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Volume 30, Number 5, Issue 257, September/October 2021

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Volume 30, Number 5 Issue 257
September/October 2021

Common Home Theatre Pitfalls To Avoid

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I have been designing and calibrating home theatres for decades. I also frequently get hired to help improve the sound experience of existing home theatres. Over the years, there are many classic design mistakes that I still see commonly employed. Many of these just logically go against simple physics, while others may not be as obvious. Some have to do with noise control, some sound quality. Note that you can't get to sound quality until you first control all the unwanted noises, vibrations and resonances, both inside and outside of the listening space. Also note that noise is a two-way street, in that external noises may bother the listener, and/or the theatre noise may bother those outside of the theatre.

The mistakes we will discuss have a huge impact on the end results. The performance potential of your equipment, and your enjoyment, will be limited by these pitfalls, regardless of the quality or expense invested in the associated components. These distortions work collectively and reduce the "leave your troubles behind" and the "you are there" experiences we are all trying to achieve. W e will break down these audio/video design errors into cost categories. We'll start with the free ones everyone should be implementing.

No Additional Cost To Implement

1. No center seat

It is only possible for all the collective loudspeaker's sound energy to converge at a single point in space and time. This is where the maximum magic occurs and should be symmetrically located between the loudspeakers and centered with the screen. If there is no centered seat, where do I calibrate from—this seat, that seat, or the armrest?

2. Room EQ Averaged

A well-intended practice, with destructive consequences that is commonly done without properly understanding the outcome. The intent is that each seat will have the best sound, but the result is that every seat will be sound-compromised *(see figure. 1 and 2).* Trying to average the frequency response of all the seats means that all of the seats will be compromised, no more sweet spot, no more magic chair *(see figure. 2).* There are many reasons why frequency averaging is a bad idea:

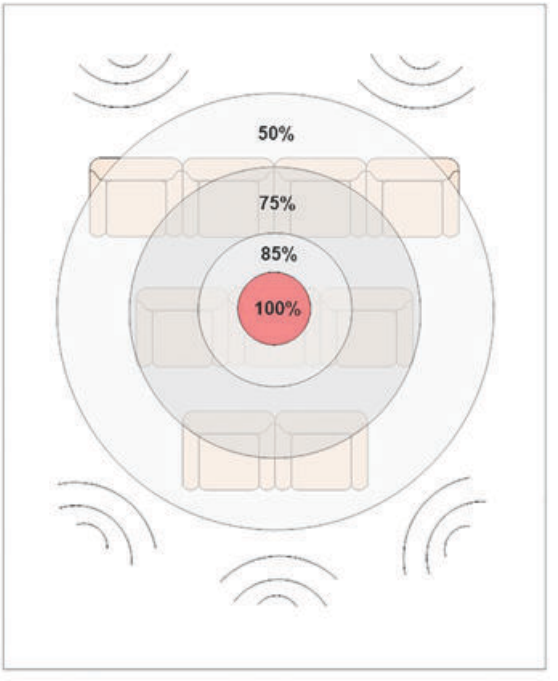


Fig. 1 Approximation of performance percentage of a properly set up and calibrated 5.1 system at different seats.

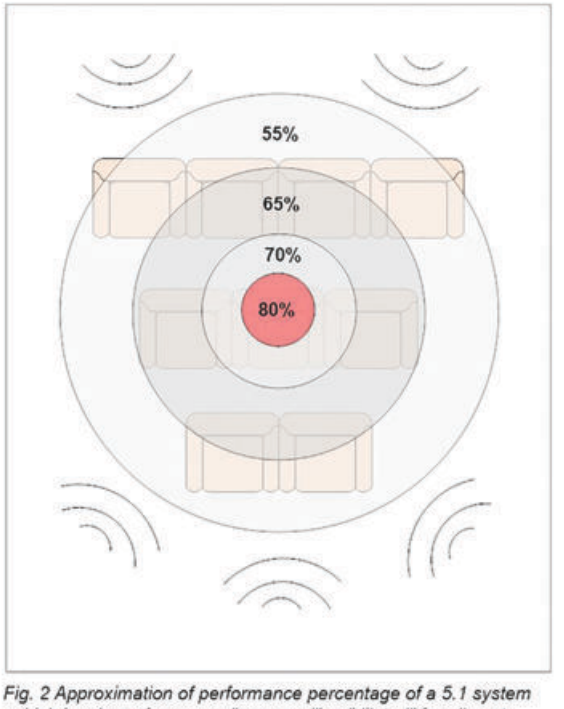


Fig. 2 Approximation of performance percentage of a 5.1 system which has been frequency "averaged" or "diluted" for all seats.

a. All seats become skewed, none are correct. On the other hand, when one seat hits the target, the others are closer to the target. Equalizing frequency response is usually about room modes around 250 Hz and below. These are long wavelengths and can easily swing 25 dB in sound-pressure level! Such long wavelengths can cover many seats and many rows.

b. Half of the battle with low-frequency room modes is high-pressure (loud, combining) spots, and half is low-pressure (quiet, cancelling) spots. For the most part, and no matter how fancy an equalizer you have, you cannot push up the quiet frequencies, you can only pull down the loud ones. As a result, each seat will still be unique with quiet frequencies.

c. Because we rarely listen to steady tones, I would rather suffer the occasional dip or bump than to suffer with lean bass response all of the time, at every seat.

d. Due to the laws of physics, there is only one point in the room where time, energy, and frequency can converge—this point should be the money seat. For example:

i. You can't seat-average time arrivals. Loudspeaker time arrival correlations are our spatial cues. They tell us where things are in the soundstage and help us determine the size of the recorded space.

ii. You can't seat-average energy levels. The loudspeaker closest to the listener will always dominate all other loudspeakers.

iii. You shouldn't seat-average frequency response. All seats are then tainted and diluted.

e. Averaged frequency response is not the sound the artists envisioned. Enjoy what was intended, and when you have guests over, let them sit in the money seat. You'll be close by noticing the time and energy distortions well before the frequency imperfections.

3. Listener Too Close To The Loudspeaker

I feel bad for anyone sitting close to one loudspeaker. They are feet from one loudspeaker and yards away from the others. They essentially have no soundstage. They often can't tell what's going on because all they can hear are sound effects. Understand that as the number of seats increase, so must the size of the theatre. It should work like inflating a balloon. Don't push someone next to a loudspeaker—it's cruel.

4. Listener Too Close To Wall(s)

I feel the same for anyone sitting next to a wall. The same rules apply as above. Everyone knows that it sounds weird when you (or a loudspeaker) are close to the wall. It sounds muddy from the bass build-up—the mids and highs also experience reflective interferences that distort tonality and spatiality. The effects are compounded for someone sitting in the corner of the room!

5. Subwoofers In The Corners

The best place to place subwoofers is where they avoid the room mode problems, and up next to the front mains. This is where they offer the most linear bass response and blend with the main loudspeakers to sound like one voice. Though it may be convenient to place them in corners, and yes that offers greater bass energy output for less power input but:

a. Exciting all the room modes is not accurate and will require some frequency equalizing, phase, delay, and level-matching finesse.

b. Even with all that optimized, you will be audibly aware of their location, as they will not blend with the mains as one voice. There is also the idea of placing the subwoofers in the mid-point between each wall. Their location becomes even more audible there. Yes, it offers some smoothing of room modes, but you will not have one voice, and it would be especially annoying to someone sitting close to one, and will introduce larger time delay errors for more seats.

I recommend two subwoofers up front. If the room is larger, then incorporate larger or additional subwoofers up front to handle the space. You shouldn't have to place any in the back unless the surrounds are only good down to say, 80 Hz.

6. Screen Too Wide

This tip will save you money. The screen's occupied field of view is important to the viewing/movie experience. With the higher resolution of UHD/4K images having smaller pixels, people are pushing the screen size beyond being comfortable and practical, to the point where you have to move your head in order to see the entire picture. This is not what the artist intended, and you may miss information in the scene designed to be seen. What is worse is what happens to the audio when the screen is too wide. Because you have to push the loudspeakers so far out to the sides, you lose the solid sound imaging. The audio industry standard is that the left and right front loudspeakers should form an equidistant triangle with the primary seat. This offers a naturally spacious and solid image, which correlates with the picture. It also complies with SMPTE and THX video angle standards. Both standards are a result of biological human traits, rather than egos. With loudspeakers too far apart, sounds occur outside the pictured action—the soundstage is not convincing, and the LCR loudspeaker locations are obvious. You can place the loudspeakers behind a perforated screen, but then you're compromising both sound and picture to varying degrees.

7. Seat Back Is Too High

This is likely the most over-looked and common blunder found in home theatres. Having a seat back above your shoulders will create two very serious distortions:

i. The seat back will reflect the front loudspeakers

ii. The seat back will block the surround loudspeakers.

Seriously dumb, right? You are not even in the ballpark when using such seats. There is only one way to fix it—replace it. Recliners are for watching TV and taking naps, not for a home theatre experience. There are cinema seats available without high backs, and models with removable or motorized head rests.

8. Poor Choice Of Interior Colors

In a proper-performing theatre, you should not see or hear the room. Brightly colored walls, carpet, seats, etc. will light up from the light output of the screen. You may even see distracting shadows move across the floor from the action on the screen. Additionally, those colors will reflect back to the screen, causing color distortions. Ideally, matte black (or neutral matte greys)

should be used on the rear wall, and side walls, ceiling and floor in front of viewers. The front wall behind the screen could be something other.

May Cost

1. Over absorption Of Mid And High Frequencies

A very common mistake with acoustic treatment is to use too much standard foam or fiberglass panels to control the reverberation times. However, they only absorb frequencies found in the upper half of the piano, and offer no treatment for the lower half. This imbalance sounds unnatural, dry, closed in, and even uncomfortable to be in. There are specially designed acoustical products available to help address lower frequencies. In order to sound neutral and natural, you must control the entire audible range in a linear fashion, within the desired time window *(see Figure 3)*. This means combining the right product, at the right locations, with the right quantity.

2. Center Channel Loudspeaker Mismatch

In movies, around ninety percent of the audio information comes from the center channel, so you can imagine that it is a very important component in your playback system, yet it is often sacrificed with a cheaper, smaller, even a different brand loudspeaker than the front left and right mains. This causes timbre discontinuity between the front loudspeakers. Additional compromise is frequently implemented by locating the CC loudspeaker much higher or lower than the mains. Lack of correlation between the loudspeakers and even the picture creates confusion. The tweeters should be within about one foot elevation of each other, and as close to the bottom of the screen as possible. This usually works out well, as both the bottom of the screen and tweeters perform best at about nose height.

Additional Cost

1. Poor Shell Construction

Typical home construction does not offer noise control. Noise is a two-way street. If noise can get in, it can get out too. Without proper construction design, listeners in the theatre may be distracted by external noises, and/or those trying to sleep or study elsewhere in the building may be distracted by the home theatre. It is amazing how many invest in a home theatre with no thoughts about noise control, only to discover that they cannot use the theatre after the kids are in bed.

Typical home construction is hard-fastened and does not offer enough sound energy containment, so sound is easily heard on the other side of the partition and vise versa. The materials and methods don't have enough isolation or mass to block the sound. Low frequencies travel right through, as if they're not even there. Low-frequency energy also travels through the entire connected structure. Not only is this a problem from a noise control point of view, but also from a sound-quality view. Buzzes, rattles and resonances also occur. In addition, thin, light materials mean that too much energy is lost and you have to turn up the volume to feel visceral impacts. On the other hand, a concrete bunker does a good job of blocking transmission, but too much energy is contained inside the room, and the bass lingers and muddies up the sound big time. Typical home construction also allows cavity resonances to play back into the room. Note the sound of a drum when you hit your fist between studs. Any time that frequency is played by a loudspeaker that wall will sympathetically resonate and play back the frequencies into the room later in time—more mud, less fun. Walls, floors, ceilings, risers, etc. have cavities with different frequencies. No wonder most rooms sound droning and inarticulate. There is a fine balance in construction materials and methods in order to create a room that controls sound transmission and sound quality optimally. Mass, but not too much, decoupling, damping, bracing, insulation, and sealing are the design tools needed. Again, the low frequencies are very difficult to control. The shell itself can be a great low-frequency absorber if designed well.

2. Electrical

A home cinema should be provided a dedicated electrical service. Not paying attention to the electrical layout can cause grief in the form of noise and interference, digital errors, harsh sound, flat soundstage, narrow dynamic range, loss of resolution, and numerous forms of A/V electrical distortions, even damage to equipment. Proper amperage, grounding, power isolation, and wire dressing go a long way and usually cost little. Maintaining clean, tight contacts should be a routine.

3. HVAC

Not having a dedicated HVAC system designed for the home theatre can cause the following problems:

a. Uncomfortable temperature in the room. Often home theatres, with their amplifiers, people, insulation, and interior acoustic treatments become hot boxes. But, it can go the other way too when the temperature is being regulated elsewhere.

b. HVAC systems can be noisy. They can be a distraction when they turn on or off, pulling you out of the movie experience. Dedicated systems can include quieter compressors, duct lining and/or silencers, lagging, and other methods of reducing noisy air turbulence, etc.

c. They can be a means of noise being transferred to or from other rooms, acting like acoustic intercoms. You may not be able to use the home theatre after the kids go to bed. On the other

hand, you may hear your kid's music when you are using the home theatre.

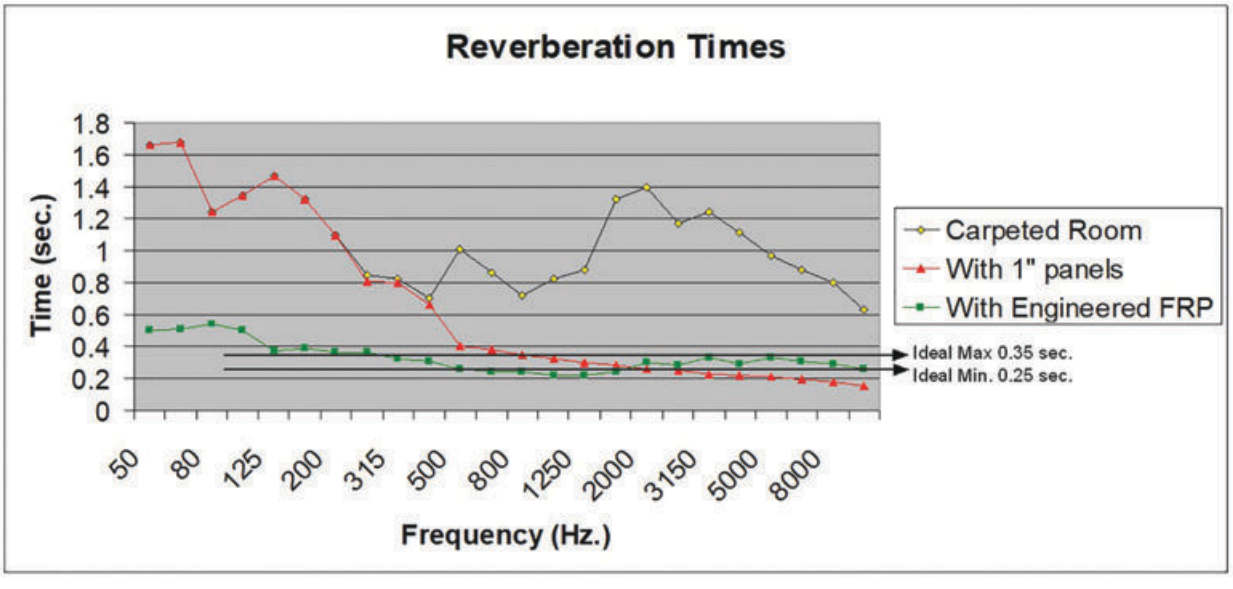
d. Noisy HVAC systems reduce dynamic range. In order to hear small details, you have to turn up the volume, which is not always practical, or even possible. This means that low-level details will be masked.

4. Additional Acoustic Treatments

There are a number of other related noise control and sound quality issues regarding acoustic treatments for construction. They include room dimensions for good room mode distribution, interior treatments for first order reflections and reverberation control, etc. I will cover these in more detail in the next issue.

In conclusion, I am disappointed that these blunders are still so common. In this day and age of accessible information, training, certifications, books, etc., these faults should not be happening. A/V integrators are either being lazy or careless, both of which are a disservice to their customers. Certainly, some might be a result of compromise made after an informed decision process, but most on the lists above are avoidable in every home theatre situation. Most on the list do not cost extra to implement at the design stage. Most of these common blunders should be common sense. They are not new opinions, they are well understood and documented, backed by objective and subjective data and should be standard practice. It is the responsibility of the designers and integrators to educate their clients so they understand the consequences resulting from deviations and compromises, and then they can make informed decisions. Paying attention to these basic issues will bring a much higher level of performance, which translates to a much more enjoyable experience for everyone.

In the next issue, we will discuss the important fundamentals required to make a great home theatre. **WSR**



Actual RT60 of a Home Cinema

The Yellow line represents the room typically furnished. Note the unique sonic "signature."

The **Red** line represents optimized 1" fiberglass panels. Usually we would see more area treated, resulting in an even steeper dive than shown here. Consequently, this treatment over-damps above 500Hz. and does not address frequencies below 500Hz. (about middle C).

The **Green** line represents application of FRP engineered, broadband acoustic treatment system.