Subject: Room modes, multisubs and flanking subs
Posted by Wayne Parham on Tue, 05 Apr 2011 20:24:04 GMT
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When I first considered the multisub approach, it was prompted by papers written by Todd Welti. He did several tests that showed in-room amplitude response could be made smoother using multiple subs, and gave specific guidance about placement. His favored locations for subwoofers in a rectangular room were to use a sub at each wall midpoint (four subs total), a sub at each room corner (four subs total) or a sub at opposite wall midpoints (two subs total). The idea is to counter self-interference from boundary reflections in the modal region using multiple sources to smooth the sound field. Where one sub and its reflection cancel each other out, another sub in a different location can fill it in.

I discussed this with Earl Geddes at the 2005 Great Plains Audiofest (later renamed the Lone Star Audiofest) and he proposed an alternate configuration, one that puts subs in a random or semi-random arrangement. His idea is that the statistical deviation throughout the room will be averaged better by decorrelation. It makes some sense mathematically, and common sense tell you that if you want to average everything, a random distribution might do that better than an ordered distribution. After all, the room dimensions and the reflections from them are periodic, so the best thing to do to break this up is to introduce a randomizing element. That's the Geddes idea, in a nutshell.

The problem with both approaches is they work best in the lower modal range, up to about 100Hz or so. This is because the average room size separates the woofer locations by wavelength scale at these frequencies. Spreading woofers around the room puts them tens of feet apart, and on a wavelength scale, this tends to smooth frequencies up to about 100Hz.

However, there remains about an octave of the modal range that isn't effectively mitigated by this approach. Room modes extend up to the Schroeder frequency, which is the approximate frequency where modes are no longer distinct and become more of an averaged field. The Schroeder frequency is a function of room dimensions, and is usually between 150Hz and 200Hz for most average home listening rooms. Similarly, there are also self-interference notches that can form in this range from the nearest boundaries, usually the floor, the ceiling and the wall behind the speakers. Each of these types of self-interference can (and usually do) create notches in the response between 100Hz and 200Hz, if not mitigated in some manner.

My proposed solution is to use blended local sources up to somewhere in the vicinity of 150Hz to 200Hz. This can be accomplished with dual woofers, blended mid/woofer or flanking subs. In any case, the blending of the two sources should not need to be run higher than the Schroeder frequency. A pair of woofers in the same cabinet, for example, may have a lower "helper" woofer low-passed at 250Hz. Or a midrange/fullrange driver placed high on a baffle might be run down to 100Hz, blended with a woofer that is low-passed at 200Hz. Another possible solution, attractive with stand-mounted two-way speakers, is to run flanking subwoofers placed a couple feet away, run up to maybe 150Hz.

Geddes made the comment, a few posts back in this thread, that this is a "non-Welti, or Geddes, a sort of Parham arrangement". I suppose that's true, that flanking subs aren't specifically described by Welti or Geddes. However, some Welti configurations can be done this way. So while there are no Geddes configurations that implicitly include flanking subs, there are some Welti configurations that can.

Since Welti configurations are symmetrical, mains can be placed near the subs. For example, if subs are placed in or near each corner of the room, and stereo mains are placed near two of them, then the nearby subs are essentially flanking subs. With the right spacing and crossover (blending), the whole modal range can be made smooth, including mitigation of the nearest wall and floor bounce notches.

But this should not be taken to mean that flanking subs can only be used with Welti configurations. The mains can be setup with flanking subs, and then another one or two can be placed further away, located symmetrically as per Welti or in a random location as Geddes describes.

There is a tendency by some people to overcomplicate this approach, whether you choose the Welti, Geddes or Parham methods. It can be seen as a statistical approach to averaging the sound field. It can be seen as dense interference, like rain drop ripples in a pool. Both are accurate ways to view the situation. But it can also be seen as simply filling in holes.

Where one subwoofer and its boundary reflection combine to cancel each other, another sub fills it in. If you only had one woofer in the room, and you were sitting in a position where a large notch formed at a specific frequency, then it basically is "off" for you at this point. It is making no sound, or very little. Add another subwoofer, put it in a different location, and the self-interference from source to boundary won't cancel because it is in a different location. The phase between source and reflection is different, so the cancellation notch is at a different frequency. The sound for you is "on" at this frequency, from this second source.

At frequencies where both subwoofers are "on" for you, where they are phased properly to combine constructively, you will hear the sound at a little louder volume. At frequencies where one sub is "on" and the other is "off" from a self-interference notch, the sound will be slightly reduced because only one subwoofer is "on". But it is not nearly as much a reduction as if there were complete cancellation, like the single subwoofer setup would produce. So what you get with multiple subs is a little bit of ripple, but not a series of huge notches like a single sub produces.

The same is true at lower midrange (100-150Hz) frequencies, except the distances and scale are smaller. These are usually the result of a vertical mode, higher in frequency because the ceiling height is the smallest room dimension. A second woofer or flanking sub placed a couple feet away can be used to fill in the low-mid notch. At the frequency where the midrange or midwoofer is "off" because of self-interference from a vertical mode, the second speaker, placed a little lower to the ground, is "on" because it is at a different height.

Of course, at these lower midrange frequencies, localization cues are starting to emerge so you do not want the blended low-mid speakers too far apart. But by using a blended pair of sources placed relatively close together, you can greatly reduce the lower midrange notch without introducing an odd localization shift.