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Acoustic Room Systems (ARS) Room Treatment

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I've often been surprised by how relatively little attention the high-end audio community and home-theater enthusiasts pay to room acoustics. We upgrade components semi-regularly and tweak our systems daily, but more or less ignore the massive effect our listening rooms have on the quality of reproduced sound.

Consider, for an extreme example, how lousy first-rate equipment often sounds in hotel-room demonstrations at trade shows. Even in larger rooms that have been semi-treated acoustically, the sound is distorted by several mechanisms. A room's size and ratios of length-to-width-to-height determine the severity of bass peaks and dips, and the frequencies at which these peaks and dips occur. The room itself acts as a wildly miscalibrated equalizer, introducing frequency-response aberrations that can be as great as ±15dB. Acoustic reflections (particularly first-order reflections from the sidewalls) color the tonal balance, degrade imaging, and shrink the soundstage. In addition, energy "stored" by the room can smear transient detail and reduce dialogue intelligibility.

I've long had a more-than-passing interest in acoustics; I studied the subject when I designed my first recording studio twenty years ago. During my thirteen years as a full-time equipment reviewer I've nearly always had a dedicated listening/theater room with good dimensional ratios, solid construction, and free-standing acoustic treatments. For the past five years I've been listening in my current purpose-built room and have been very happy with the sound. (It has also passed muster with the many designers who have set up equipment here, including

Richard Vandersteen, Arnie Nudell of Genesis, Kevin Voecks of Revel, Neil Patel of Avalon, Peter McGrath of Wilson Audio, and Keith Johnson and Rick Fryer of Spectral.)

Thus when Acoustic Room Systems (ARS) approached me with an offer to install its acoustic-treatment package I was of two minds—I didn't want to screw up a good thing and, yet, I was curious what the ARS package could do for a room which already had optimum dimensional ratios.

Founded in 2001 as a spin-off from fiberglass giant Owens-Corning, ARS specializes in designing and installing acoustic treatments in high-end music and theater rooms. Owens-Corning,

Figure 1

which is reported to have one of the most advanced acoustics laboratories in the world, developed the fundamental technologies on which the ARS treatment is based. ARS works in association with A/V RoomService, an acoustic-design firm that also has its roots at Owens-Corning. A/V RoomService performs the computer-based acoustic modeling of your room, specifies the location of the acoustic panels, and as an option, will come during the installation to acoustically measure your room, compare it with the model, and make on-site adjustments.

As noted, I had several reservations about letting ARS treat my room. First, it's been my experience that most acoustic-treatment packages include far too much absorption, deadening the room and killing dynamics. You can spot such a room instantly by the eerie feeling you get seconds after walking inside. (Anyone who's been in an anechoic chamber—a reflection-free room—can tell you it's not a pleasant experience.) Second, I was skeptical about whether the thin ARS panels could absorb low frequencies. In my experience, low-frequency absorption requires thick materials or deep structures (quarter-wavelength bass traps, polycylindrical diffusers, 16-inch Full Round ASC Tube Traps, perforated-panel absorbers, etc.). Third, the installation would be semi-permanent; removing it would entail refinishing the interior walls. Fourth, as I've said, my room sounded quite good as it was.

The ARS's effect on the spatial aspects of the sound was as profound as the improvements it wrought in the bass and dynamics.

Nevertheless, after ARS allayed my concerns, I gave them the go-ahead and ARS and A/V RoomService went to work. To start, Norm Varney of A/V RoomService asked me for a detailed layout of my room, a description of its construction and furnishings, and a synopsis of my music and home-theater listening habits. From that information, his computer model produced a map that identified the optimum orientation of the ARS panels and diffusers as well as the best loudspeaker and listener positions. Figure 1 shows Varney's reverberation-time model of my room with and without treatment.

The patented ARS panels are 1.25-inch-thick fiberglass with thin sheetrock on one side. With the fiberglass facing the room, the panel is *absorptive* above 300Hz. With the sheetrock facing the room, the panel is *reflective* above about 300Hz, while simultaneously acting as a diaphragmatic absorber from about 100Hz–300Hz. (Sound striking a diaphragmatic absorber causes it to flex, converting acoustic energy into mechanical energy which is dissipated as a minute amount of heat.) Although the amount of diaphragmatic absorption at low frequencies is small, the panels' large surface area has a cumulative effect. A second diffusive element, the same thickness as the ARS panels but molded from plastic with a convoluted surface, scatters sound back into the room in a semi-hemisphere. (The diffusers are the shiny areas on the rear wall and ceiling visible in the bottom left photo on the previous page.) Every square foot of wall and ceiling is covered by a panel or diffuser. After a fabric retainer (the framework most easily visible in the top left photo) has been mounted to the walls and ceiling, the panels are attached to the walls. Fabric is then stretched between and tucked into the retainer to create a seamless appearance that completely hides the acoustic treatments beneath. Indeed, my room looked nicer after the installation.

For an additional fee to ARS, acoustician Norm Varney will voice the room *after* the panels and diffusers have been mounted, but before the fabric is installed. (A/V RoomService is a sub-contractor to ARS; its design and modeling fee is included in the ARS package, but not its on-site measurement and voicing.) Once my components and loudspeakers were put back in place, Varney measured the room and compared the on-site test results to the computer model. He also listened to the system playing reference music recordings and film soundtracks, and suggested flipping some panels to reverse their absorptive/ reflective characteristics. After this process was complete, the electronics and loudspeakers were again removed so the installer had room to work with the fabric. (The installation took five days.)

The majority of ARS installations are in new construction, which doesn't provide the opportunity for "before and after" listening or measurement comparisons. Fortunately, I've had five years' of listening experience in my room through a variety of loudspeakers (including the Genesis 200, Avalon Opus and Eidolon, Revel Gem and Studio, Aerial 7B, Vandersteen Model 5, and Wilson Sophia). This allowed me to perform direct comparisons with and without the ARS installation.

Listening Impressions

Comparing the identical system before and after treatment, I was taken

Comparing Movie-Theater and Home-Theater Acoustics
"Why Can't I Hear the Dialogue Clearly?"

If you're like many home-theater enthusiasts, you've experienced the problem of turning up the volume because you were straining to hear the dialogue, then a few minutes later leaping out of your seat again to turn the volume back down because the effects were now way too loud. If you set the volume so the dialogue is right, those explosions are deafening. Set the volume so the explosions don't blow you out of your seat, and you can't hear the all-important words. Although film soundtracks are played far too loudly in most theaters for my taste, I seldom hear in theaters the dialogue intelligibility/dynamic range problem so common in the home.

But why should the same film soundtrack sound so different in the home than in the theater?

The answer flies in the face of conventional wisdom. It's natural to assume that in the movie theater we sit in the acoustic "farfield," in which the sound energy is dominated by reverberation rather than by the direct sound from the loudspeakers. Concomitantly, we assume that at home we sit in the acoustic "nearfield," in which the sound energy is predominantly the direct sound from the loudspeakers, with very little reverberation. We associate the large spaces of movie theaters with a long reverberation time, and the small spaces in our home with little reverberation. According to research by Tomlinson Holman, the ideal mix of direct-to-reverberant sound occurs when the listener is seated between 50 and 70 percent of the "critical distance"—the critical distance being the distance from a sound source at which direct sound and reverberant sound are equal.

Although we think we're sitting in the nearfield at home, the radiating patterns of typical loudspeakers combine with the typical lively sheetrock-dominated acoustics to create a situation in which the listener is actually sitting at perhaps *1.8 times* the critical distance, i.e., in the farfield. Conversely, the heavy drapes, narrow loudspeaker directivity, and acoustic absorption by chairs and people in the movie theater mean that listeners sit in the relative nearfield—perhaps half the critical distance. This is the exact opposite of conventional assumptions.

How does this explain the dialogue-intelligibility problem? Film-sound mixers create film soundtracks to sound right in movie theaters, not in homes. When we play these soundtracks in the relatively live acoustics of the average home, the dialogue tends to get lost in the reverberation and to be confused by acoustic reflections. Dialogue intelligibility is further degraded by room resonances (a greater problem in small rooms), which boost the amplitude of certain frequencies, momentarily storing energy at those frequencies and releasing it a split-second later, smearing one sound into the next. Room acoustics have such a large effect on dialogue intelligibility that the science of acoustics includes two specific criteria for expressing how dialogue intelligibility is affected by the room: "Speech Transmission Index" (STI) and "percentage articulation loss of consonants" (%AL_{CONs}).

By shortening and controlling the reverberation time (among other improvements) the ARS system increases the ratio of direct-to-reverberant sound, putting the listener closer to Holman's ideal of the listener at 50–70 percent of the critical distance. The theoretical advantages of the ARS system—increased dialogue intelligibility with no need to boost the center channel a couple of dB to hear more clearly—were exactly what I benefited from after the ARS treatment was installed. And because I didn't need to turn up the volume to hear dialogue clearly, the film soundtrack's loudest passages were no longer too loud. The result was less listening fatigue, and a more involving home-theater experience.

But what if you can't afford the full ARS package? Simply apply these principles to your own room by shortening the reverberation time with some strategically placed hanging rugs, installing Tube Traps by Acoustic Sciences Corporation (ASC, www.acousticsciences.com), covering large windows with absorbent drapes, and placing area rugs over wood floors between you and the loudspeakers. Note, however, that these materials (except Tube Traps) absorb only high frequencies, not bass. For the best results, balance high-frequency and low-frequency absorption. (For more on this subject, see Tomlinson Holman's pioneering Audio Engineering Society paper, "Translating the Experience of Film and Television Sound from Room to Room," published in *The Proceedings of the AES 12th International Conference: Perception of Reproduced Sound*.) **RH**

aback by the wholesale change in the sound. The best general description I can give is that the sound was more precise in every way: bass definition, dynamics, spatial resolution, and dialogue intelligibility. The overall improvement in clarity and immediacy was startling.

This global transformation was the consequence of the various specific sonic attributes improved by the ARS system. First, low frequencies were substantially sharper and stronger, with less midbass energy and more apparent low bass. The impression of deeper low bass was no doubt the result of less smear and bloat in the bass and midbass, which had previously masked the lowermost notes in music and sound effects. The entire bottom end had a new power, solidity, and tautness that served as a more convincing foundation for the rest of the audio spectrum. In *Das Boot*, for example, when the diving submarine's hull is slowly being crushed by the increasing sea pressure, the sense of claustrophobia and impending doom were made more palpable by the depth and clarity of the low bass.

Bass dynamics were also improved, imbued with greater impact and power, and given a startling ability to start and stop suddenly. This made low-frequency effects more like sharp punctuation marks—exclamation points that heightened the excitement they were intended to convey. On music, kick drums cut through rock and jazz ensembles with an explosive, lightning-flash speed that intensified rhythmic drive. Double basses in orchestral recordings and film scores were more sharply articulated and agile. The ARS system simply removed the thickness and transient smear I'd become accustomed to in my system.

The reduction in midbass thickness also enhanced midrange clarity, manifested most prominently on vocals in music and dialogue in film soundtracks. Voices were cut free from the loudspeakers. Dialogue seemed to emerge from space, rather than being tethered to the center-channel speaker. I could also hear more clearly small inflections in spoken words, and the subtle nuances of personality and drama they conveyed.

Significantly, I heard no other changes in the tonal balance, beyond the reduction in midbass thickness and the apparent increase in power and articulation in the lowermost octaves. The midrange and treble balances were identical to the way they sounded pre-ARS, which I took as good signs.

The ARS's effect on the spatial aspects of the sound was as profound as the improvements it wrought in the bass and dynamics. The soundstage snapped into tight focus; every movement of sound now matched on-screen actions. Pans were smoother and more continuous, rather than jumping from one speaker to the next. This was true even between the front and rear loudspeakers, heightening my sense of envelopment in a sonic landscape.

Measured Performance

One of the advantages of having Varney voice the room is the measured data he collects, which can be compared to the computer model (and to the untreated room). In addition, Christopher Klein of ARS performed the MATT (Music Articulation Test Tone) test in my room with and without Tube Traps, then again after the full ARS installation. Let's first look at the MATT results.

The MATT is a special test signal of a swept sine wave, spanning the range of 20Hz to 1950Hz, that is interrupted by silence every sixteenth of a second. The signal sounds like a series of blips of ascending frequency, as the signal quickly goes on and then off. As this signal is reproduced through the loudspeakers, a microphone picks it up at the listening position, and the results are plotted graphically. This test shows how the room modifies the sine wave—specifically the frequencies at which the room is storing energy—and how severely the transient nature of the test signal is distorted. Acoustic energy "hangs" in the room during the silences between blips, filling in the gaps on the chart. This translates sonically to bass muddiness, loss of articulation, and smearing of the sound's dynamic structure. The deeper the nulls in the trace, the flatter the peaks, and the more regular the trace's shape, the better.

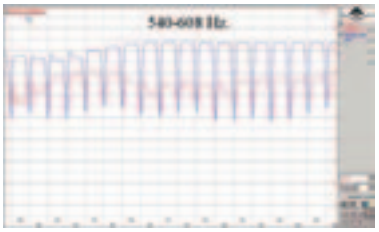

Figure 2

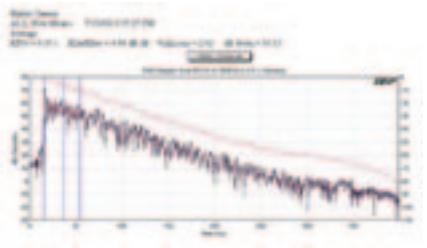

Figure 3

Figure 2 shows my room before (red) and after (blue) the ARS treatment. (I've selected a representative band of frequencies.) You can see how (after the ARS treatment) the nulls are deeper and the tops flatter, indicating less stored energy in the room. This is a dramatic improvement.

Figure 3 is the room's reverberation time plotted as a function of frequency. This measurement is an average of six taken at and near the listening position. The smooth, continuous slope is ideal, as is the 0.3-second Rt_{60} (reverberation time). Figure 1, shown earlier, is a model of the room's Rt_{60} without treatment, along with curves showing the ideal and the model after treatment. (Varney estimated an Rt_{60} of 0.32 seconds including drapes and fabric. In the model, he aimed for an average Rt_{60} of 0.25–0.35 seconds, and was pleased by the measured result of 0.37 seconds before the fabric and drapes were installed, which brought the Rt_{60} down close to the ideal.)

Other measurements showed that the Speech Transmission Index (STI), a measure of intelligibility, was greater than 0.75 at all frequencies (overall STI Rating was 0.89 measured from 63Hz–12.59kHz, an outstanding result). Varney's measurements of background noise indicate my room is an NC 20, which suggests an amazingly low level of background noise. (I live in a semi-rural area, which helps.) An NC 20 rating is the minimum for a dedicated listening room and would normally require special shell and HVAC construction to achieve.

Conclusion

With prices starting at about $11,500 and going up to $45,000 (depending on room size—my room treatment with on-site voicing cost $33,000), the ARS system isn't for everyone. But before you sink that much money into first-rate audio equipment, consider upgrading that distortion-introducing element between you and your loudspeakers—the listening room. If given the choice between listening to $40,000 worth of state-of-the-art controller and multichannel power amplification and no room treatment, or a high-quality A/V receiver and the ARS package, I would choose the lesser electronics in the treated room. Room acoustics are that important, and the ARS package is the ultimate realization of the goal of minimizing the room's effect on music and film-soundtrack reproduction.

The Finishing Touch: Custom Lighting

Retrofitting my room with the ARS system gave me the opportunity to add custom programmable lighting to my theater. There's nothing like track lighting, wall sconces, and remote lighting control to create a more theater-like experience in your home.

I started by running low-voltage wiring behind the ARS panels to points on the walls and ceiling. On the room's sidewalls, I installed theater-like sconces, and on the ceiling, three halogen track lights to illuminate the equipment rack and CD/DVD storage. These were controlled by a Lutron 3500 Grafik Eye controller and GRX-8IT remote control. The Graphik Eye can be programmed to create several different "scenes," such as "full on" for entering the theater room, "spot lighting on the equipment racks" for changing discs or making equipment adjustments, and "all lights partially on" for those moments just before the movie starts. In addition to these presets, you can also program in certain sequences of dimming. For example, you can program the system to make the track lights dim quickly, followed by a slower dimming of the wall sconces, just as the movie starts. This control can also be programmed into universal learning remote and executed as a macro (such as by pressing PLAY on the DVD player). It may sound a bit like gilding the lily, but this lighting control adds enormously to a theater-like experience.

I bought the lighting package from Image Crafters (www.imagecraftersinc.com), a company specializing in theater lighting, environments, and seating. Lutron makes a full range of lighting control products, from a simple remote-controlled dimmer that works with any lamp, to whole-house automated lighting control. (www.lutron.com) RH

MANUFACTURER INFORMATION

ACOUSTIC ROOM SYSTEMS
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