TECH TOPIC

Thinking Inside the BOX Part 3

No scale models this time - Bass traps in a real room

This is the final Tech Topic in this series. The first installment examined the use of a scale model to investigate room modes. We discovered that the low frequency response of a "shoebox" room is relatively predictable by the wave equation. There was good correlation between the predicted and measured responses.

The second installment examined the use of active low-frequency treatment. Resonant devices were tuned to specific frequencies and placed in the model. These band reject filters have parameters similar to electrical filters, and represent the truest form of "room tuning."

This third and final installment uses low-frequency absorbers in a real room to "tame" the boominess associated with such spaces. Broadband absorbers differ from resonant devices in that they work over a broader range of frequencies (lower Q) and are less affected by temperature changes and room furnishings.

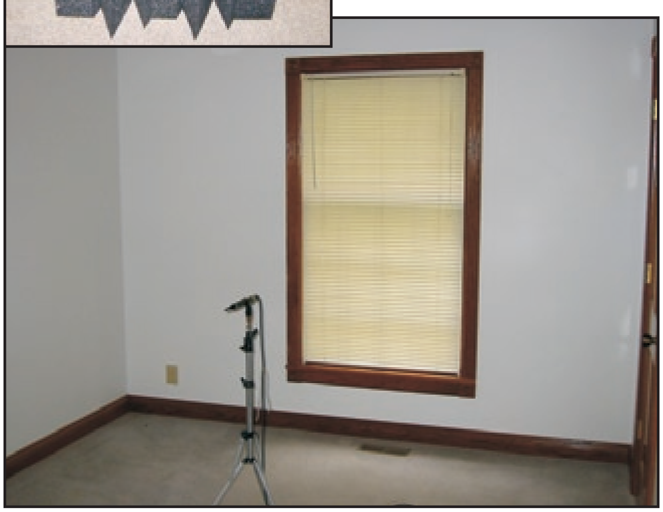
The LENRDs are 61 cm (24") tall porous foam units that are stacked or glued into the room corners. The surface shape provides increased surface area at higher frequencies.

The absorbers used in this investigation are the LENRD™ units from Auralex Acoustics. The idea is a simple one, place absorptive material in the room corners, where sound pressure is at a maximum for all modal frequencies. The sound energy is converted into heat by the absorptive action of the trap.

Fortunately, a spare bedroom was empty and available. It is a typical gypsum board "shoebox" that one might convert into a listening room or project studio. Such spaces can become good listening environments with a little work and minimal investment.

Since we are stuck with the geometry, there is no reason to predict the modal response. It can be measured with greater accuracy. While not optimal, at least the length, width and height are different lengths - very important for good modal distribution. The room measures 3.7 m x 2.9 m x 2.4 m (12 ft x 9.5 ft x 8 ft). From our previous installment, this should place the fundamental axial modes at about 47 Hz, 60 Hz, and 70 Hz respectively. Additional axial modes will be present at integer multiples of the above frequencies. Tangential and oblique modes (four and six-surface modes) will also exist. Critical frequency for this space is 430 Hz, so we will extend our measurements to 500 Hz. Above this frequency, the modes become too diffuse to calculate.

From the above we would expect severe coloration of a loudspeaker's response in the low-mid frequency region, which we will try to correct with treatment.



The room prior to corner treatment

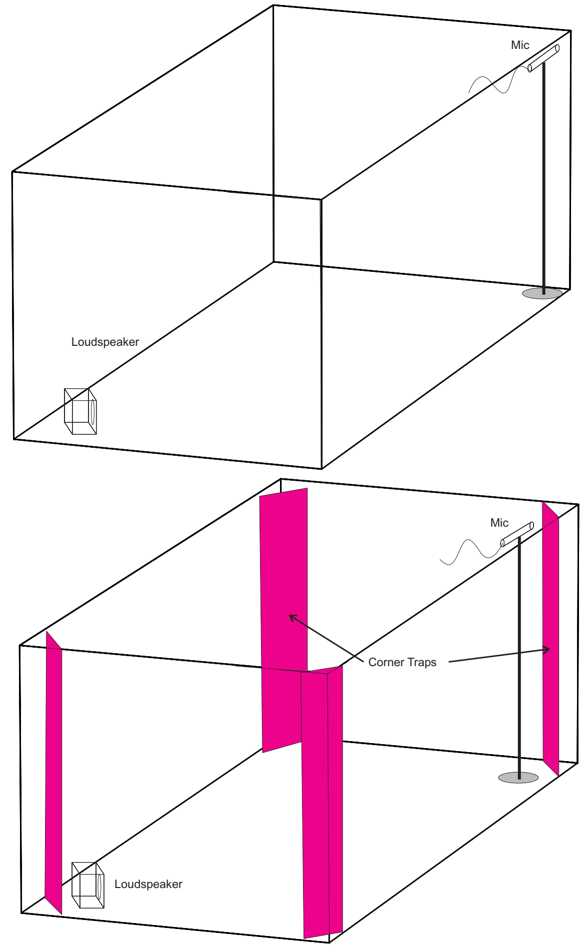
Two of the four treated corners

The Total Response

Figure 1 shows the low frequency room response before and after the introduction of the bass traps. The loudspeaker and microphone placements are shown at right. The opposite-corner placement technique allows all axial, tangential and oblique modes to be measured. The measurement data were gathered using the transfer function mode of SIA SmaartLive™ run on a notebook PC using a USBPre™ audio interface.

The effectiveness of a low frequency absorber is frequency-dependent. These relatively shallow traps (about 30 cm) provided significant absorption (>12 dB) in the low-mid spectral region (125 Hz to 500 Hz). As one would expect, their effect diminished below 100 Hz, where the acoustic wavelengths become quite large. In this region, room geometry and loudspeaker/listener placement are still the most significant factors that determine the frequency response. Even so, there is considerably more audible information between 100 Hz and 500 Hz than there is below 100 Hz, so we will be content to achieve a significant energy reduction in this spectral region.

Given the above, we can see that for a fixed-size trap, the smaller the room, the more effect it will have. Corner traps are a small-room treatment. Large auditoriums would require a different approach (or a MUCH larger trap!).



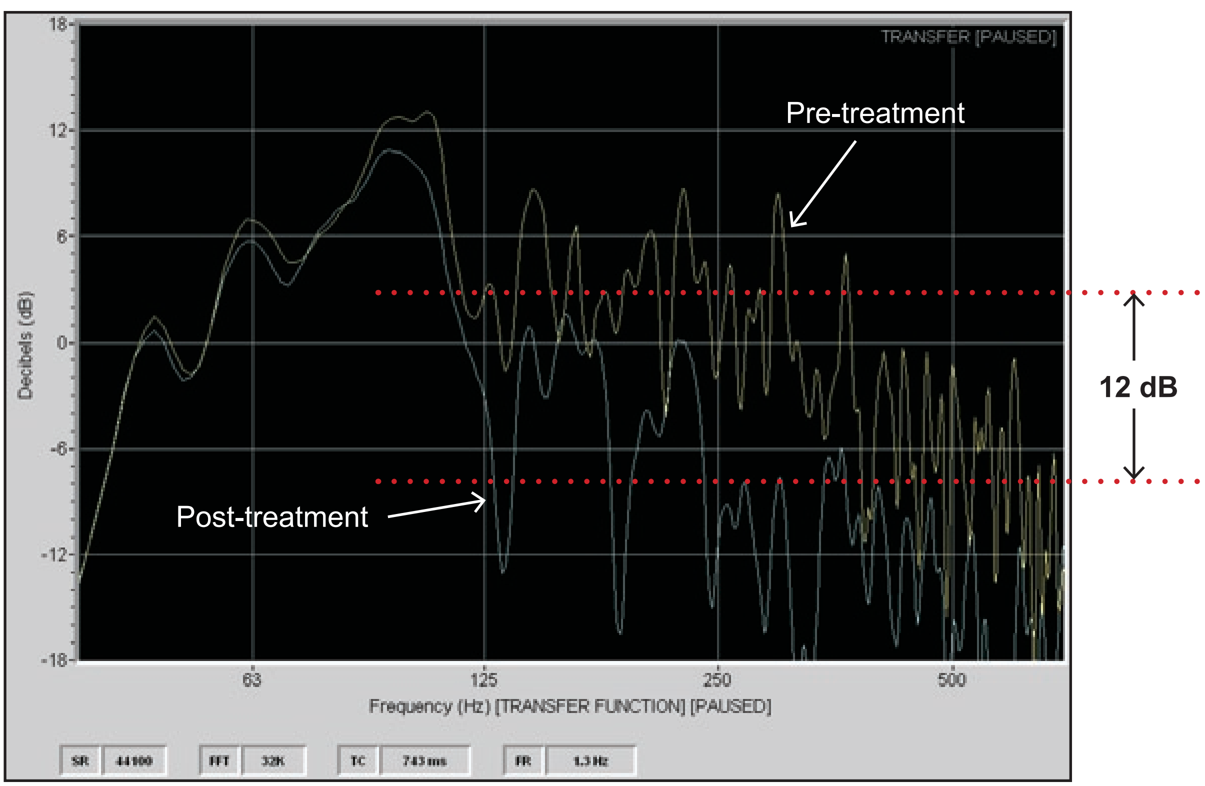
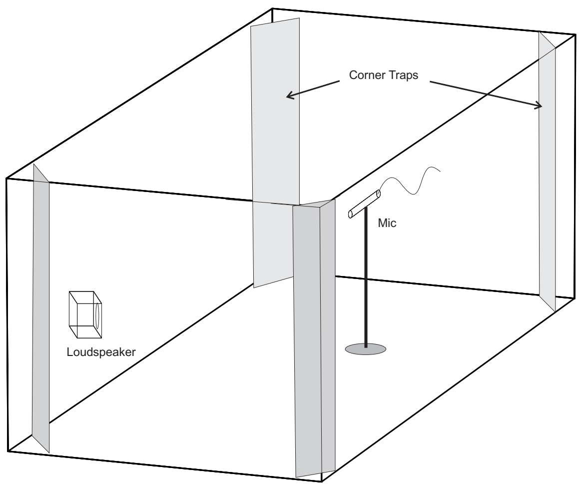


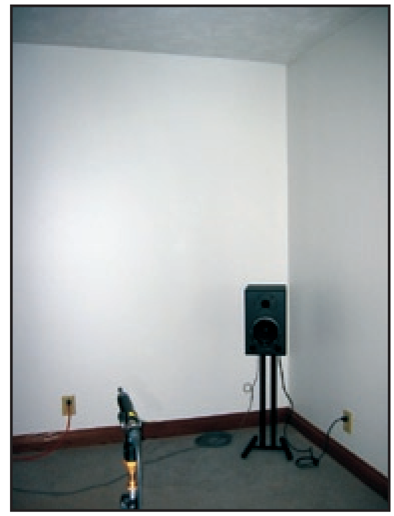
Figure 1 - Before and after corner measurements of the listening space

A Listener Position

While the corner measurements allow the complete modal response to be gathered, they don't represent an actual listener position. Next, I placed the loudspeaker on a stand and the mic at a likely typical listener position given the room's size and geometry. Figure 2 shows the effect of adding the corner traps one-at-a-time. Note the cumulative effect of treating all four corners. The subjective effect of the absorbers is to reduce the typical "boomy" sound that characterizes spaces of this size, converting it into a much more listenable space. The use of bass traps in this space does not negate the need for good room geometry, loudspeaker placement and listener position. Below 100 Hz, these are much more effective at achieving a smooth room response than room treatment. As frequency increases, the modes become increasingly random and broadband absorption becomes a more effective treatment.

Low-frequency corner treatment leaves the major room surfaces available for diffuse and reflective coverings, allowing the room to be tailored for specific uses. The Live-End-Dead-End (LEDE) is a good example.[1]





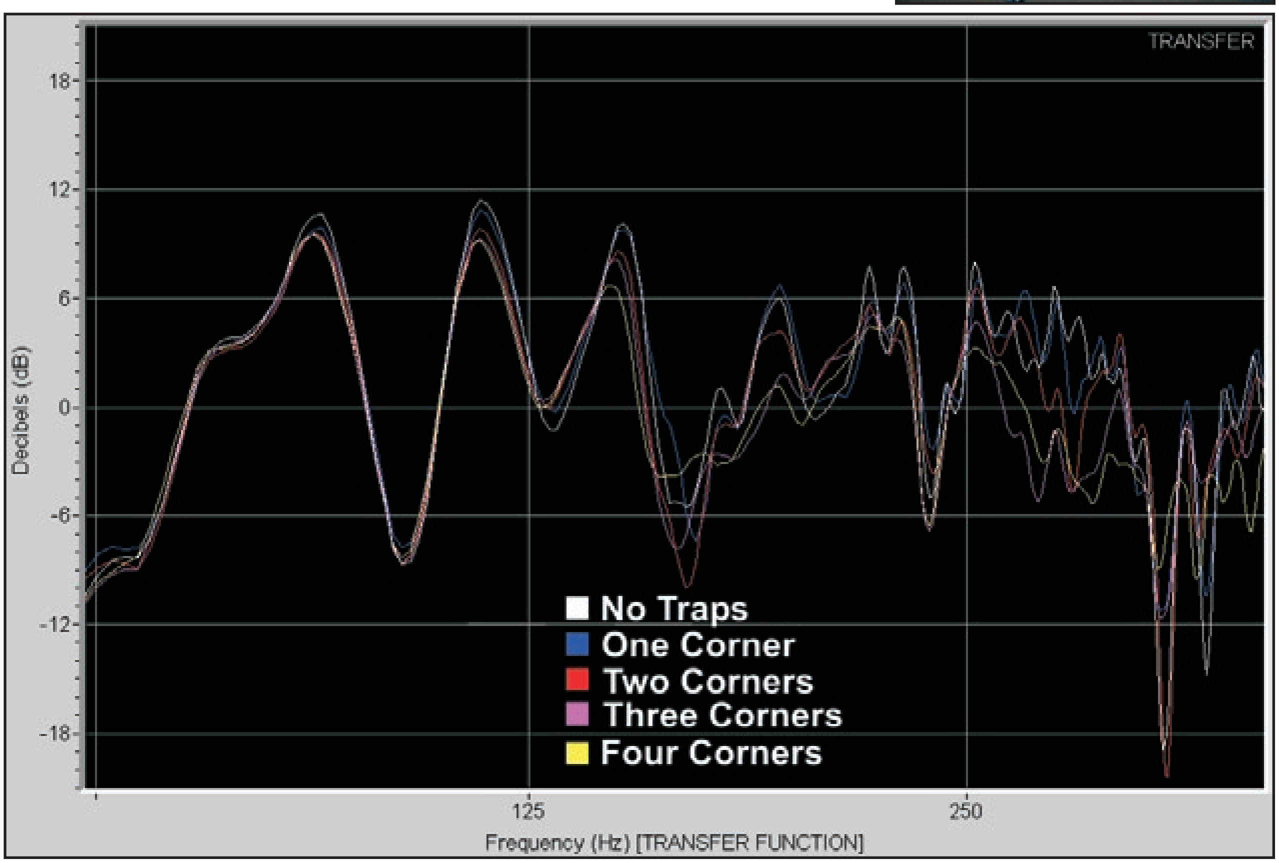
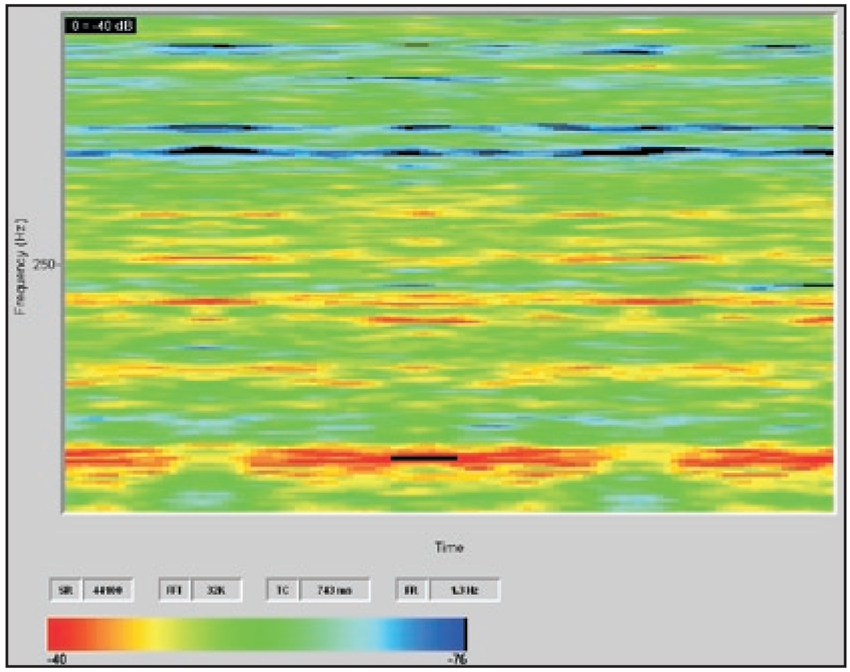


Figure 2 - Cumulative changes at a listener position

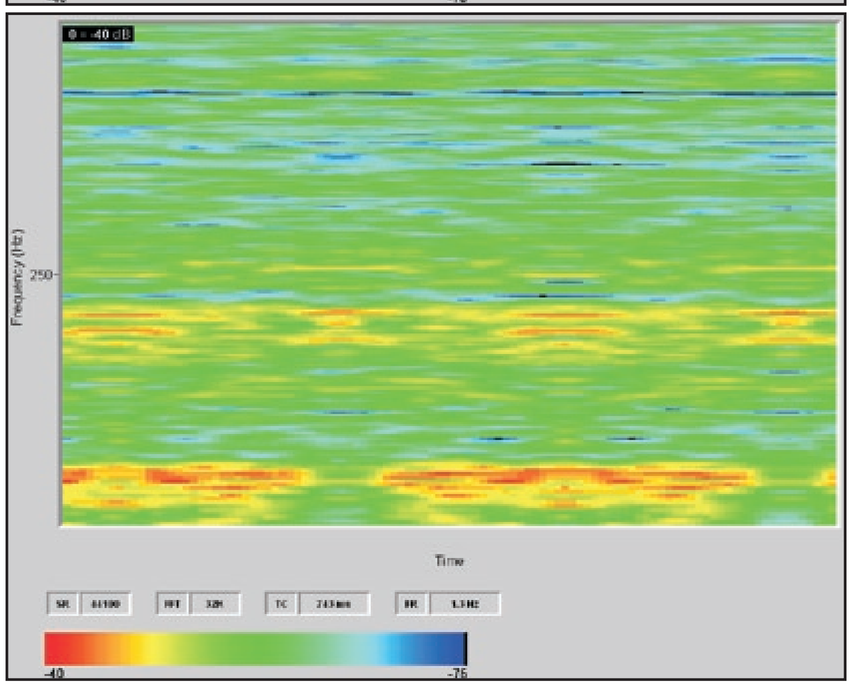
A Different Perspective...

The Spectograph display of Smaart-Live provides another interesting view of the modal response and the effect of the bass traps. The vertical axis is frequency and the horizontal is time. The colors represent the sound level. The stimulus is steady pink noise.

Room modes manifest themselves as horizontal stripes in the display. This is an alternative to the traditional "waterfall" plot that can also be used to view frequency/time trends.



The effect of adding the four corner traps is apparent. Note the diminished level of the modes. The traps have made the room response more neutral, producing less coloration of the loudspeaker's response. Treatment is preferable to electronic equalization because the correction extends over a wider area and has less impact on the loudspeaker's direct field.



In conclusion, I hope that you have found this series of Tech Topics both interesting and informative. I learned a lot by having to "crunch through" the math and correlate measured vs. predicted data. The principles that have been examined should aid in improving the listening experience in small spaces. For more information on room modes and treatments, I provide the following links to the World Wide Web:

www.rpginc.com
www.acousticsfirst.com
www.auralex.com

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[1] <u>*Sound System Engineering*</u> *by Don and Carolyn Davis*