Performance Media Industries, Ltd.

Baffled Again
6/2004

by A. Grimani

I just had an endless debate with a customer over front speaker placement for a home theater. He couldn't believe that speakers mounted in a baffle wall would actually produce a decent soundstage – and they really can, despite the fact that it may seem counterintuitive.

The collective thought in speaker placement over the last 20 years has been to put speakers as far into the room as possible to reduce the effects of wall reflections. This reasoning is logical, of course, but understand that, if you put a speaker directly *in* a wall, you also eliminate the detrimental effect of that wall's reflection. Completely eliminating one wall reflection is totally worth the effort of mounting a speaker in a wall. You end up with cleaner low end and really good imaging. Yes it's true, and my customer was fully convinced when he heard a showroom that my firm designed with baffle-mounted speakers.

So what does a reflection do, and how does it mess with your sound? Imagine a Left speaker placed 3 feet in front of a room's front wall, up 3 feet from the floor, and out 4 feet from the left wall. It will send a direct sound to your ears, and it will also send sound to all three of the boundaries I just mentioned. The direct sound will take about 10 ms to reach you since your listener position is typically about 10 feet from the speaker and sound travels at about 1 foot every millisecond. The floor sound reflection will have a path length about 1.5 feet longer than the direct sound, taking an extra 1.5 milliseconds to reach you. The left wall sound reflection will

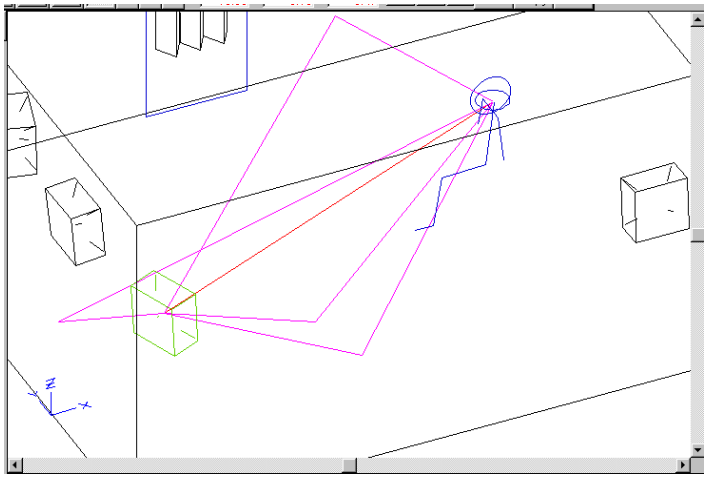

Figure 1: Ray trace of Left speaker in a room

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reach you 4 milliseconds after the direct sound. The front wall boundary will reflect the bass portion of the sound with a path length about 4.5 feet longer than the direct sound, arriving 4.5 milliseconds after it. Figures 1 and 2 show those time and distance relationships as calculated by a program called Ulysses. With Ulysses, you can draw up a 3D CAD view of the room, place speakers in it, and the program will figure out the reflection points, time, and level through a process called ray tracing.

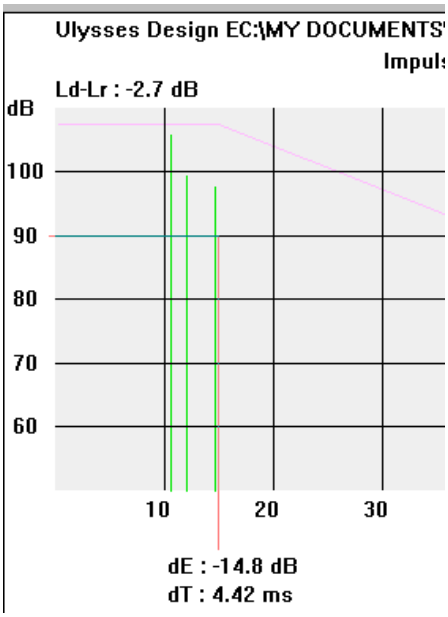

Figure 2: The sound levels and arrival time of the reflections from Figure 1

So what? Well, those reflections are going to cause cancellations of sound energy at some frequencies and peaks of sound at other frequencies through an effect called comb-filtering. Figure 3 shows the effect of the 4.5 millisecond delay from the front wall in the time domain and then in the frequency domain. You will end up with a cancellation at 125 Hz, which is the frequency at which 4.5 feet is a half-wavelength. You will also end up with a peak at 250 Hz and another cancellation at 375 Hz, etc. If you move the speaker further from the front wall, the cancellation frequencies move down and are also less noticeable because of the signal loss in the round trip. As you move the speaker closer to the front wall, the cancellation frequencies move up until they magically disappear…when the speaker breaks the drywall because you pushed so hard on it. Eureka! What happens once the speaker is in the wall? The back wave radiated from the speaker no longer reflects off of the wall. Instead, the back wave is pushed forward at the same time as the front wave; you get free bass. (Everyone loves free bass!) You also eliminate the dip-peak-dip series you had before. The result is cleaner sound and better speaker-to-speaker match, which means – you guessed it – better imaging. That's why my customer was so floored when I sent him to listen to a system with a speaker baffle wall. The imaging was fabulous despite the fact that the speakers were buried into a wall.

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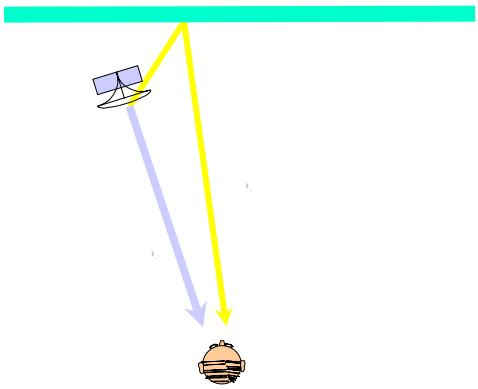
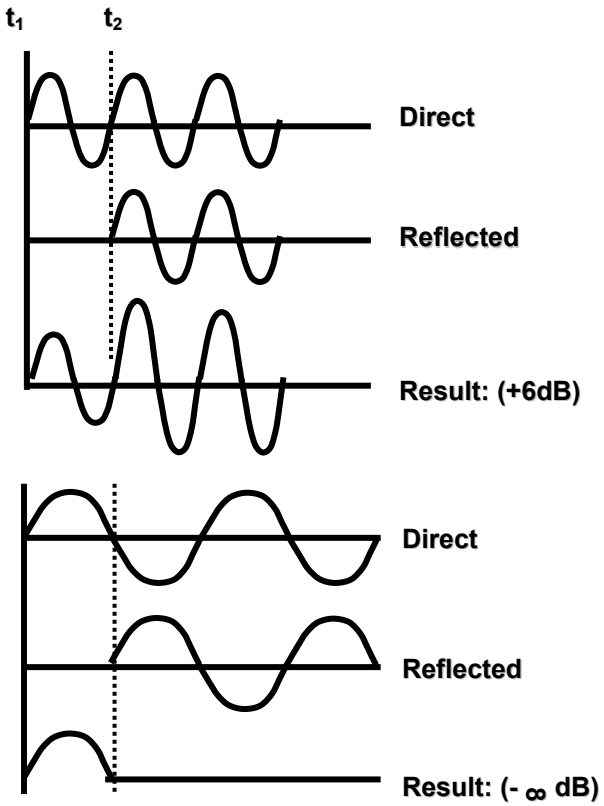
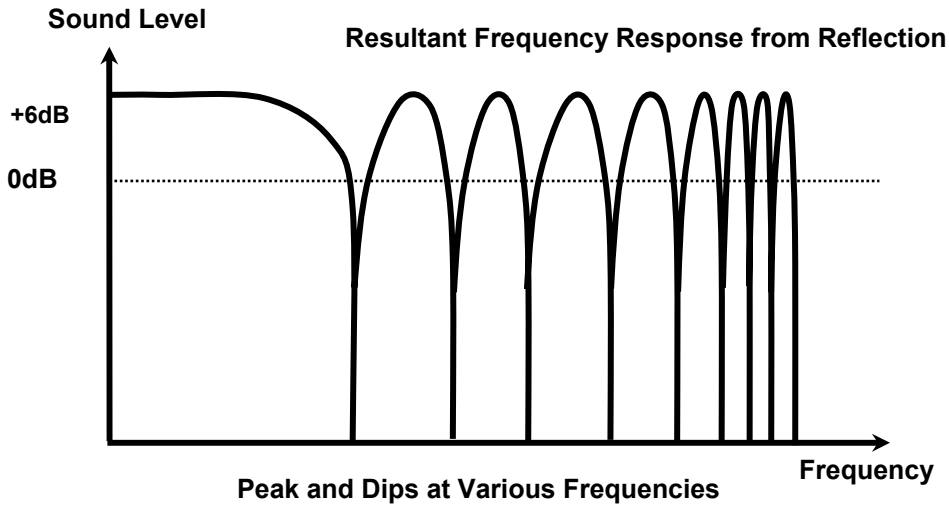
Figure 3: Effects of the front wall reflection. The reflected sound is delayed and results in additive frequencies and canceling frequencies.





An Additive Frequency: 250Hz

A Canceling Frequency: 125Hz



Peak and Dips at Various Frequencies

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You have two choices. Put a speaker more than 3 feet from the front wall of a room, or put the speaker *in* the front wall. I have been designing speaker baffle walls into as many rooms as possible during the last few years, because I just love the stunning effects of cleaner mid-bass. In addition, I like the fact that baffle walls reinforce the bass output of speakers. The added bass can be pulled out with appropriate equalization so that the speakers and amplifiers don't have to work as hard to output the prodigious amount of bass required by modern films and music. With a baffle wall, 10 watts of power will do what 100 watts could barely do without the baffle!

An interesting fact is that old-school audiophiles used to mount their speakers in walls, creating what was called an "infinite baffle." Talk about early times in custom installation! They had already figured out the benefits of baffle walls back then, and it's high time we started using that knowledge again.

There are a few notes of importance if you are going to design baffle walls for your front speakers. First, the Left and Right speakers really need some amount of toe-in so that all the listeners in a theater are in the horizontal radiation beam of the speakers. If you simply implement two side wings to the baffle wall, you will get the toe-in, but you will also create something of a concave shape in the front of the room. This may, in turn, result in focused hot spots of sound in some areas. The simple solution is to build up the front wall as three convex curved surfaces, as shown in Figures 4 and 5. This creates a good amount of low frequency diffusion and eliminates the risk of uncontrolled reflections from the front wall. Strategically place some absorption on the baffle curves to eliminate mid and high frequency diffractions, and you'll get some serious imaging and deep soundstaging. We designed a showroom for a dealer in Southern California using this technique, and the results speak for themselves. You could swear that all the speakers are on when you listen in 2-channel stereo mode!

The nice thing about a baffle wall is that you now have a good place to hang the screen and somewhere from which to build out your proscenium – what more could you want?! Go ahead; get baffled!

This article is based on a column published by A. Grimani in Residential Systems magazine June 2004.

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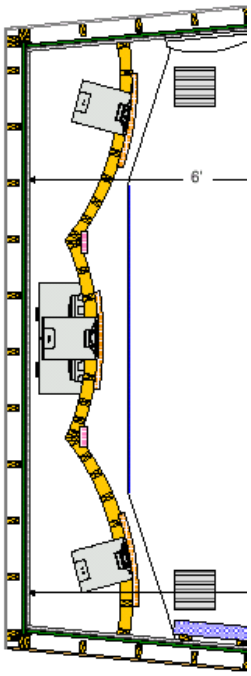

Figures 4 and 5: A curved speaker baffle wall

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