Subject: Sub placement
Posted by Wayne Parham on Tue, 21 Feb 2006 16:08:09 GMT
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We've looked at this before, but I think it is always an interesting topic.Outdoors, the problem is you have a lot of area to energize.  There is no room gain.  But you don't have standing wave modes within the walls to worry about either.  Just the nodes that might setup between subs, if

room size and proportion, subwoofer number and position and listener position.  Large rooms are typically less problematic where room modes are concerned, because modes shift down in frequency.  The larger the room, the more it acts like open space.  Smaller rooms generally have more noticeable room mode problems.  One solution involves using multiple subs strategically placed to partially cancel peaks and fill in the holes caused by standing wave nodes within the room.Welti suggests four corner placement or four subs placed at wall midpoints.  Geddes prefers random placement.  I tend towards a staggered symmetrical approach, one placing subs in different places in all three planes but symmetrical with respect to the listener.  Each placement method has its strengths and weaknesses, and many of them are room specific.What works best for you?

Subject: Re: Sub placement
Posted by hurdy_gurdyman on Tue, 21 Feb 2006 22:23:10 GMT
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Wayne (or anyone else),What would you consider to typically be the best location for a single sub in a mid-sized room?Dave

Subject: Re: Sub placement
Posted by Wayne Parham on Wed, 22 Feb 2006 17:19:27 GMT
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That's a tough one, as best location is really room specific.  One thing I'd suggest is that you don't crossover the sub to the mains but allow them all to overlap.  This will provide multiple bass sources which will help smoooth room modes.

Subject: Re: Sub placement
Posted by akhilesh on Wed, 22 Feb 2006 21:56:22 GMT
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I keep mine asymmetrical, and close to mains. This eliminates accentuation of nulls on any one frequency. -akhilesh

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Subject: Re: Sub placement
Posted by Wayne Parham on Thu, 23 Feb 2006 14:44:13 GMT
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I think I'd put the sub where the mains and the room reflections combined to form the deepest cancellation notch.  Wherever that is, it's probably the best place to put the sub.

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Subject: We've discussed this before
Posted by Earl Geddes on Thu, 23 Feb 2006 16:38:19 GMT
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I did a simulation for a small room and one to several subs and looked at the frequency response and the spatial average.  Once one reached four subs the average was as good as it gets, and it made no difference where the subs were placed just so long as they wern't clustered together.  I also found in this study that at least one of the subs needs to be up off the floor.With three subs you could get a comparable quality, but placement became more critical.  One in a corner, one along a side wall and the last one 2/3 the way up to the ceiling along another side wall.  This worked pretty well.In this same study I allowed each of the woofers a totally independent amplitude and phase and let a computer find the "ideal" for each sub.  The most interesting thing was that if I took the three woofers and made the amplitude and phase at two of them completely random, I got about the same result as the complex adaptive one.  But think of the advantage.  The complex adaptive one has to be set for each room, but the random approach works the same in any room.I'll leave the concept of making a random filter as a task for the reader (Here is a hint: its called a decorrealtion filter).

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Subject: Re: Sub placement
Posted by akhilesh on Thu, 23 Feb 2006 16:54:10 GMT
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YEah, Wayne. Makes good sense.-akhilesh

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Subject: Re: We've discussed this before
Posted by Wayne Parham on Thu, 23 Feb 2006 17:07:03 GMT
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Welti suggests a handful of specific placements, four corners, four wall midpoints, etc. I know you propose random placement. I would expect the ideal locations to be room specific, with different wall ratios and features like entrances and halls lining up the standing wave nodes in different places. But I'm not sure random would necessarily stagger the nodes properly. I would guess some random placements would do it, but others might not. How can you be comfortable that random placement will always give the desired results? To be honest, I'm not sure that it does.

Subject: Re: We've discussed this before
Posted by Earl Geddes on Thu, 23 Feb 2006 17:53:51 GMT
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As I said with enough subs it doesn't matter where you put them.

Subject: Re: We've discussed this before
Posted by Wayne Parham on Thu, 23 Feb 2006 18:46:08 GMT
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I agree, with enough subs it doesn't matter where they go. In a sense, I suppose this is all academic if you use enough subs. It may be that two subs in addition to two woofers in the mains works pretty well. The more you add, the smoother response becomes. By the time you've reached three or four subs, you've reached a point of diminishing returns and it also becomes less relevant where they are placed.In Welti's study, several placement configurations were tested. A single sub was used and placed in various locations. Pairs and groups were also tested, with group sizes of 3, 4, 5 and even large groups like 10 or 20.The results were pretty clear, that the most uniform response was obtained with large random placement, subs in each corner or subs at the midpoint of each wall. The large random group placement was found to be good, but no better than the placement in each corner or at the midpoints of each wall.I think it is important to notice the large random placement had two unique features, one being the number of subs and the other being their random placement. In this case, I think the high number was more important than the placement because there was just so many of them.

Subject: Re: We've discussed this before
Posted by Earl Geddes on Thu, 23 Feb 2006 19:02:52 GMT

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In a space with modes all are connected.  In other words, unlike above the modal region, all points in the room are correlated and depend on what is happening at every other point.  This is why random works as well as it does.  Go random, it works better even for a small number of subs.

Subject: Re: We've discussed this before
Posted by Wayne Parham on Thu, 23 Feb 2006 19:46:05 GMT
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I understand what you are saying, and agree with you in principle.  But I ask again, how can you be sure that a random placement will produce the desired result in all cases?  I think everyone agrees that bass smoothing in a small room is accomplished with increased numbers of bass sound sources.  The question is where is the best place to put them.  Welti suggests a handful of specific placements, you seem to suggest rolling the dice.AES Preprints: AES 112th Convention, #5602

Subject: Re: We've discussed this before
Posted by Earl Geddes on Thu, 23 Feb 2006 20:00:41 GMT
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Its been a while since I read it, but as I recall a finite number of studies were done because it was mostly an experimental one, with a little simulation.  But what I remember was that he had missed some important configurations and the ones that I recommend were not among them.Maybe I should reread it, but as I've posted, I did my own studies and my results were not exctly the same as Todds.  I remeber rereading his to see how it was that we disagreed and found that he hadn't tested what I found to work best.  In other words he was drawing broad conclusions based on a limited investigation and my work did not cooberate his.If I get a chance I will run the four subs in corners against four radndom subs and I think that you will find that they are not much different. And then I'll run three subs at random and show that this is only marginally worse than the four corners, with one fewer sub.

Subject: Re: We've discussed this before
Posted by Wayne Parham on Thu, 23 Feb 2006 20:23:12 GMT
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The study indicates that random placement was good.  It also indicates that four corner placement

is equally good. Like you said, if there are a lot of subs involved, their placement matters less. But I am still concerned though about the "roll of the dice" issue. The decorrelation idea by random placement sounds good, but I can't help but wonder how many random placements happen to line up nodes in an undesirable way.

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Subject: Re: We've discussed this before
Posted by Earl Geddes on Thu, 23 Feb 2006 20:36:14 GMT
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As I said I cannot cooberate Welti's study, so that leaves me with some doubt. Its natural I guess to believe in your own study and doubt the other guys, but the fact remains that I did not get the same results he did. Todd and I did tend to agree on the random placement, but we did not tend to agree on the symmetric placement. So what has been cooberated is the random placement and, to me, what is in doubt are the symmetrical placements.

---

Subject: Re: We've discussed this before
Posted by Wayne Parham on Thu, 23 Feb 2006 21:02:33 GMT
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I hate to sound like a broken record, but how can you be comfortable that random placement always provides desirable results? How many tests have you setup and run?

---

Subject: You don't seem to listen
Posted by Earl Geddes on Thu, 23 Feb 2006 21:15:20 GMT
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My PhD thesis was on LF room modes. The Welti study was incomplete because it did not include the configurations that worked best. Any conclusions he drew were shortsighted at best.

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Subject: Re: You don't seem to listen
Posted by Wayne Parham on Thu, 23 Feb 2006 22:30:58 GMT
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I read your comments. And I respect and consider them. But the only data I see is from the Welti

study.  You have presented no other data to the contrary, just unsupported assertions and qualifications from your resume.Please don't take that as being said in a condesending tone.  It isn't mean that way.  But I do not see your data rising to the level of Welti's, in fact, I do not see any data from you at all.  What I would prefer to see, is a study of a large number of random setups that showed the energy distributions in each.  That way it could be determined how reliable this approach is over a number of different iterations, different rooms, different random setups, etc.

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Subject: Thanks for giving the Welti source
Posted by Duke on Fri, 24 Feb 2006 20:27:47 GMT
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I'm off to read it now.  By the way, I have enjoyed this exchange immensely.  If it weren't for the passionate and the stubborn, us in the peanut gallery wouldn't learn nearly as much. Duke

---

Subject: Re: Sub placement
Posted by Manualblock on Fri, 24 Feb 2006 21:29:10 GMT
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Can I ask why they in the Welti Study feel that summing all the sub-woofers is the most optimal implementation? Why do they considor stereo bass of no value?Just asking.I assume the original signal is recorded in stereo; is that right?

---

Subject: Re: Thanks for giving the Welti source
Posted by Wayne Parham on Fri, 24 Feb 2006 21:50:26 GMT
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The Welti paper documents an exhaustive study that compared many placements, some with few subs, others with a small group and even some with an impossibly large number of subs.  The room was measured from various locations, not just a preferred listening spot.  The goal was to determine what configurations resulted in the best uniformity throughout the room.A lot of time must have been spent getting all those measurements, with the numbers of subs, microphones and placement configurations involved.

---

Subject: Re: Sub placement

Posted by Wayne Parham on Fri, 24 Feb 2006 21:50:44 GMT
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The main thing the study searched for is placements that provide uniform coverage, i.e. reduction of nulls throughout the room.

Subject: decorrelation
Posted by Duke on Fri, 24 Feb 2006 22:18:50 GMT
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I guess the central question would be something like "what really matters regarding low frequency reproduction, and what's the best way to get it?"

Apparently one thing that matters is the sense of spaciousness that good low frequency reproduction can impart.

I just finished reading a paper entitled "Localization and Image Size Effects for Low Frequency Sound" (118th Convention, May 2005, paper number 6325) that does a little bit of exploration into decorrelated low frequencies. I'm not quite sure of their use of terms, but they're noting that low frequency energy increases the image size (sense of spaciousness, or width of soundstage?) and then studying the effects of single sub vs two subs correlated vs two subs uncorrelated using various corner placement arrangements.

From the data, it looks to me like if you're going to use a single sub in a corner, image size is best served by placing it in a corner behind the listening position.

Two subs almost always outperform one sub in image size, which is not surprising. With two subs, it looks like correlated slightly outperforms uncorrelated, and using the front two corners slightly outperforms using other corners. But in each of these cases the two subs are equidistant from the listener, so none of them really test Earl's proposition.

Another paper I read on the subject, presented by David Griesinger of Lexicon at the May 2005 "acoustical society" meeting in Vancouver, lends greater support to the desirability of decorrelation. From his concluding paragraph:

"Although widely held to be unnecessary or impossible, reproduction of envelopment [sense of large acoustic space] at low frequencies in small rooms can be achieved, particularly with a multi-channel sound system. Successful results depend upon: 1. Having an input recording that includes at least two channels where the reverberation is independently recorded, and thus uncorrelated with the other channels. 2. The presence of independently driven room modes that overlap in such a way that the lateral pressure gradient of one mode combines with the pressure of another. In the case of two channel stereo, the best results usually occur when an asymmetric lateral mode (driven by the difference signal between the loudspeakers) cerates a pressure gradient at the listening position, and a medial mode (usually a front/back mode) supplies the pressure. Ideally both modal systems should be broad enough in frequency that there is

substantial frequency overlap, as well as a spatial overlap. Such spatial and frequency overlaps occur in rectangular rooms of various dimensions, but are rare in rooms that are close to square in dimension. Putting the front speakers along the long wall of a small room can be helpful, as can a somewhat asymmetric speaker layout. In many rooms it can be helpful to place the low frequency drivers at the sides of the listening position rather than at the front of the room. Where high Q modes exist it is useful to damp the modes electronically by an inverse filter with precisely the same frequency and Q."

It sounds like Griesner is in favor of decorrelation and asymmetrical subwoofer placement, apparently preferring subwoofers located to the sides of the listening position. I don't think he considered using more than two subs, but I might have missed it as I skipped over some parts.

So the first paper considering only corner placements seemed to lean slightly in favor of correlated low frequencies, while the second which allowed asymmetrical placement anywhere in the room clearly favored uncorrelated bass with asymmetrical placement (though no data tables were given). In both case, I think they were trying to maximize the same quality - "image size" or "envelopment".

Do we trade off anything else that's desirable in pursuing "image size" or "envelopment" though decorrelation?

Duke
"Loudspeaker and listener positions for optimal low-frequency spatial reproduction in listening rooms"

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Subject: Re: Sub placement
Posted by Manualblock on Fri, 24 Feb 2006 22:21:37 GMT
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I see. But they did specify their bias for mono-bass irregardless of the studies purpose. I was just wondering if there is some consideration regarding that issue.I like the model of 5000 subwoofers in the room; no modes there; nosiree!

---

Subject: 5000 subwoofers
Posted by Duke on Sat, 25 Feb 2006 00:19:28 GMT
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Yes it looks like the 5000 subwoofer model is the "holy grail" as far as bass smoothness over a large listening area.I wonder if there's a better way to approximate the 5000 sub ideal than any of the positioning arrangements tried in the text. Specifically, the modelled and/or tested multi-subwoofer positions all had symmetry (sometimes diagonal), and decorrelation was not used.

---

Subject: Re: decorrelation
Posted by Earl Geddes on Sat, 25 Feb 2006 01:25:22 GMT
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DukeI was familiar with the Griesinger paper and I saw the other one but have not read it. I am not sure that the term "decorrelation" is always being used here to mean the same thing. Two sources can be uncorrelated without there signals be decorrelated.Let me read that other paper and get back on this topic.Although it may not be here since I am getting a little annoyed at all my work being discounted.

Subject: Re: 5000 subwoofers
Posted by Manualblock on Sat, 25 Feb 2006 01:36:32 GMT
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Here is a very good study done on the integration of multiple subwoofers and the title is:
The Spatial Auditory Display Using Multiple Subwoofers in Two Different Reproduction Environments. They address the correlation and decorrelation effects through extensive testing. Let me see if I can get the link; it cleared up a lot of this for me although it is very technical.
The Spatial Auditory Display Using Multiple Subwoofers in Two Different Reproduction Environments

Subject: the more I know, the more I don't know
Posted by Duke on Sat, 25 Feb 2006 01:50:53 GMT
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I didn't even realize that "uncorrelated" and "decorrelated" mean two different things.The world just keeps getting bigger and bigger. Does it ever reach a point where it starts getting smaller again?

Subject: Re: the more I know, the more I don't know
Posted by Earl Geddes on Sat, 25 Feb 2006 03:10:22 GMT
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Well I don't want you thinking that either. I'm just saying that the authors could mean different things.Two sources can be SPATIALLY uncorrelated yet have correlated signals applied to them. And they can have uncorrelated signal - ie. time domain and yet be spatially correlated. Mathematically the term correlation means the same thing, but its applied differently and has different implications.Its hard to explain this without getting into a lot of math - you know five out of four kind of thing.

Subject: Re: 5000 subwoofers
Posted by Duke on Mon, 27 Feb 2006 01:14:46 GMT
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Thanks for posting the link. I just got around to reading it, and a lot went over my head but it sounds to me like the author found that placing the two subs to either side of the listening position was better than placing one in front of and one behind the listening position because the ear could derive spatial information better from laterally placed subs. At some time in the future I'll have to try that lateral sub placement; for the moment it's not possible in the room that I'm using because of a doorway and a large propane heater. Duke

Subject: Re: 5000 subwoofers
Posted by Manualblock on Mon, 27 Feb 2006 12:38:06 GMT
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The study had a lot to say about decorrelation regarding your interest so I thought I'd post it. Not being trained in acoustics I have only a rudimentary understanding of exactly what these terms mean but a good bit of this particular study came through. I have to say that I like university funded studies if only for the reason that they are more independant. While commercially funded studies of course must still provide the data and methodology; we all know how these things can be subtley tweaked towards a finding commiserate with the philosophy of the commercial entity.But yes; they absolutely said the Front to Back is a no-no.

Subject: Room energy distribution
Posted by Wayne Parham on Wed, 01 Mar 2006 19:59:32 GMT
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Please don't take offense, Earl. Your work is not being discounted, not in the least. Let me try to phrase this differently.My problem with random placement is that it is, well, random. I do not see how you can assert with any confidence that a random placement is better than an ordered placement. You can say that a random group arrangement will smooth the sound field by averaging, but that can be said of an ordered array too. In general, the more sources the better, whether random or ordered. But the question remains, where are the best places to put the subs. I am not convinced that a random arrangement is best.What I'd like to see are 3D energy distribution plots of each of a handful of test setups. Not just the average and deviation, and not just the plot of a single position or small area in the center of the room. I'd like to see energy distribution charts of the whole room, showing various room sizes and speaker placement configurations. So far, Welti has provided the most data. Perhaps his study is incomplete, but that has yet to be seen.

Subject: you know Earl...
Posted by PakProtector on Sun, 05 Mar 2006 01:25:44 GMT
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all this discusion regarding your theory would be a whole lot different if everybody who actually heard your wares had a high opinion of them.cheers,Douglas

Subject: Re: Sub placement
Posted by Earl Geddes on Mon, 20 Mar 2006 01:27:24 GMT
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Some years back, at Ford, we measured the LF signals for about 100 CD's. I believe that every one of them, or at least virtually every one, had mono LF signals. There is simply no way to distinguish between a mono LF signal and a stereo one so why not have multiple speakers share the LF load. Now if the audio producers figured out the advantage of a decorrelated stero LF signal things might be different, but then when summed to mono, the signal would be degraded.No, the right thing to do is to send a mono LF signal, and then decorrelate this signal between several sources on playback. That way there is no degradation in the case of a single sub.

Subject: Re: 5000 subwoofers
Posted by Earl Geddes on Mon, 20 Mar 2006 01:39:12 GMT
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Thanks for that posting. I have not read the report thouroughly, but it looks interesting.I did read enough to know that you should be carefull in interpretation of these results. Thats because they generated ideal signals that were correlated and uncorrelated and we cannot do that with real sources like CDs.There was no discussion of "preference" only "audibility". So it cannot be concluded, per se, that they would recommend front to back or side to side placement, only that there is a possibility that they will sound different.