not first treated in such as way as to reduce the number of additional arrivals of sound at the listener's ear. I began with my clickbait title that said, "traditional (pistonic) loudspeakers don't work very well indoors…[without corresponding treatment of the room]". Because of this, all of that effort being put into the 1% (perfecting the signal chain) will produce results, as the DML itself already takes care of the 99%. In other words, the best (pistonic) speakers in the worst room can still sound unsatisfactory.

If your room doesn't sound good, or you are battling feedback issues, you may have been told that acoustic treatments are the next step. But let us encourage you to consider a demonstration of DML technology from FlatPanel Audio. Over and over again, we continue to see amazing results, and it's likely your space could benefit.

[1]It's important to note that acoustic treatments can still be beneficial in some rooms, to reduce the reverb time if necessary, however our experience is that the results can be very satisfactory even without the expense of room treatment. Room treatment also has a positive effect with DML loudspeakers, but the "untreated" room with DML loudspeakers generally sounds significantly better and more intelligible than an untreated room with pistonic speakers.

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