Subject: Speaker placement and wavefront launch
Posted by Wayne Parham on Sun, 02 Oct 2011 05:35:04 GMT
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The ideal: The constant directivity cornerhorn. In this configuration, the sound source is within

confining radiation to the angle of the walls. There is no waveform disturbance - It creates a perfect section of a purely spherical wavefront from the corner into the room.

Of course, not all rooms are suitable for constant directivity cornerhorns. Some have obstructions or entryways near the corners. Others have corners that are just too far apart. So not all rooms can support constant directivity cornerhorns.

This is a look at what other placements do to wavefront propogation. Let's start by moving the sound source slowly out from the apex of the corner, to see what happens. Where we cannot be

placements near boundaries? Or should speakers be placed far away, if they cannot be

I suppose it might be helpful to define acoustic scale. Things that are said to be acoustically close

sum as a single sound source. A boundary that is acoustically close is not a reflector, but rather a confining boundary, which is equivalent to a waveguide, with the bounding surface setting the radiating angle.

Things are acoustically distant if they are several wavelengths apart. They will not sum, but will not cancel either. They will develop interference patterns of energies and nulls, much like a

where interference is worst at close range, but where spherical radiation emerges within a short distance. All sound sources will develop spherical radiation at large distances, and the acoustic scale sets the range.

is so often found in home hifi installations. In this range, wavefront propogation, while not being as pure as acoustically close sources, does become spherical before the wavefront reaches the far walls. This is a generality, of course, but I think it's a reasonably useful one, and makes a good working definition of acoustic scale, e.g. close, distant and transition.

Note that the wavelength of 500Hz is 27". At 1kHz, it's half that, 13.5". These are important figures because this is the region where most matched-directivity (waveguide) speakers become directional. It's useful to be able to position speakers in the room where boundaries influence this range and below. So one should think in terms of one to two feet, when considering wavelengths in these illustrations.

apex of the corner. There is a mild band of reduced amplitude right down the center, and there is definite wavefront distortion but it isn't too bad except very close to the speaker.

wavefront distortion, worse as the speaker gets further away from the walls. But move just a little ways from the speaker, and the wavefront becomes spherical. There are also two bands of reduced amplitude, one on each side.

Now let's move it to a full wavelength away. And let's look at the expansion as it develops, to get a better view of the way energy is distributed. Note that black areas are pressure minima, and color is pressure maxima.

One cycle:

Second cycle:

Third cycle:

Now, let's see the wavefront expansion through the room. It is clearly distorted up close to the speaker, and it remains that way for some distance. But the wavefront is still what I would call "pseudo-spherical" (for lack of a better word), in that it retains that basic expansion, on average.

Now let's see a typical loudspeaker placement, closer in from the side wall than from the wall

wall. When the speaker is placed this far from the walls, the wavefront becomes pretty fragmented. In terms of actual distance, for a 500Hz tone, this condition would exist with the speakers four feet from the back wall and six feet from the side wall.

All of these have been transition region distances, with the exception of the last one which was just past. That's the toughest placement to deal with, because the interference is worst. Ironically, it's also the one that is most popular, probably because it is "furniture friendly".

Now let's try moving the speakers much further, to minimize the influence of the reflections. Having the walls further away not only reduces the amplitude of the reflections, it also tends to

make them less problematic at the center of the room, where listeners most likely will sit. As an

of actual distance, for a 500Hz tone, this condition would exist with the speakers eight feet from the back wall and twelve feet from the side wall.

You can see why some audiophiles often prefer to have their speakers placed far away from walls. It does tend to make the center of the room less jumbled, the wavefront is relatively clean at some distance.

I think this series of illustrations makes another point abundantly clear, that there's another useful placement choice, to make the speakers nearer to the boundaries. They can be very distant, or they can be very close. It's the range in between that should be avoided.

midrange. Above that, directional tweeters and absorbent materials can be employed to reduce reflections. Where possible, avoid speaker-to-wall distances between two feet and eight feet.

The best approach is clearly to use constant directivity cornerhorns. But where that's not possible, if even the speakers can be kept within a wavelength or so, this is helpful, and makes relatively clean wavefront propogation in the listening area. But if the speakers cannot be placed this close to a boundary, it is better that they be placed far from it.

Also remember that reflections at higher frequencies are easily absorbed. Tweeter frequencies can be absorbed nicely with thin material, such as curtains. As frequency drops, the absorbent material must be thicker, or at least spaced further from the boundary. Below 1kHz or so, even fairly thick rugs won't do it, you need a foam or something that's a few inches thick. Below 500Hz, it is really tough to find things that will absorb reflections. That's where sound source locations become really important, because you can't do much to absorb the sound.

More information:
High-Fidelity Uniform-Directivity Loudspeakers

Room modes, multisubs and flanking subs
Helper Woofer Location
Flanking Subs vs Helper Woofers