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Why are acoustical treatments so important?

The home theater experience is about being immersed in the audio/visual experience – maybe even letting go of reality for a few brief hours to join the characters on the screen for a new adventure or experience. The technologies that are available now to capture and manipulate images and sounds are continually pushing the envelope of challenging the senses into believing what they are experiencing. So why is it that we sometimes cannot entirely let go, what keeps us from making the journey into the world that the DVD is spinning for us? To blame any one thing would be ridiculous. There are many factors which contribute to a successful or not so successful theater experience. For the purposes of this article, we are going to assume that the temperature, lighting and the manners of your fellow viewers are contributing positively to your theater experience. We'll also assume that in the construction phase of your theater, attention was paid to 'external acoustic' issues such as disruptive sound transmissions into the theater and interference from the mechanical, electrical and plumbing systems. While we're at it, let's assume that the audio/video delivery system has been engineered and implemented appropriately. We want to focus on what is happening in your theater environment as speech, music and effects spill out of the 5-10 speakers placed around the room and what your brain must be thinking, as all those sources and their reflections off the different wall and ceiling surfaces impinge on your ear canal in a symphony
(or cacophony) of sounds…

The Missing Element:

The missing element in most home theaters is proper acoustical treatment. Why is the room so important? The reason is that sound must eventually travel the acoustic path from the loudspeakers to our ears. The sound that we hear in a room is a combination of the direct sound from the speakers and the indirect reflections from the room surfaces and room contents. Indirect reflections can cause acoustic distortion, so that you end up listening to the room and not the intended soundtrack. Hence, reflection control is a central problem in creating rooms that allow a suspension of disbelief.
In my experience, most soon-to-be home theater owners know that 'acoustic' panels are necessary components. This is mostly due to the fact that we see different types of wall and ceiling surfaces when we go to the large movie theaters and other performance spaces. We may not be sure what exactly they are, but we know that they are serving some purpose and that they should probably be there. Although it is beyond the scope of this article to go into detail, one thing we do know is that small rooms can cause a lot of problems when you force sounds into them. One of the main issues in creating a natural, neutral listening environment in a small room is what to do about the proliferation of reflections caused by so many speakers firing around the room. We know that if you absorb all of them, the room sounds unnatural (what most people refer to as 'dead') and this tends to keep the brain very aware that it is indeed in a small room and not out on the ocean on a sailboat or in the mountains where we hear no boundaries. Unfortunately, because not everyone is familiar with the latest acoustical technology, absorption is often improperly used as the only solution.

We also know that if you do not treat the room, leaving the wall surfaces reflective that it will be excessively reverberant and hard to even take sitting in there due to harshness and poor intelligibility of the program material. Even if we use absorption in moderation, we are still not going to be able to create a balanced room acoustic. So where does that leave us? We have to utilize surfaces that do not directly reflect sound or absorb sound!

The Solution:

Sound diffusion has been around for a long time. In classic architecture, statuary, columns, relief or a variety of other ornamentation broke up sound waves and contributed to the experience by enveloping the listener in rich, even sound fields. While beautiful, these surfaces operated only at high frequencies. In the early eighties, Dr. Peter D'Antonio successfully implemented a new type of surface utilizing the number theoretic mathematics of Dr. Manfred Schroeder. This new surface neither absorbed nor reflected sound. It uniformly scattered sound. Today, the research of Dr. D'Antonio and Dr. Trevor Cox has created a broad palette of sound diffusers that provide uniform scattering over any designable bandwidth. We are all familiar with the need to use air diffusers to provide uniform temperature, lighting diffusers to provide uniform luminosity and it should come as no surprise that we need a surface called a sound diffusor to provide uniform sound coverage. Here is a breakdown of the acoustic tools that you now have available for your own Room without Boundaries. There are many new developments in diffuser technology coming down the pike, so for now, we'll stick with what you will be able to find readily available on the current market.

Primitive Root Diffuser

Designed utilizing modulated prime root number theory, the math shows us that the reflected energies will be equal in all the diffraction directions, yielding an even sound redistribution pattern as shown in the above right balloon plot. Its special performance feature is that it virtually eliminates the specular component of the incident sound wave. This means that in terms of creating a sense of spaciousness, while supporting imaging, there is no equal.

1D Quadratic Residue Diffusor

Designed utilizing quadratic residue number theory, the math shows us that there will be equal energy in the diffraction directions, which depend on the number of wells and how wide they are. The bandwidth depends on the deepest and narrowest wells. The scattered energy is in the form of a hemi-disc. The photo to the right shows an optimized quadratic residue diffusor, with nested components for increased performance. One of the most effective diffusers across the largest range of frequencies, these are most often used on the rear wall of theaters and listening rooms when the listening position is not close to the surface.

2D Quadratic Residue Diffuser

Designed utilizing modulated quadratic residue number theory, the performance of these units is similar to their 1D counterpart, only in 2D! The scattered energy is in the form of a hemi-sphere. Now available in a lightweight expanded polystyrene as well as molded gypsum and furniture grade wood units, this panel technology brings high performance in a low profile – great for applications where headroom is at a premium.

Binary Amplitude Grating

Designed utilizing optimal binary number sequences, this panel technology has revolutionized small room acoustic design. By placing a 5/32” diffusing template between the fabric and fiberglass of a common absorptive panel, an often overused and misused tool in many theaters and listening rooms, this hybrid panel diffuses high frequencies in 2 dimensions, while simultaneously absorbing low frequencies. The low frequency absorption is determined by the thickness of fiberglass behind the template and the depth of the air cavity behind the panel. When the surface is flat, these panels are typically 2-4” thick, which work well in rooms that cannot afford to lose many inches in its length or width dimensions. Also, because it is a hybrid surface, the listener can sit much closer to them without experiencing near field phasing effects. The template that separates the fabric from the fiberglass provides a diaphragmatic mass, which allows it to absorb frequencies much lower than a common fabric wrapped absorptive panel. The panels are now available in a curved profile, which enhances the diffusion and increases the imaging and spatial performance.