VIEW POINT

Loudspeaker Misconceptions

A different view...

By Bennett Prescott

There is a lot of misinformation floating about regarding the benefits and detriments of line array and point source loudspeaker technology. For reasons unclear to me, the industry seems to be split down the middle with dogmatic "traditionalists" on one side, "new-fangled" line source users on the other, and the seemingly few of us who just use whichever is most applicable and don't worry about it – stuck in the middle. Neither technology needs defending, neither technology is inherently superior at all tasks, and to be honest there isn't that much difference at a base level between the two anyway. Most of the ammunition used by either side seems to be from examples of poor design or poor application, neither fault having anything to do with the concepts involved. Physics is physics. Both models must adhere to it, and with a little bit of compromise thrown in due to real world limitations both models can create one hell of a loudspeaker system. It is our job as professionals to look past the marketing, forget what we think we've learned about how things should be, and bring it back to the basics: the physics of good design, and the right application.

I'm going to start off by eliminating three myths that have encumbered this "debate" for some time.

Number One: No loudspeaker array is a point source. Sure, a single loudspeaker can approximate a point source pretty well (most of them don't), but once you build an array of those you've got nothing of the sort, especially if you don't build that array correctly, i.e. with no pattern overlap between sources more than 1/4 wavelength apart. Just look at it and do the math: if you have four, 60-degree horizontal enclosures covering less than 240 degrees of audience area, you don't have a point source anymore. Furthermore, even if you set your loudspeakers up properly, you don't have a point source at the intersections of their patterns where, by definition, a listener hears the output of more than one driver. Better designs handle this better, but this is the bête noir of arraying point source loudspeakers.

Number Two: No line array is a line source. It is so wildly impractical to build and deploy a true (wide bandwidth) line source in the real world that I'm almost positive nobody has ever done it. A true line source has to be infinitely long, with all radiating elements within 1/4 wavelength of each other. This is impossible outdoors, and impractical in (where one may stack elements between two boundaries and emulate an infinite line). Modern line arrays behave enough like a line source to be very useful, depending on how long the array is (I look at 10 feet as a minimum hang length) and how well the manufacturer has dealt with getting the higher frequencies to behave like a line (where it's very hard to get sources within 1/4 wavelength of each other).

Number Three: Line arrays do not create cylindrical wavefronts. This sort of behavior is impossible as we understand linear acoustics. What appears to be a cylindrical wavefront is the result of a large number of spherical wavefronts intersecting (see **Figure 1**). Cylindrical wavefronts are possible in other disciplines, such as shallow water waves (which are non-linear and do not pass through each other undisturbed), but not in ours until the sort of extreme SPL that we don't see out of any normal loudspeaker. Cylindrical wavefronts are also be possible in antennas, but again that has little to do with us. The reasons why not, and the reasons it doesn't matter, are well beyond the scope of this article.

In any case, let's not let what these loudspeakers should be on paper get in the way of what they can be in the real world. Obviously there is plenty of utility behind both approaches, or we wouldn't be using them.

What line arrays are good at is coherent output at a distance. When used properly a line array is a powerful tool for offering smooth coverage between the farthest seats and the nearest seats, with even frequency response and little front to back SPL variation. Unlike "traditional" point source loudspeakers, where you're limited to the output of your loudest enclosure, if you need more output from a line array... hang more boxes! This means that that a company can have only one kind of line array in inventory and bring however many boxes they need for the show. Ideally, everyone would always put way more speakers in the air than they actually need for SPL because the additional low frequency pattern control is a big deal and the additional boxes mean you can have more vertical coverage, but there are practical limitations. A long line means a high hang (which means expensive towers), and more boxes missing from inventory that could have been used on other shows. Fortunately, "reasonably" long line arrays have shown themselves to be plenty effective, with some caveats. Like any professional product, it takes both a good box and a good system engineer to get everything to work properly.

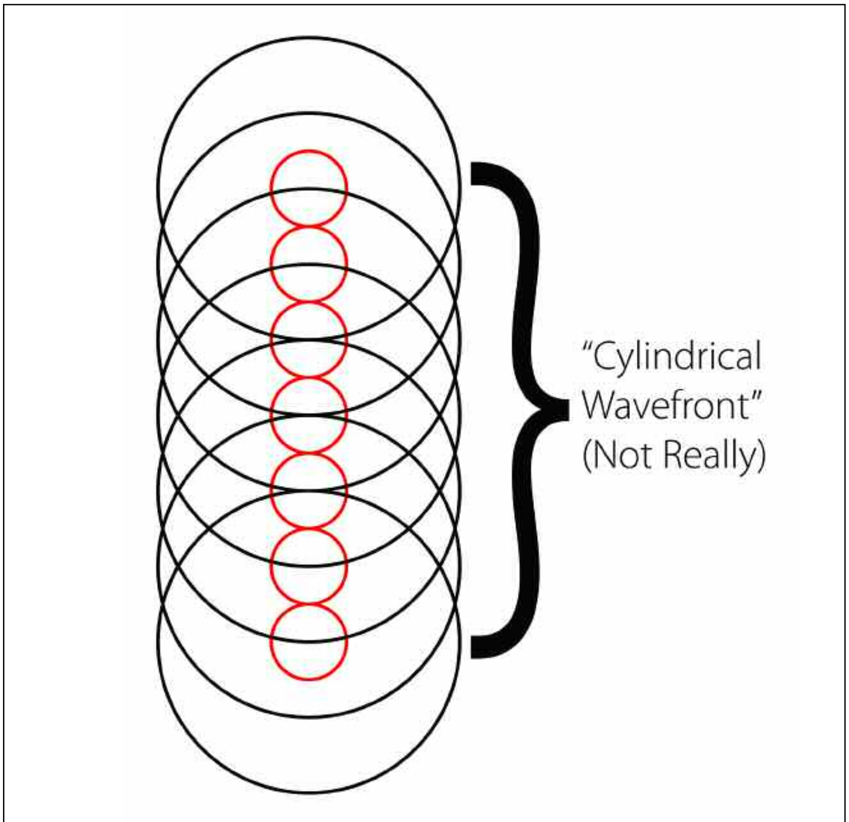

Figure 1

An important point to remember is that all line arrays are not created equal. Just as all trapezoidal "point source" enclosures are not designed with the same goals in mind, a line array has to be designed with an idea of its use in mind as well. It's a trade-off between coverage and throw. A line array with a very narrow vertical pattern (say, 5 degrees) can throw a long way… usually longer than is even practical because at a certain point atmospheric interference necessitates delay towers... The array can get the sound out there, but the slightest wind will blow it all over the place. That narrow pattern is a detriment up close, because if you have a 5-degree vertical box the most inter-box angle you can practically use without separating your coverage patterns (read: weird HF issues) is about 3-4 degrees. If you need 30 degrees of coverage, that means you need at least 8 boxes in the air just to hit all the seats, and you'll really need more than that to keep your frequency response and SPL even (more boxes pointed at the farther seats).

The antithesis of this is a line array with relatively wide vertical coverage (say, 15 degrees). These loudspeakers blur the line between "vertically arrayable point source" and "line array." The trade off is that their output at a distance is significantly reduced and they won't behave as well when arrayed flat, but they can offer a smooth response with much more extreme angles between boxes up close. They still behave like a line array, so there is coherent summation that creates an SPL increase when using multiple boxes, but you can hang just a few of them and not have a sonic mess on your hands.

Where line arrays fail is in situations where there needs to be extreme coverage variability (either horizontal or vertical), where audiences are going to be within a few array lengths (I don't like to let anyone hear a line array any closer than two array lengths), or where the array is very low (read: ground stacked) and needs to cover both near and far with only a few degrees of vertical angle to do it in. These are all situations where a point source loudspeaker system should either be the main PA, or significantly supplementing a line array for the nearer seats. Any line array deployment can benefit from support by decent point source boxes in the near field, and it is often convenient to do side and out fills with them too.

Point source "trapezoidal" or "trap" loudspeakers are good at all the things that line arrays are bad at. They sound fine up close, you can use them in essentially any configuration you want, you can use just one of them or you can use several, and they work OK at head height. They're not perfect, however, the very effects that make line arrays work are a detriment to large point source arrays. When using larger number of boxes the high frequency coverage pattern widens because of inter-box aiming, but mid frequencies and low frequencies actually narrow due to array effects. Essentially, the physical size of a point source array relative to the frequencies being reproduced creates a horizontal line array… if the array is also tall there is an additional line array effect in the vertical domain. The end result is a teardrop like pattern that can easily be significantly narrower than the pattern at high frequencies, and at low enough frequencies the output of the array will be essentially omni-directional.

That is not to say that traps cannot do what a line array can do, it's just that most companies do not have the breadth of inventory to make it happen. You need a large number of large boxes for near, mid, and far throw, with very high output (especially in the high frequencies, to make up for air loss) boxes for the latter. You need a rigging system that allows splay in two dimensions, and is variable enough to allow you to deploy four boxes a side, or 24. Doing it wrong means you no longer have a much coveted "perfect point source array". For many companies it has proven much simpler to deal with the imperfections in the complex summation of a line array than with the complications in the complex deployment of a large trap rig.

If you take one thing away from this article, it should be that high output PA technology is always a compromise. There's nothing wrong with that, but it is important to recognize where the compromises are being made and how they affect your final result. Without being able to tie the compromises that were made to develop the product you're using to the compromises you made in deploying it, you have no way to understand why the compromises in your final sound quality exist. We can't always do everything exactly right (actually, I think I've never been 100% satisfied), but by digging back to the source of our frustration we can better understand how to solve it in the future, instead of dismissing a product or an entire type of product as being unsatisfactory. That's not to say there aren't plenty of crap products out there, but understanding the physics behind loudspeaker design will help you weed them out too. Good loudspeakers are only one small part of the equation, you as a good system engineer can make the biggest difference by understanding how many of which products to use, and by deploying them properly. May the sound be with you! ■

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