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Subject: Thoughts on focused arrays and the phase problem  
Posted by [Dave Peterschmidt](#) on Tue, 15 Feb 2005 05:25:50 GMT  
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I've been kicking around the idea of designing a large line array speaker which would be essentially a floor to ceiling array. I've been doing some research along these lines, and recent ran across Jim Griffin's white paper. Excellent document! I'd like to thank Jim for his hard work that benefits so many here. Ok, to the business at hand. Since my desire is to build a tall array, it will need a way of dealing with the phase differences between the ends of the array and the middle, as outlined in the white paper. My current thinking is that some kind of focused array would be the best solution to this. However, what I had in mind differs a little from a normal concave curved front baffle. I have in mind what I call a "stepped" baffle. Basically all drivers would be oriented perpendicular to the floor as in a normal flat baffle, however, in a stepped baffle, each driver would be stepped forward a small amount as you move toward the ends of the array. This might be better than a typical focused array since the drivers at the ends of the array won't be facing the focus point directly, maintaining the cylindrical sound front better. At least that's my speculation. To understand my thinking on the reason the stepped baffle would be better than a flat baffle with power tapering, let's consider a flat baffle. This baffle can be thought of as being focused on infinity. Let's assume we have a listener whose head is positioned level with the middle of the array. The closer the listener gets to the speaker, the more pronounced the phase difference between the middle driver and the end drivers becomes. For example, if the listener is one foot from the middle driver, he would be about four feet away from the top and bottom drivers of an 8 foot tall array. A large difference. As he moves away, the distance discrepancy goes to zero as we move toward infinity. So, in short, what we have effectively is an array that would sound more phase-coherent the farther away we get, and wouldn't be optimal phase-wise until we reach infinity. This doesn't seem to be the best approach to use in practice. Let's say we step the drivers outward from the middle to the ends. Each driver sits, say, 1/4 inch forward of the one just below it (or above if we're looking at the bottom half of the array). (Note that I just picked that quarter-inch number out of the air for discussion purposes). If our array consists of 21 drivers, the top and bottom drivers would sit 2.5 inches forward of the middle driver. Now as our listener moves away from the speaker, there will be a spot somewhere before we reach infinity where the phase is close to perfect, as well as a band of area around that perfect spot where the phase is very close to perfect. Since the "optimal" listening distance band is now in the room instead of at infinity, it seems to me that the sound would, on the whole, be more coherent with this approach over most of the listening area. Not a perfect solution, for sure, but an improvement over most of the normal listening area. Obviously the step distance would vary depending on design goals and such, but it seems like some step would be preferable to a flat baffle. This would also allow the use of full power vs a power-tapered array with something less than full power. I'd love to hear anyone's thoughts on this. Is there a flaw in my thinking?

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Subject: Re: Thoughts on focused arrays and the phase problem  
Posted by [Jim Griffin](#) on Tue, 15 Feb 2005 19:25:55 GMT  
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Dave,I'll take exception to your proposed design. A curved array is not necessary if your line array operates in the near field. Line arrays that are sometimes curved to yield good sound to a wider audience. Pro sound arrays use a J shaped curving to establish the close listeners in the near field and then fire the far field over their heads to the cheap seats in the balcony. Hence, the goal for the J curve is to broaden the dispersion to the audience. The line array curving that you suggest is a concave shape that limits the effectiveness of a near field line array. With this approach you severely limit the sweet spot area. Such a design will localize the listener at the focal point of the line curvature for proper sound. No where else in the room will the sound be correctly focused or balanced. My solution is to design the line array or source with a flat baffle but place the listener in the near field of the sound. My white paper describes the criteria for near field operation of a line array. In the near field the sound radiates outward from the source parallel to the planes of the ceiling and floor. Thus, little sound energy impringes off of the ceiling or the floor. Effectively, the listener will hear only the sound localized in the horizontal plane wherein he is listening. You can do deep knee bends or stand on your tip-toes and you'll hear the same sound--the vertical coherent wavefront extends from the bottom of the array to the top of its active radiating area. Hence, once you have established a near field situation for the listening area, then you have no need to worry about the various distances from the drivers in the array to the listener. Take a look at Figure 2 in my white paper and you'll understand that the coherent sound front travels for a near field array. The sound doesn't overlap so you need not worry about different sound paths from the top and bottom of the array. Finally, you need to understand that our ears accurately locate sound direction in the horizontal plane because the shadowing of the head helps to discern direction. In the vertical plane sound localization is less accurate because our ears are in the same plane. The Haas effect also comes to contribute to minimize smearing. Bottom line is that curving the front baffle isn't needed for near field listening. The sound will be correctly balanced for sound staging and imaging throughout the listening room wherein the near field exists. You can listen close to the sources or farther away and still hear great sound. A slight power taper may help balance the in-room power response from the ends of the array.Jim

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Subject: Re: Thoughts on focused arrays and the phase problem  
Posted by [Dave Peterschmidt](#) on Tue, 15 Feb 2005 20:26:51 GMT  
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Jim,Thanks for responding, and again, many thanks for your excellent white paper. What you're saying makes sense to me, especially the vertical plane sound localization problems the human ear has. I do think a stepped baffle would be an interesting aspect of arrays to play around with, though. I find myself disagreeing with you a bit on the aspect of "focusing" the sound as tightly as you describe, at least with my "stepped" baffle idea as opposed to a true concave baffle. I can understand how a true concave baffle would orient the outer drivers inward toward the middle of the array and result in a tightly focused sweet spot. But I'm having trouble seeing how that effect would be created by my "stepped" baffle concept where the drivers are still oriented vertically on the baffle. Instead of a sweet-spot focusing effect, what I'm thinking you'd get would be a normal cylindrical wavefront as with a flat baffle, but with a slight reduction in the amount of smearing over entire nearfield listening area due to slightly improved phase coherency among all the drivers. Of course, in practice it may be that this effect isn't even noticeable. Or I might be completely out in left field and not even close to reality. I'm just thinking out loud here...

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Jim Griffin](#) on Tue, 15 Feb 2005 20:46:22 GMT

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Dave, You can do whatever you wish on this subject but I think that a stepped baffle isn't necessary. My reply was more directed toward a focused baffle than what you are suggesting. But I'm pointing out that it isn't necessary to step the baffle and in fact might lead to lower sound quality as you disturb the wavefront. I'm not buying the sound smearing issue that you raised as I believe that you don't have it in the vertical axis near field as I wrote in my earlier reply. Jim

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Dave Peterschmidt](#) on Tue, 15 Feb 2005 21:01:47 GMT

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Jim, Disturbing the wavefront was my concern as well. Without an array wavefront simulator of some kind it's hard to imagine all the wave interactions in my head. I plan to get some drivers in the near future and play with some cabinet mockups and we'll see what happens. I'm sure you're right, but I have this curiosity inside me to try out a stepped baffle and see what it sounds like. Maybe I'll get ambitious enough to do that someday. By the way, do you have any thoughts on how the new CSS WR125ST would work in an array? I'd like to build using high-quality components to get a very high performing speaker, and have my eye on the 16-ohm version of this driver, to be paired up with an array of either BG Neo3 or Fountek JP-2 tweeters. The link for the CSS driver is: [http://www.diycable.com/main/product\\_info.php?products\\_id=533](http://www.diycable.com/main/product_info.php?products_id=533) Thanks, Dave

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Jim Griffin](#) on Tue, 15 Feb 2005 21:45:12 GMT

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Dave, I like the looks of the CSS WR125S and ST drivers. The initial reports from others are favorable. Al Wooley and CSS have demo'ed some line array models (with the WR125 drivers) and I suspect that they will be sold as kits in the near future. Most initial reports on sound quality that I have read on these designs have been mixed though but I would guess improvements are underway. The Fountek NeoCd2.0 ribbon (replaces the JP-2 version) would work great in a line array. I'm not a Neo 3 nor Neo 8 fan. Jim

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Dave Peterschmidt](#) on Wed, 16 Feb 2005 01:23:49 GMT

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Thanks Jim. What were some of the weaknesses reported on the WR125ST? I've only heard some very preliminary reports from users listening to single drivers who reported excellent dynamics and sound quality. Are you saying the drivers themselves need improvements or the speaker designs need improvement? Also, what don't you like about the Neo3? I've never heard it, but it looks like it has a nice flat response out to 20khz and I've read sparkling reviews of the Epiphany arrays using it. I do like the Founteks, although an array of them would be a little more pricey than a Neo3 array by my calcs.

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Jim Griffin](#) on Wed, 16 Feb 2005 02:04:08 GMT

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Dave, No issue with single driver, MT, etc. on the WR125 designs--all glowing reports. The line array designs with the WR125's were early models just after availability of the drivers and thus had not apparently reached enough design maturity, I suspect. Again, I'm reporting what I read on the web and not personal listening experiences. On the Fountek 2.0 version it offers inherent length and minimizes the gaps which would result if you used Neo 3's in a line. Jim

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [jdybnis](#) on Wed, 16 Feb 2005 06:39:31 GMT

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Here are a couple of thoughts...In the frequency range where drivers operate in a nearfield line array, they are omnidirectional. So the angle of the driver will not make a difference. However the driver will interact with the baffle edges, the steps will make a difference there. On a large flat baffle a driver's wavefront is a coherent semi-sphere. When the wavefront encounters an edge of the baffle it diffracts causing interference. This should be taken into account when designing any speaker. On a stepped baffle it will be more significant than a simple box. There will be interference above and below each driver, not only from the adjacent edges but also from the edges further away from each driver.

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Dave Peterschmidt](#) on Wed, 16 Feb 2005 14:14:45 GMT

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Jim, thanks for your thoughts and insights. Much appreciated! Have you ever used a line array in a home theater setup? If so, do you have any thoughts on what kind of form a matching center

might take, preferably one that sits horizontally? Simply tipping an array on its side would defeat the controlled vertical dispersion of the array that's desirable in a theater speaker.

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Subject: Re: Thoughts on focused arrays and the phase problem  
Posted by [Dave Peterschmidt](#) on Wed, 16 Feb 2005 14:22:50 GMT  
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Good observation. I hadn't thought of that. I suppose one could bevel the lower edges of the steps to remove the edges, but there might still be some effect. Something to think about, for sure.

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Subject: the interference field?  
Posted by [lcholke](#) on Wed, 16 Feb 2005 19:35:05 GMT  
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Button in his paper argues that the high frequencies are attenuated due to interference in the near field. I would think this would be eliminated with a focused array. This could be a new thread topic on this board. I would mount the drivers on axis to the listening point to get the most benefit of the drivers designed flat on axis  
response.<http://www.jblpro.com/vertec1/doug%20button%20258%20final%20rev%20c.pdf>-Linc  
<http://www.jblpro.com/vertec1/doug%20button%20258%20final%20rev%20c.pdf>

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Subject: Re: the interference field?  
Posted by [Dave Peterschmidt](#) on Wed, 16 Feb 2005 20:09:19 GMT  
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So the attenuation would be caused by wave cancellation as the phase discrepancy approached the wavelength of the sound, is that the idea? That should be a measurable phenomenon, as should your proposed fix.

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Subject: Re: the interference field?  
Posted by [lcholke](#) on Thu, 17 Feb 2005 03:36:00 GMT  
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I think most people want a large "sweet spot" for their sound system so the focused array is not their design of choice. Pro sound needs to have every seat in the house be a good seat. So not many people have a need to measure the focused array performance. Measuring my system is on my list of audio things to do. I have a 16 nsb focused array. The flat array phase shift always made me hesitant to build one. I am thinking of making a straight 16 to see how the sound will be different. I heard Jim's needles and they seemed to have a similar sound. I think it is the nearfield effect that I like. Jim gave a short talk and he pointed out the different way the nearfield sound field produced from an array sounds compared to a point source. -Linc

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Paul Anton](#) on Thu, 24 Feb 2005 03:09:27 GMT

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Jim, I have also read the initial reveiws on the css wr125s driver.The arrays you mention ,I assume, are the Lambda and Omega LS kits on the CSS site. I have not found any reveiws on these models as of yet. Where did you find these "initial reports"?Thanks,Paul

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Subject: Re: Thoughts on focused arrays and the phase problem

Posted by [Jim Griffin](#) on Thu, 24 Feb 2005 03:51:23 GMT

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Paul,On the DIYaudio site you can checkout Dave D.'s (Planet 10) comments in the Loudspeaker thread on the Northwest DIY event in Vancouver last fall. One thread reference is:  
<http://www.diyaudio.com/forums/showthread.php?s=&threadid=45268&perpage=10&pagenumber=3>See post #24.Dave also had a post on this area last week on the same subject. See <http://www.diyaudio.com/forums/showthread.php?s=&threadid=51613&perpage=10&highlight=wr125&pagenumber=4>Post #32.That will get you going. Likely you can find others by searching.Jim

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