Subject: Re: Speaker placement and wavefront launch
Posted by Wayne Parham on Thu, 06 Oct 2011 19:46:46 GMT

skywave-rider wrote on Thu, 06 October 2011 11:35In some of the examples you posted above a distorted wavefront close to the speaker eventually attains a spherical shape at a distance. How can the wavefront become "aligned" like that? I always thought the wavefront very close to the speaker would remain the same propagated out into space if there are no reflections.
I have two answers for you, one that you asked for and the other, you didn't.

First is the reason sound waves become spherical at a distance. All sound waves in free space tend to radiate this way, even if they start off as a plane wave (like from a vibrating piston) or are fragmented by reflections, diffractions or whatever. At some distance - again, in free space - they'll tend to form a spherical radiation pattern. The reason for this is superposition, a sort of averaging mechanism that forces them into this wavefront, the natural propagation mode of sound in free space.

Now the second answer, also related to superposition of waves. The same property that causes the wavefront to "settle down" into a spherical pattern at a distance is also what causes it to become distorted by self-interference, room modes, diffraction and refraction. When a wavefront encounters a disturbance like a sharp edge that causes diffraction or an object that refracts part of the wave, then a new vectored wavefront forms with a different trajectory, sort of a new virtual source. When a boundary reflects a wave, then it also can be seen as a virtual source. And of course, other (physical) sound sources create wavefronts of their own too.

All these kinds of things combine by superposition to create a wavefront that is anything but spherical. That's what makes the jagged looking wavefront, and it's what creates room modes and self interference notches. It's the mechanism that creates vertical nulls too. So the same thing that makes a wavefront spherical at a distance is also what makes it fragmented in the presence of interference.

Inside a room, the truth is the wavefront doesn't keep the spherical expansion even from the most perfect sources. The best case has a direct wavefront expansion that is spherical until it reaches the opposite walls (or furniture, people, cats and dogs). Boundary reflections create wavefronts that interact with one another to form a complex modal "checkerboard pattern" inside the room. The checkerboard pattern is "pockets" of peaks and nulls, positions where the sound is loud at a given frequency right next to adjacent positions where sound pressure level is low.

The shape of the modal pockets and their size and position are determined by frequency and positions of sound sources, reflectors, refractors and diffractors. At high frequencies, the pockets of energy are so closely spaced that they average together. Several of them span the distance between your ears, so they sound like a uniform sound field. At lower frequencies, the pockets are larger, wide enough you can move a few inches and pass between a high energy and low energy position. These larger modes become more noticeable. That's why we look to multisubs and flanking subs to help smooth this frequency region.

The thing that's nice about constant directivity cornerhorns is two of the most audible and troublesome self-interference problems are eliminated at the source. The reflection from the wall behind most speakers almost always makes a deep notch in the midrange, but there is no reflection from that wall when constant directivity cornerhorns are used. There is no horizontal self-interference, whatsoever, because the source is acoustically close to the walls all the way up through the midrange. And the midhorn and woofer overlap in the 100-300Hz range, which tends to smooth vertical modes. Where self-interference between the floor or ceiling reflection and one source causes cancellation, the other source being in a different location, fills it in. So the response is very good from about 100Hz upwards. No need for flanking subs with this configuration, although more distant multisubs can be employed to smooth lower frequency room modes.

installations cannot be done with them quite as close to the wall as I'd like, because they're physically large speakers. I usually put them on stands about 12" to 15" up, and toe-in 45° like the cornerhorns. This prevents me from putting them as close to the wall as I'd like, but the midwoofer isn't much further than two feet from the wall behind them. I put flanking subs on the floor, one beside each main, and push them back against the wall so they are offset in all three dimensions - several inches below, several inches behind and several inches beside. Each sub is run with the same signal channel as the main it is flanking, low-passed fairly high with a gentle second-order slope. I usually low-pass around 100Hz, and with a second-order slope, there is a fairly good amount of overlap up through the next octave, smoothing the lower midrange band.