SECTION: Rat Tales
HEAD: Line Arrays
DECK: Fad or future?
PULL QUOTE: yes, at end
WORD COUNT:
BIO: yes, at end
PHOTOS: to come
CAPTIONS: in text near to where image should appear

By Dave Rat

I am asked a lot of sound questions. Many are aimed at unraveling and understanding some particular function, feature or concept, while others are directed toward distilling my opinion on methods or industry trends. A while ago I was asked some questions that starting me pondering a particular subject in depth "Why are line arrays so popular? Do you think they are a fad or here to stay? What do you think will be the next big thing?" As I so often do, I began rolling the questions over in my mind in an attempt to construct a clear and understandable answer based on my real world experiences, observations and research. The fact is that line array type systems have taken over the professional sound reinforcement industry by storm. Nearly every manufacturer offers several line array choices, and of the two well known manufacturers that I am aware of that do not offer them in their product line, both have been forced to take defensive vocal positions justifying why they do not. What is it about line arrays that have positioned them to so completely dominate the industry? Is it just a gimmick or is there truly some aspect of the vertical configuration that offers an inherent advantage over other system types? Stepping back and taking good long look, I found that there are several properties these thinner line systems possess that are readily apparent plus one substantial advantage in particular that is not so obvious at first but perhaps the most important of all. So let's start see what it is about the line array that has positioned it to steam roll over just about every other array type in the professional sound reinforcement industry.

Just to keep thing interesting and hopefully clear, I am going to examine the basics of sound system design from a slightly different angle than perhaps is common. Let's divide the modern day sound systems offered by manufacturers into two categories based on how the system's deal with the listening area. First, the conventional and intuitively logical approach is to deal with a large acoustic space as a multitude of smaller zones. To cover the area with sound, one would construct a cluster of loudspeakers and aim each one at a particular region or zone. Each loudspeaker box can then be EQ'ed and volume-adjusted to provide proper sound for the humans in its coverage area. I will refer to this approach as 'zonal.' With this type of system configuration, in order to maintain clarity and intelligibility, it is advantageous to minimize the overlaps between the box-to-box coverage patterns. The goal and challenge for the system designers and technicians setting up the system is to try to achieve seamless sonic transitions from zone to zone. In order to accomplish smooth and seamless coverage, the system would be constructed such that the listeners would not be exposed to sound emanating from boxes that are in close physical proximity to each other, yet different distances from the listener. More simply put, sound from multiple sources arriving to the ear at differing times = not so good. When dealing with projecting sound over varying distances some issues arise. The coverage area of each box increases in size with distance meaning the angles between boxes pointed far away should be increased but since the volume naturally drops with distance it means that to maintain volume at distance, you would want to decrease the angles between the boxes to point more loudspeakers at each far away zone. Typically zonal coverage systems will employ a long throw narrow dispersion cabinet to help counteract this issue.

The second popular reinforcement approach utilized to cover larger-ish acoustic spaces with loudspeaker arrays I will call summed. Summed coverage is the attempt to get the outputs of multiple loudspeakers to add together and act as a single larger loudspeaker source. The coverage pattern of this giant loudspeaker would then be adjusted to cover the venue by varying the angles between the individual boxes to optimize the coverage pattern. The big challenge with the summed approach is optimizing cooperation between the various loudspeakers, this is generally achieved physically aligning the loudspeakers very close together in order to minimize them acting as separate sources. Subwoofer arrays are almost always act as summed array.

A common goal of well-designed versions of both approaches is to avoid is having a listener hear two acoustically "separate" sources that are in close proximity to each other that are also not equidistant from the listener. Why, you may ask? Well, mainly because non-equidistant sound sources reproducing the same signal creates comb filtering issues that reduce output levels, messes up the frequency response and most importantly, does not sound so good to our ears.

I will give a few examples of  some systems and my observations on the design approach behind their creation. Nexo's Alpha system, Electro-Voice's X-Array and Turbosound's Flashlight and Aspect systems are all excellent examples of zonal systems. Much effort was put into these designs in order to achieve distinct and consistent vertical and horizontal coverage projected from each individual box. The building blocks for these zonal systems is typically utilizing a relatively few loudspeakers in each box that are mounted on some sort of horn to assist with pattern control.

The summed-output system approach, until recently, was considerably less wide spread with some examples being the Clair Bros S-4 system, the Rat Trap 5 and to some degree perhaps the Showco Prism systems. (*The actual components and configuration of Showco's Prism system is kept "secret," so it is my opinion, based on mixing on the system and its sonic characteristics that lead me to believe that it is based on a summed-output type design.)* These systems tended to rely on boxes with quite a few loudspeakers in each box placed in relatively close proximity to each other allowing them to unify their outputs. A major issue with these systems results from the physical spaces between the loudspeakers themselves which can cause the components to act as multiple sound sources creating box-to-box overlaps and comb filtering and inconsistencies in coverage patterns.

Sound, like everything else in life is never black and white and exists only in varying levels of gray and the reality is that practically all real-world concert sound systems exhibit varying degrees of both approaches with the low frequencies tending toward summed and the high frequencies tending toward zoned. The techniques that sound system designers implement to push the various sound system designs toward zoned or summed coverage patterns and at what frequency that transition occurs is a key factor in the clarity, coverage consistency and versatility of the system created.

Caption:
A Rat Trap 5 in summed config (have pic), Clair S-4 in summed config (I have a medium res photo of it from U2 Pop mart tour I took) and a Showco Prism (needs to be located if you want to use it).

One offshoot of the summed array approach is the line array. Line arrays are not new, the old Shure Vocal Master with a stack of 10-inch loudspeakers inside is an old example. Take a close look at a Clair S-4 and you can see that the 18- and 10-inch loudspeakers form vertical line arrays when stacked. The Rat Trap 5’s also could be configured in a line type array and check out the Grateful Dead's Wall of Sound, which had vertical line arrays for nearly every instrument. Depending on the system design and configuration, the speaker outputs were summed up through the midrange frequencies.

Rat Trap in line array config (have pic), Clair Bros.' S-4 in line array config, Shure's Vocal Master (need pic), and the Wall of Sound (I have low res pics, may need permission).

So up through the mid 1990's, the high frequencies of all large-scale pro audio systems behaved as a zoned system while the low frequencies behaved in a summed manner with the major difference between the two approaches being the quality of the zoning or summing realized and the frequency that the transition from summed to zoned, occurred. The designers of zoned coverage type systems aimed for a lower transition frequency and summed systems designers aimed for a higher frequency.

Then along comes a sound system design by L'Acoustics called V-Dosc that, for the first time on a major scale, employs a fully summed-output approach that effectively incorporates the high frequency components in the summing. For the first time a unified design approach now existed where system designers were able to either eliminate the transition from summed to zoned or push it to such a high frequency that it was relatively insignificant.

So getting back to the original question, "Are line arrays truly better and here to stay or just the latest fad?" Let's take a look at couple of things that make well-designed line arrays interesting, useful and unique. I have heard it described in different ways, and even read various manufacturers doing press releases of arguing about who describes it accurately. For all practical purposes though, they are all saying pretty much the same thing which is; a quality designed line array system offers improved volume level consistency vs. distance over a zonal type coverage system. Now, whether you prefer to envision it in the "cylindrical waveform" description offered by some folks or you just think of it of "as you get farther away the sound gets quieter, but since there are more loudspeakers pointed at you, the volume drop with distance is somewhat counteracted." The fact remains that a line array system can be set up to project sound over shorter or longer distances merely by altering the vertical angles between the boxes.

A practical feature that the slender line systems offer is that their narrow profile is quite easily intermingled with the exceedingly popular video walls and set pieces. Most people want to see, and what most people want to see is not the sound system, except for a few of us, and having the ability to slide a large scale system into the small gap strong asset. The relatively simple two dimensional rigging that only deals with vertical adjustments not only allows for a high degree of predictability, it also is fairly easy to get and typically requires less motor points for rigging in most venues. The fact that line arrays are simple, practical and predictable, gives them a real-world implementation advantage over systems the require multiple precisely-spaced motor points to provide proper venue coverage.

But you know what? Even with all those useful assets, none of them truly give line arrays a hands-down advantage. Zonal systems can deal with volume consistency over distance issues by implementing long-throw boxes and utilizing volume shading to compensate and project louder sound to the far away areas. Compact high volume zonal systems can be incorporated into well thought out set designs, and even flown behind new modern video walls that allow sound to pass through. Well-designed rigging systems that allow zonal PAs to be flown, rotated and adjusted, and perhaps someday even remotely, are either in existence or not far off. Additionally, the generations of cardioid subwoofers are offering advances in low frequency zonal coverage. Finally, sonic prediction software is not unique to line arrays and the playing field between the two design theories is fairly even from a technical standpoint.

So all in all it should be fairly balanced with both concepts propagating and it should be just a matter of preference and venue logistics, except for one thing that it has absolutely nothing to do with the sound system or the quality of design. That thing is all of us. We just happen to be humans, and like many critters that run around this planet, we have ears, and also like many critters, our ears are on the sides of our heads. The physical placement of our

biological hearing devices provides us an extremely accurate high resolution ability to discern the precise horizontal positioning of sound sources while only offering a low resolution approximation of the vertical positioning. Does it not make sense that a two-legged walker of a human would require an increased sensitivity in auditory perception in the horizontal plane where most food to hunt for and predators hunting us would exist? Even our necks are designed with a limited vertical range of motion and a much wider horizontal rotation. At any given moment we are turning our heads or bodies, scanning the horizontal auditory plane. We enjoy things in stereo. We place the stereo loudspeakers spaced apart horizontally to maximize the effect. Have you ever seen heard or wondered why stereo loudspeakers are not placed vertically? In some apartments and houses it would make sense logistically. Unfortunately for the apartment dwellers our ears find horizontally spaced sound sources pleasing and complex while we have more difficulty discerning vertically spaced sources. Is it true? Try it and listen.

Have you ever tried to stack a line array on its side? It is quite interesting, and I am confident that you will find that it typically offers less enjoyable sound. For those of you pondering in your mind the horizontally array-able products, take a close look at the manufacturers offerings and you will find that there are strict fixed angles between boxes when horizontally arrayed that minimizes overlaps in HF coverage that are set to seamlessly merge the coverage patterns. Hey, wait a minute… isn't that a zonal system? Exactly!

So here is the deal as I see it. With current loudspeaker technology it is necessary to utilize multiple loudspeakers in order to cover a large venues, as no one makes a single loudspeaker that is loud enough, sounds great and is versatile enough to cover tens of thousands of people in a wide range of venues. These multiple loudspeakers need to be arranged in some sort of configuration vertically, horizontally, both or even one behind the other. Currently, we can get loudspeakers to sum together quite well but not perfectly. We can also get them to zone together quite well but not perfectly. Our ears are very sensitive to those imperfections in the horizontal domain and our ears are considerably less sensitive to those same imperfections in the vertical domain. Therefore, the true design advantage that line arrays posses is that they take advantage of the human deficiencies in vertical hearing by keeping their imperfections in the plane where we as standing or sitting humans are least likely to perceive them and provide little or no component to component imperfections where our hearing is most sensitive. Combine that with the fact that they hang nicely like a string of beads and I will venture to say that line arrays may just be a bit more than the latest fad.

As far as “What will be the next big thing?” Well, that is the million-dollar question that every loud speaker manufacturer is drooling to figure out. Whatever it turns out to be, my personal bet is that it will be a technology that better adapts the way music is presented to the way we hear or maybe something just cheaper, smaller and more convenient that is sonically mediocre like the MP3 player did for personal audio.

Dave Rat *is the founder of Rat Sound Systems Inc. and has been the Red Hot Chili Peppers FOH Engineer for the past 16 years. If you are interested in other articles or writings by Dave Rat, check the* Transmissions From Dave Rat *page on ProSoundWeb.com and also his current tour diary* Roadies In The Midst – Touring With The Red Hot Chili Peppers *at www.ratsound.com/cblog.*

Pull quote:
"The playing field is completely even from a technical standpoint, except for one thing…"
-- Dave Rat