ACOUSTOLOGY 09/2003

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This month: *"Loudspeaker + Room = ?"*

Bass Trap Fact and Fiction Part 2

Last month, we reviewed low frequency behavior in small rooms. This month is no different! Continuing the discussion of low end problems, I would like to talk a little bit about the low frequency behavior of loudspeakers in small rooms; specifically the behavior of "nearfields" used in many control rooms and home studios.[1]

Most "nearfields," which I will call "reference loudspeakers" from here on since "nearfields" is really a misnomer[2], are designed with the intention of providing the user with a "flat" reproduction of audio. In other words, between certain frequencies, the response curve looks "flat." For a good example of this, simply look up the frequency response curve in the user's manual for a good reference loudspeaker. Or look at the technical specifications. There is usually a line that looks something like:

Freq. Response: ±2 dB from 57 to 16,000 Hz

What does this mean? Well, it depends on the loudspeaker manufacturer. "Standard" tests will actually vary widely by manufacturer. Often, there is some "smoothing" of the response going on so that the user is not confused by severe "dips" at the crossover frequency or from microphone-loudspeaker distance anomalies. Simply looking at the specifications will not reveal how the test has been conducted. If the tests are conducted in accordance with standard test methods such as those prepared by the Audio Engineering Society (AES – www.aes.org) or the Association of Loudspeaker Manufacturing and Acoustics International (ALMA International – www.alma.org), then odds are good the manufacturer is giving you good data. Otherwise, the only real way to find the response of the loudspeaker *in your room* is to measure it yourself. Explaining how to do that is an *Acoustology* piece for another time. Suffice to say here that if you see a specification that says the loudspeaker is "flat" over a major portion of the audible range, take it with a grain of salt – all loudspeakers have anomalies that cannot be corrected electronically. And many of those anomalies are in the (you guessed it!) low frequency range.

So how does this affect your decisions regarding the treatment of your room? To find out, let's look again at the frequency response specification from above *and* at an example room in which we will (virtually) place these reference loudspeakers:

Freq. Response: ±2 dB from 57 to 16,000 Hz

Room Dimensions: 12' long x 10' wide x 8' high

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[1] Note that this discussion is also relevant to small- to medium-sized "bookshelf" loudspeakers used in home theater rooms.

[2] "Nearfield" in acoustical terminology refers to the area immediately around a sound source that is placed *outdoors*. It is more accurate to call a "nearfield" loudspeaker a "direct field" loudspeaker since "direct field" refers to the same area around a sound source *indoors*. "Reference loudspeakers" avoids any confusion on the matter.

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f (Hz)	Type
47.1	Axial
56.5	Axial
70.6	Axial
73.5	Tangential
84.9	Tangential
90.4	Tangential
94.2	Axial
102.0	Oblique
109.8	Tangential
113.0	Axial
117.7	Tangential
122.4	Tangential
130.6	Oblique
133.3	Tangential
141.3	Axial
141.3	Axial
141.3	Oblique
147.1	Tangential
148.9	Tangential
152.1	Tangential
152.1	Tangential
157.9	Tangential
159.3	Oblique
163.2	Oblique
167.7	Oblique

Using our equation from last month's *Acoustology*, we can figure out that the lowest possible frequency that is going to pose a problem in this room is 47.1 Hz, which is actually below the published range of the loudspeakers. Thus – in theory – we should not be overly concerned with that mode. But what about the other modes? On the left is a list of the first 25 modes for this room in ascending order of frequency. There are quite a few frequencies here that could give us some serious problems, include the axial mode at 56.5 Hz – more or less at the "cut-off" for our loudspeakers. Are all of these modes important? No. See the oblique mode at 102 Hz? It's not likely to give you much trouble unless you have a room that is six solid concrete surfaces (i.e., very hard). In fact, in most home studio/home theater type rooms, oblique modes die away so quickly and are so much higher (relatively) in frequency that we rarely consider them major problems. Also, as we saw earlier, the axial mode at 47.1 Hz can probably be safely ignored since it is lower than the loudspeaker "cut-off." So what does that leave us with? The table to the right (above) shows us the major modes of concern. The red text indicates modes under 75 Hz. Why? Well, we are finally to the stage where we are beginning to look at specific low frequency control devices – a.k.a., "bass traps."

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117.7	Tangential
122.4	Tangential
133.3	Tangential
141.3	Axial
141.3	Axial
147.1	Tangential
148.9	Tangential
152.1	Tangential
152.1	Tangential
157.9	Tangential

Fiction: **Foam "corner traps" cannot treat problems below about 300 Hz.**

Fact: **Properly placed in the room, foam "corner traps" such as "LENRDs" are effective down to the 75 to 100 Hz range.**

How is this possible? Easy: It's not only about *size*, but it's also about *placement*. LENRDs are designed to go in corners. Once they're in the corners, they are going to absorb much of the energy present as a result of tangential and axial modes. (See last month's *Acoustology* for more discussion and illustration of this.) Many naysayers will tell you that a foam device with the dimensions of a LENRD cannot absorb below 200 or 300 Hz due to its size. This shows that people can certainly read text books, but obviously have never tried *using* LENRDs in their room. In theory, a device has a limited frequency range based on its size. In practice, however, many other factors come into play. The overall result of these other factors is that absorptive material in a corner often works a lot lower than you would think. Not convinced? Pat Brown, the chief audio guru at Synergetic Audio Concepts (Syn-Aud-Con – www.synaudcon.com), actually measured LENRDs in action and found pretty much what we have known to be true all along: LENRDs can control down to about 75 to 100 Hz. (A reprint of Pat's review can be found at www.auralex.com/press/reviews.asp.)

OK, so what about the problematic frequencies *below* 75 Hz? So glad you asked ☺:

From the right-hand table on the previous page, there are three main frequencies we need to be concerned with in this range for our example, which I've reproduced here with a little more detail about their behavior in the room:

nx	ny	nz	f (Hz)	Type
0	1	0	56.5	Axial
0	0	1	70.6	Axial
1	1	0	73.5	Tangential

There are a four different ways we can look at treating these lower frequency problems:

1. Roll-off ("EQ out") the low-end.
2. Use "Helmholtz resonators."
3. Use "diaphragmatic" absorbers.
4. Use broadband absorbers.

And next month we will look at the pros and cons of each of these solutions in detail!

[I know I promised you more this month, but alas – I have run out of space (and time). So stay tuned!!!]

Next month: *Specific low frequency devices and what they can (and cannot) do.*

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