S&V OBSERVER

Alternative Testing for Acoustic Treatment Products

Ethan Winer, RealTraps, New Milford, Connecticut

Most professional acousticians understand the role of testing labs for measuring the effectiveness of absorber materials and products. Briefly, a sample is tested flat on the floor of a highly reverberant room and the reverberation decay times in third-octave bands are measured with and without the sample present. A suitably large sample is needed for reliable results to ensure that the decay times change sufficiently with and without the sample present.

To reduce the effects of standing waves and the resulting "dead zones" at different frequencies and locations in the reverberation room, dozens of tests are performed in succession while the measuring microphone moves around in all three planes (Figure 1). The absorption in sabins for each band is derived from the amount of change in reverberation decay time, and the tests are averaged to yield a single value for each band. Finally, the results are converted to absorption coefficients by dividing sabins by the front surface area of the sample.

Reverberation rooms have been used successfully for many years to test different types of absorbers this way, and most vendors of commercial absorber products and materials offer test data in the form of absorption coefficients. However, I believe this method is inadequate for testing some types of acoustic treatment meant for use in audiophile listening rooms, home theaters and smaller recording studios. These days, recording engineers often work in relatively small rooms and small rooms have specific problems and needs, especially in the lowest octaves.

Limitations of Standard Tests. This article details what I feel are limitations of the standard lab tests currently used to measure performance of acoustic treatment products and materials. Please understand I am not dismissing the value of the current testing standards. The world of audiophiles is full of products based on "new physics" and other dubious science and standard lab tests can identify deficient products. However, I believe a different approach is needed – in addition to the standard tests – for many of the products currently sold for use in smaller rooms.

Figure 1. The microphone at end of boom arm moves continuously up, down, left, and right as dozens of successive tests are run.

One problem with standard tests is that they assume the absorbers will be mounted flat on a wall or ceiling, with only the front surface area exposed to the room and actively absorbing. But in practice, flat absorber panels are often mounted spaced away from a room surface because they work better with an air gap (Figure 2). When a panel is mounted with an air gap, its absorption extends to lower frequencies, which is always welcome, and its effective surface area increases. That is, sound striking the wall or ceiling at an angle near the panel is reflected into the rear of the panel, which can also absorb. So with an air gap of a few inches or more, the panel behaves as if it's larger than it really is, which is also a benefit.

When the rear surface of a panel is exposed, the notion of an absorption coefficient no longer applies, because coefficients consider only the front surface area. Similarly, when a flat panel is mounted straddling a corner, which is typical for bass trapping, a triangle shaped opening forms above and below, letting sound reach the rear of the panel to be absorbed. Likewise, thicker panels can absorb a substantial amount via their edge surface as well as their front, and the edge surface is not considered either when converting from sabins

Figure 3 shows that a 2-by-4-foot panel that's 4 inches thick has 50% more exposed surface area due to the edges. The E-mounting standard of ASTM C 423 allows for testing panels mounted with an air gap – for example, ceiling tiles meant to be placed in a suspended grid. But the standard requires that during testing, the edges and rear be blocked from absorbing by applying a skirt around the panels to simulate how the panels will actually perform when installed. Further, when testing with an air gap, the panels are required to be adjacent to minimize the contribution of edge absorption. But in practice, acoustic panels often are not mounted adjacent but rather placed independently at key places such as first reflection points.

Another problem with the current test method is that there is no standard for measuring absorbers intended for mounting in corners as bass traps. For example, a panel that measures 5 sabins at 100 Hz when placed near the center of the lab floor typically exhibits two to four times more absorption when placed straddling a corner of the same room. Further, bass traps meant for corner placement are not always flat panels. Some are cylinders, others are wedges, and yet others are flat panels in the shape of triangles for mounting in tri-corners where two walls meet the floor or ceiling. Figure 4 shows several commercial bass traps that are not rectangular panels and cannot be compared fairly using the standard methods. Nor can their performance be expressed properly using absorption coefficients.

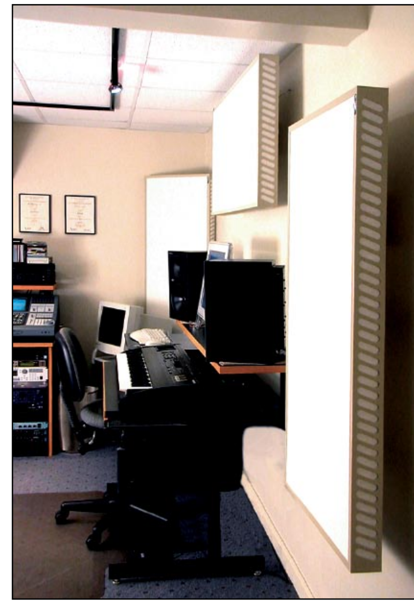

Figure 2. RealTraps MiniTraps spaced off wall in professional project studio.

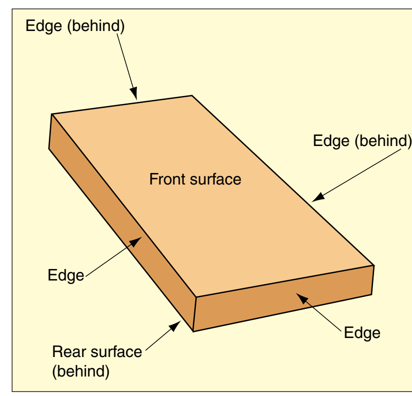

Figure 3. This panel is 2 by 4 feet by 4 inches thick. During testing, edges increase total surface area by 50%, yet edge surface is excluded from calculation to absorption coefficients from sabins. When a group of panels is mounted adjacent to cover an entire wall or ceiling, no edge surfaces are exposed, even though some surfaces absorbed during testing.

Cylinders have no front surface at all, so it is impossible to derive an absorption coefficient. And while wedges – a popular shape for bass traps made from acoustic foam – do have front surfaces, other surfaces may be exposed during testing but not exposed when installed. Figure 5 shows how a triangle-shaped column has different surface areas exposed during testing versus when installed. Because there is no standard for grouping and placing wedge-shaped foam in a test lab, it's anyone's guess as to what surfaces were exposed during testing. Even if the vendor states clearly how the devices were placed and grouped, it's impossible to compare what's measured to other devices that were placed and grouped differently in other labs. Indeed, it seems pointless to measure a device designed for corner placement anywhere other than in a corner.

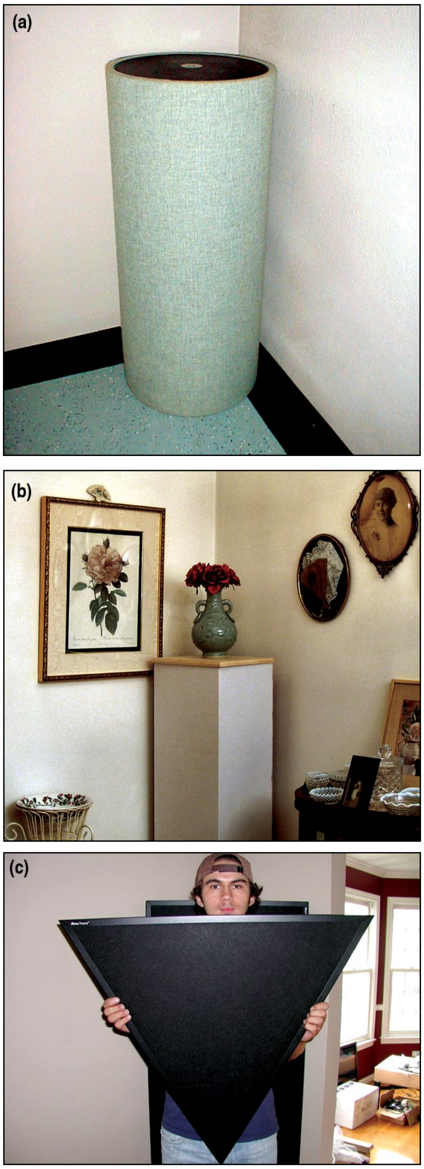

Figure 4. a) ASC tube trap; b) RealTraps StandTrap; c) RealTraps Tri-Corner. Photos courtesy of respective companies.

Yet another problem with using absorption coefficients for acoustic treatment products is that they ignore the size of the device. Because acoustic treatment in a home setting often requires spouse approval, a number of products that are simply too small to be useful are sold to that market. One popular design is a small triangle made of thin fabric and pillow stuffing, typically 10 inches per side. It is attached with tape or push pins in the wall-ceiling tri-corners of a home listening room. I call these "bikini corners" because that's just about how big they are! An absorber like this might boast an absorption coefficient similar to a legitimate absorber that's 20 times larger. Yet the smaller device is not useful at all, while the larger device could be highly effective. Because the whole purpose of test data is to inform consumers, it makes no sense for devices that perform very differently to be able to claim identical performance based on a dimensionless specification.

Bass Frequencies Matter Most. Performance below 100 Hz is what separates the

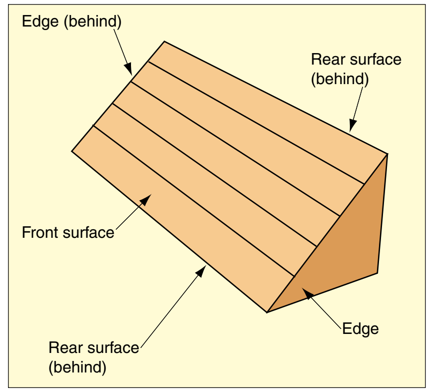

Figure 5. Foam blocks like this are meant to be mounted in corners, stacked atop each other from floor to ceiling. When measured for absorption, as many as four of five surfaces might be exposed, but when installed as intended, only front surface absorbs. In practice, two-foot corner wedge like this may provide as little as 65% of absorption measured. The shorter the wedge, the larger the disparity between measured and actual absorption.

men from the boys with acoustic treatment products. It's easy to build an absorber that works well at mid and high frequencies, and rigid fiberglass or acoustic foam 1 or 2 inches thick are common materials that do a fine job above 500 Hz. However, it's much more difficult to design an absorber that is highly effective below 100 Hz. Yet these very low frequencies are usually the main problem in small or poorly proportioned rooms. With bass traps, performance below 100 Hz is what matters most.

This reveals another limitation with standard tests. Most U.S. labs are not certified to measure below 100 Hz, because they're not large enough to develop the reverberant field on which these tests rely. Rather, at very low frequencies, the reverb room's modes dominate, and those modes may or may not align with the standard third-octave test frequencies. Further, lab results can vary as much as 50% at 125 Hz even though 125 Hz is within the range of certified frequencies. Results vary even more below 125 Hz, and I've even seen negative sabins reported due to the inherent inaccuracy of the reverberation room method at very low frequencies.

As a designer and manufacturer of bass traps and other acoustic treatment, I needed a more reliable way to assess low-frequency absorbers and compare proposed trap designs. The solution I devised is to use room analysis software in the small 'lab' room at my company's factory (Figure 6). I use ETF and R+D, which are Windows programs that cost $150 for both from www.etfacoustic.com. For Mac users there's FuzzMeasure, which is equally capable and costs $150 from www.fuzzmeasure.com. These programs are intended mainly for consumers to measure the frequency response of their listening rooms, but they also offer waterfall plots to display modal ringing. When bass traps are added to a room, peaks are reduced and nulls raised, but the modal ringing decay times and the peak Qs are also reduced. A waterfall display is the key feature that

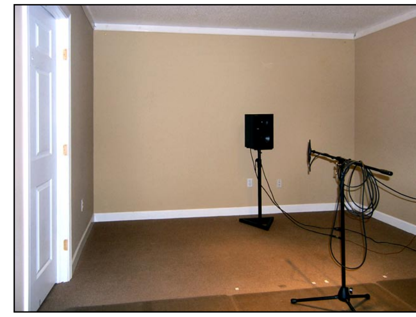

Figure 6. The RealTraps test room is 16 feet, 2 inches by 11 feet, 6 inches, by 8 feet high.

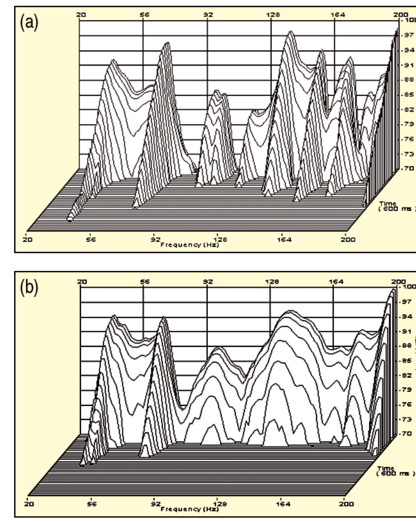

Figure 7. These waterfall plots compare the before (a) and after (b) low-frequency response, ringing, and modal bandwidth in a typical small room when empty versus with 12 pieces of rigid fiberglass placed in corners.

makes it possible to accurately assess the performance of low-frequency absorbers in a typical bedroom-size space.

In my experience, using ETF in a small room is more useful below 100 Hz than reverb-room lab tests. However, it is important to understand that 'homemade' tests like these are useful only for experimenting, not for publishing official performance data. One reason is that these tests do not give any numbers. All analysis is done visually, looking at how the decay times are reduced (the 'mountains' come forward over time) at each mode frequency and by seeing how the Q of each mode is lowered, thereby making the peaks broader. Figure 7 shows ETF screen shots taken in the RealTraps lab with the room empty and with 12 rigid fiberglass panels placed in wall-wall and wall-floor corners.

To assess absorption at 50 Hz, for example, either true reverberation or a natural room resonance is needed. Something has to decay for a change in the decay time to be observed. Fortunately, even a medium-sized bedroom has measurable resonances at very low frequencies, and the change in decay time after adding bass traps is large enough to be assessed reliably. This also reveals a limitation of using ETF and similar software to measure absorber performance. You can assess absorption reliably but only at the room's resonant frequencies. For example, in the RealTraps lab, I can test reliably at 27, 42, 57, 70, 85, 97, 114, 141, 155, 171 and 183 Hz. To test other frequencies, I'd need to use a different room. But in practice, this approach has proven quite adequate for testing the types of broadband bass traps that I develop.

In theory, it's possible to determine sabins of absorption from these waterfall plots. But the results would not be truly reliable due to a lack of climate control and isolation from outside noise such as the rumble of passing traffic. However, the relative difference between the room empty and trapped, or between samples of different proposed trap designs, is valid.

Note that the graphs in Figure 7 are taken from a series of tests that I did to help understand how the density of rigid fiberglass affects its absorption, and also what effect the paper membrane has when applied to FRK-type fiberglass. For readers who may be interested, the complete report showing data for 12 different sets of samples is available on my personal web site www.ethanwiner.com/density.html.

So Now What? I would love to see new standards developed that allow for a more reliable comparison of bass traps intended for corner placement, regardless of their size and shape. Being realistic, I also understand that vendors of acoustic treatments are a tiny portion of the overall market for acoustics labs. It's not reasonable to expect dozens of labs to invest in new facilities just to test corner bass traps a few times per year. But a few additions to the current standards could be implemented fairly easily at no cost.

Testing panels with an air gap and not adjacent in a cluster can be done using the current methods if the size of the air gap and the spacing between panels were standardized. Because this is the way panels are often installed in listening rooms, it makes sense that they also be tested this way. It would also be easy for vendors to agree to state absorption for corner bass traps as sabins instead of absorption coefficients. That will put an end to the current practice of proclaiming ever-higher – and physically impossible – amounts of absorption. Agreeing to use sabins only instead of coefficients also makes sense for products meant to be mounted away from a wall or ceiling. This gives a truer measure of a product's effectiveness, because the size of the device plus any potential absorption from the rear surface is factored into the results.

Devising tests for bass traps mounted straddling corners or tri-corners is more difficult, and measuring accurately below 100 Hz is even more difficult, because participating labs would need larger rooms or at least identical mode frequencies. But I can wish, can't I?

Ethan Winer has been a professional musician, composer, circuit designer, recording engineer, recording instructor, computer programmer, technical writer, and consultant since the 1960s. He was a contributing editor for *PC Magazine* for many years and has written many feature articles for most of the main-stream audio magazines. Ethan now designs acoustic treatment products and runs RealTraps in New Milford, CT. Contact him at: ethan@realtraps.com.