Subject: Re: Speaker placement and wavefront launch
Posted by Wayne Parham on Wed, 05 Oct 2011 22:35:00 GMT
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The illustrations show radiation from a monopole source with boundary distances relative to wavelength. You're right that different frequencies create different patterns in the room, because the speaker is a fixed distance from the boundaries. But these illustrations show what the

whatever frequency/distance that is.

reflection, making it more of a bounding surface than a reflector. It is simply a waveguide at that point. At greater distances (with respect to wavelength), interference patterns develop, as are shown in the other illustrations.

At low frequencies, wavelengths are large so acoustic scale is large too. What I mean by that is two sound sources (or a source and a reflector) can be separated by further distance at low

room modes, a separate but very similar issue.

In the midrange, wavelengths grow shorter, yet not so small that reflections are easily trapped with absorbent materials. So the lower midrange is actually a tough range to deal with. It is nearly impossible to position a speaker in a small room where midrange quality isn't adversely affected by boundary reflections. In fact, the only configuration I know of that truly solves this problem in a small room is the constant directivity cornerhorn.

There are actually a few regions where indoors sound radiation patterns act differently. The lowest frequencies make up the pressure region, where wavelengths are long compared to room dimensions. Reflected sound sums constructively with the direct sound, so the whole room is pressurized equally. It can be thought of as slightly increasing air pressure in the room on one half cycle and slightly decreasing pressure on the other half cycle.

source, so reflected sound no longer sums constructively. This is where room modes are, typically in the 20-200Hz region. Pockets of energy form, with some places in the room having strong bass energy, and others having nulls. These pockets are in different positions depending on frequency and loudspeaker placement with respect to walls. They're fixed-position standing wave modes that setup between boundaries, mostly between opposite walls and floor/ceiling, but to a lesser degree diagonally from corner to corner.

As frequency rises, above about 200Hz, the distance (both in frequency and position) between the modes grows closer and closer together, so at some point they are so close you cannot distinguish them apart. This is called dense interference, and it is the characteristic of the reverberent field, in the statistical region.

A few other things can be observed about these regions. At higher frequency, the sound is sort of an averaged energy field. Reflections are usually many wavelengths from the direct sound, so they don't really sum with the original - they modify the direct sound signal several cycles later. It's a different phenomenon. Also, higher frequencies are more directional and much easier to absorb with damping material. In fact, many things that are in every home naturally absorb sound, like carpets and drapes. Tweeters can be designed that put the sound in a pattern with constant narrow beamwidth. So higher frequencies are usually much easier to deal with than lower frequencies.

Low frequencies are harder because the long wavelengths don't lend themselves to damping with fibrous materials. The only things that are really effective at damping low frequencies are large vibrating membranes. Actually, homes with framed drywall construction act as natural sound dampers at some frequencies, because the drywall vibrates and some of the energy is therefore lost. But they don't work at all frequencies. The panel absorber has to be sized to match the frequency band of interest.

But one can use a technique that provides dense interference at low frequencies, in order to smooth the sound field in the modal region. This is what multisubs and flanking subs do. The frequencies to focus on are from 20-200Hz, because this is the modal region. A close second is the range from 200Hz to 1000Hz, where most sound sources are not directional enough to be aimed.

My take away from all this is that it is best to use directional (monopole) speakers and to place them either right up against the wall or a long way away, like over eight feet. The best approach, in my opinion, is the constant directivity cornerhorn because it is close enough to the apex of the

acoustically close to the boundaries, so they have a perfect wavefront. Only the tweeter is operating high enough to be acoustically distant, and as I said earlier, high frequencies are easily absorbed with pleated drapes or whatever. The tweeter is directional too, so that helps.

The next best thing is to have sound sources either eight feet or more from all walls, or less than about two feet from the nearest walls. This is sometimes hard to do, because the acoustic center of the sound source is often in front of the speaker, and rarely at the back. So to have the face of the speaker be (just) two feet from the rear wall means it pretty much has to be scooted back nearly against the wall. But I'd rather do that than to move it out four or five feet. Having the

inches away - but it is better than being four or five feet out. If you can't put it at least eight feet away, it's probably best to move it right up against the wall.

That's really the point of this thread, the most important thing I wanted to point out. In having many discussions with people over the years, I find that one of the biggest misconceptions (audiophile) people have is that pulling speakers out away from walls is good practice. That is true only if the speakers are really far away from the walls, like eight to ten feet or more. If your room is 20 x 30, that's just not practical, and in this case, I see some people pulling their speakers out from the walls around four or five feet - which is probably the worst distance they could choose. That's why I wrote this, to suggest that it would be better to put their speakers right up against the wall than it is to have them four or five feet from it.

There is another solution, which I mentioned earlier. The flanking sub approach is one I from the nearest boundaries, so self-interference notches form as a result. Speakers on stands get this self-interference notch from the floor, and often times they are also two or three feet from the back wall, making another self-interference notch, often in the same octave, forming a big wide valley.

A solution is to overlap two sound sources spaced a couple feet apart. The two sources can be a woofer and large midrange overlapping up to ~200Hz. This is the approach taken in my cornerhorns, for example. Another way to do it is with a 2.5-way speaker, with the lower helper woofer low-passed in the ~200Hz range. Or it can be a woofer in a separate box, placed a couple feet behind and to the side of a main speaker, sub on the floor and main speaker on a stand. This is a way to separate the sound sources in all three dimensions, smoothing what would have been notches from the floor and wall behind the speakers.