Performance Media Industries, Ltd.

The Importance of Diffusion
11/2007

by A. Grimani

"Um, what's diffusion, and why do I need it?" is the question from my client. Slowly, I take a breath, count to ten, and consider my options. First, I could scream, stomp around the room, and pull out my hair. Second, I could suddenly remember that I'm terribly late for another meeting (which is probably true) and beg to be excused. Third, I could remain calmly in my seat, smile, and politely explain the answer. Considering the nature of this client and his job, it looks like it's option number three.

Here's the sad thing. You might think that this client is a novice end user – the type whose digital clocks all blink 12:00. But he or she could just as easily be a custom integrator! I see it all the time: People who design home theaters for a living don't know what diffusion is or why they need it. What's particularly frustrating is that I have spent many hours over that past two decades doing my best to educate them.

So let's make this real. Do *you* know why diffusion is important in home theaters?

Small Room Acoustics 101

I'm going to assume you know a little about room acoustics. After sound leaves the speakers, some of it goes directly to your ears, and a lot of it reflects off the walls before going to your ears (Figure 1). It is this reflected sound that can cause problems if it's not tamed.

I'm also going to assume that you know about absorption – that it's an effective way to treat problematic reflections. You put an absorber on the wall where a strong reflection occurs, as in the case where a speaker or listener is really close to the wall (Figure 2). Hopefully, you know, too, that acoustically treating a room is not as simple as putting absorption everywhere. If only it were that easy.

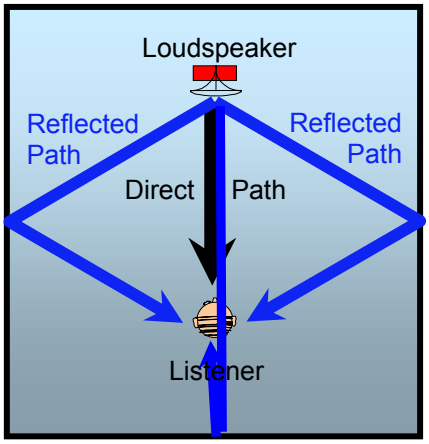

Figure 1: Sound waves reflect off of boundaries such as walls.

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9A Mono Avenue. • Fairfax • CA 94930 • USA
(415) 454 2087 • (415) 454 2171 Fax • info@pmiltd.com

Every room has a specific balance of direct to reflected sound that will make the room feel natural to listeners. You need some absorption, yes, but also some reflections. Typically, you should only cover about 25% of wall surfaces with absorption. Exceed that amount and the room will start to sound too dead. 25% absorption means that 75% of the wall surfaces will still be hard, leading to reflections that could cause errors in sound clarity. You can simply break up these reflections with diffusers (Figure 3). They generate uncorrelated and random acoustic energy that sounds more like the pleasant reverberation of a concert hall and less like the annoying hard reflections you often hear in small rooms.

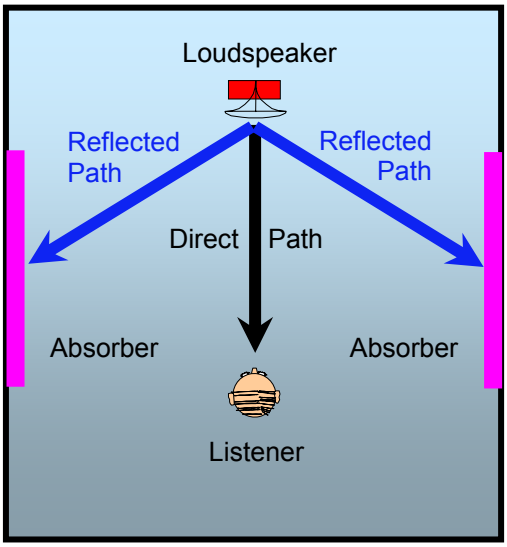

Figure 2: An absorber at work

The right balance of absorption, reflection, and diffusion results in a more pleasing sound field, with better envelopment, better imaging, and a wider sweet spot.

All Things Wild and Scary

If you have your thinking cap on, you may have realized why diffusers are very often weird and bizarre shapes. Their purpose is to create as many uncorrelated reflections as possible. The most efficient way to accomplish this is a "panel" with wildly undulating surfaces. Believe it or not, there are actually many different kinds of diffusers, officially categorized according to the scientific way in which they scatter sound. However, for your purposes in designing a home theater, you need to be familiar with two major types: those that scatter sound in a two-dimensional plane, and those that scatter sound in a three-dimensional hemisphere (Figures 4 & 5). It's not always easy to tell just by looking at a diffuser which type it is, but here's a clue. If it is cylindrical, or it appears to have lots of long and skinny slots or wells, it's probably two-dimensional. If it is really crazy, with totally random-looking surfaces, it's probably three-dimensional.

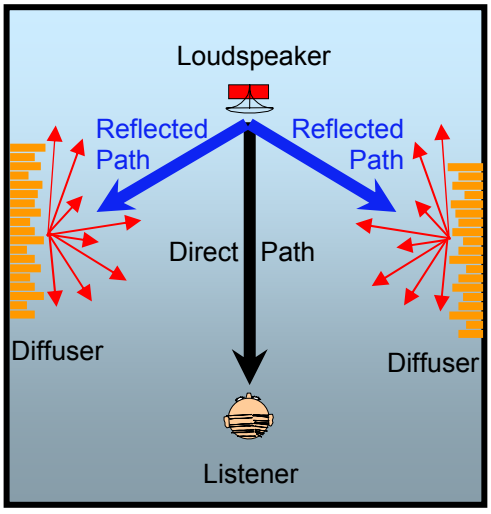

Figure 3: A diffuser at work

Like with absorbers, a diffuser's depth affects the bandwidth over which it scatters sound. Deeper is better. Six inches is ideal; four inches is OK; two inches is almost not worth the effort.

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A Word on Placement

While it is possible to use the two types of diffusers interchangeably (after all, they both create lots of uncorrelated reflections), you'll get better results if you use two-dimensional units on the left and right walls toward the front of the room and three-dimensional units toward the back. It's also a good idea to mix absorption and diffusion together in all parts of the room. That being said, you'll probably want to weight the average so that there is a bit more absorption in the front and more diffusion in the back.

One common argument against proper diffuser placement (or using them at all) is aesthetics. The things aren't pretty, unless you have an uncommon take on what looks attractive. So, cover them with a stretched fabric wall, or use diffusers that are already covered with fabric! My company does one or the other all the time – we even manufacture some fabric-covered diffusers that we sell at very good prices – and we have lots of really, really happy clients. It is possible.

Diffusers or Confusers?

A friend and colleague of mine, Floyd Toole, makes a very good point about diffusers, and it should serve as a caution to all of us. You can load a room with so many diffusers that it becomes a wash of random acoustic energy that confuses imaging. This is not what you want at all, but it is avoidable. Just don't get too heavy-handed with the diffusers. It's the same concept as too much absorption, except with a different acoustic result. Too much of a good thing is a bad thing.

Application Time

For those of you who may be wondering, the anecdote at the top of this column is not an actual event. However, it is indicative of the way many people think or feel about diffusers. Hopefully, you now understand what they do and why they're so important. Take this message to heart, and design your room accordingly.

This article is based on a column published by A. Grimani in Residential Systems magazine November 2007. Chase Walton contributed to this article.

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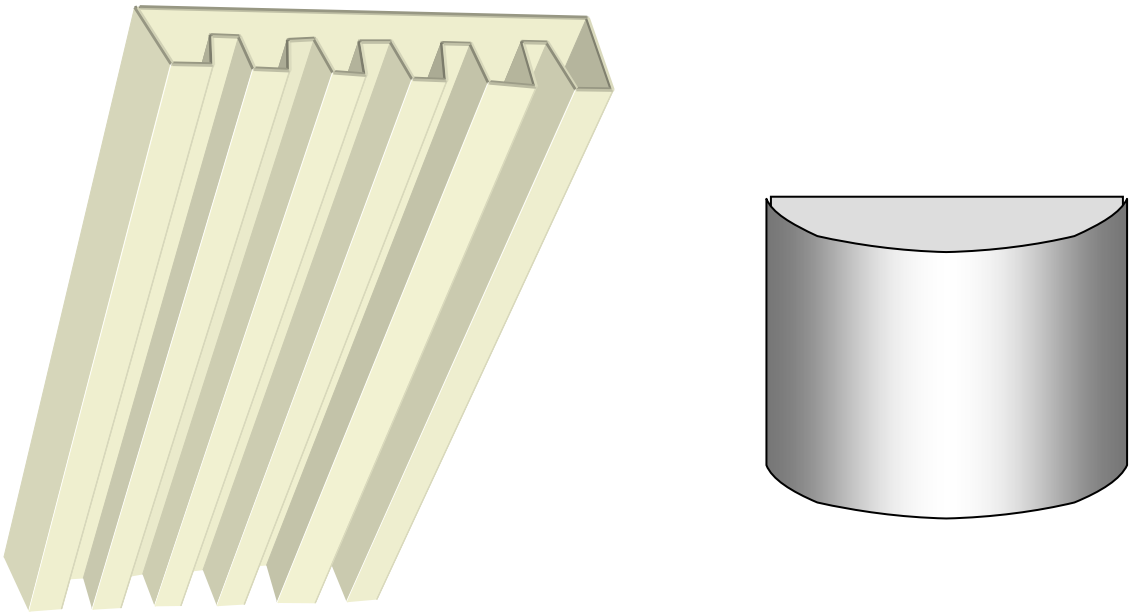

Figure 4: Examples of 2D diffusers

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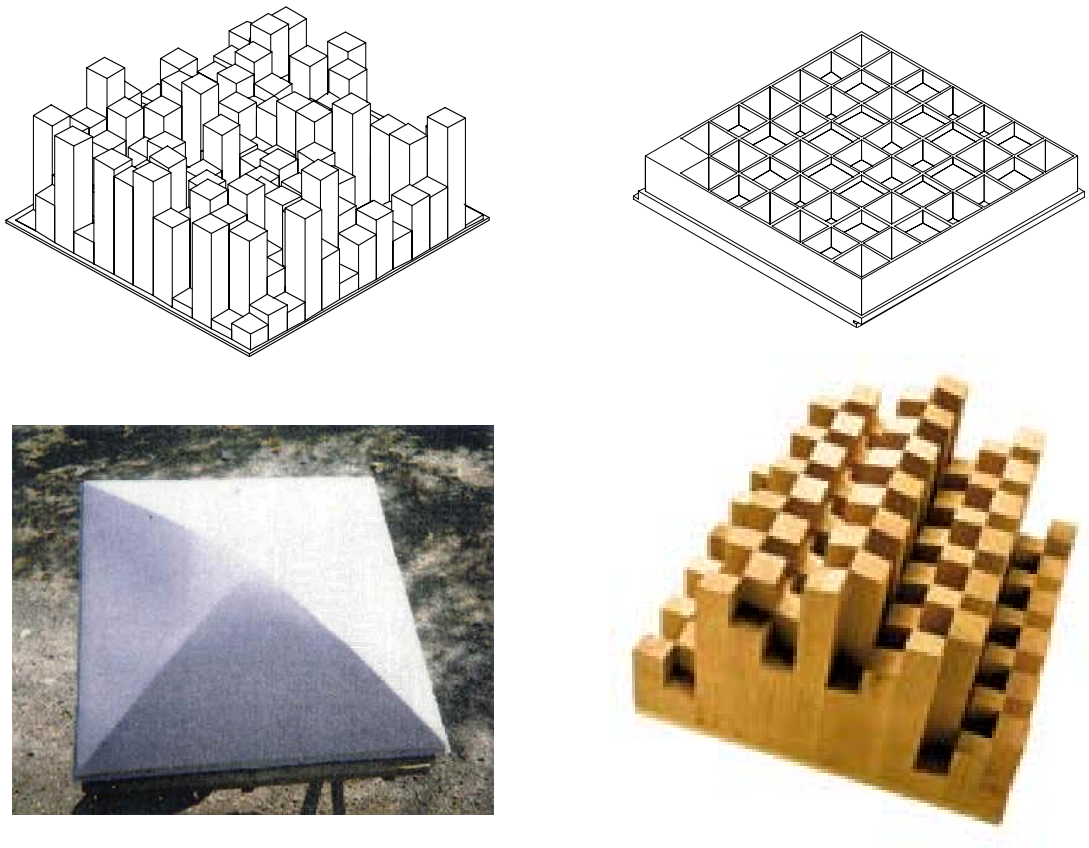

Figure 5: Examples of 3D diffusers

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