Line Array or Point-and-Shoot Speakers?

by Rick Kamlet

JC Productions found a point-and-shoot design to be the optimal solution for Summit Christian Church in Nevada. Pictured here are clusters of JBL PD Series in bipole configuration.

Sound system designers for churches need to consider many different design issues. Among these are:

- What kind of program material the system needs to be able to support.
- Designing the system to be easily operated with the expected degree of operator expertise.
- Accommodating multiple-application configurations.
- Achieving even coverage throughout the seating area.
- Minimizing splash onto non-seating reflective surfaces.
- Maximizing gain before feedback.
- Whether to use a mono system, or a left-center-right system, or a theatrical multi-channel setup.
- Architectural matters such as the acoustic environment and aesthetic concerns.

Throughout this process, designers work toward attaining the best possible performance for a particular budget -- whether to spend the limited system budget on loudspeakers, the mixing desk, a recording/duplication system, on hearing assistance, amplification, or a better wireless microphone setup.

One technology that has been getting the attention of both designers and end-users is the "Vertical Line Array". Because vertical line array systems have marked their stake in large concert touring systems, it is tempting to consider them to be inherently better than traditional loudspeakers for all venues. Yet line arrays are not appropriate for every venue. Traditional "Point-and-Shoot" loudspeakers are often a better choice for many situations. Each type of loudspeaker system has its benefits and drawbacks, so it's important to consider when each type makes sense and when it doesn't.

Before discussing the comparison between vertical line arrays and point-and-shoot loudspeakers, two technical concepts need to be introduced. First is the relationship between size and pattern control. Pattern control is important for sending as much of the sound as possible to the right places, and as little of it as possible to the wrong places. Extending pattern control to as low of a frequency as possible is an important goal, and that requires size – large horns and/or inter-driver spacings that are spaced apart at certain specific distances.

The second concept is that a soundwave emitting from a speaker has a certain shape to its wavefront. This is an important factor in regard to how adjacent speakers interact. Soundwaves tend to emit from speakers with a spherical wavefront. Spherical waves tend to interfere with other spherical wave from an adjacent speaker, causing undesirable interaction. To reduce this, the wavefront can be "flattened" by a number of different methods to emit more like a flat sheet of paper, or planar shape. The less flat a wavefront is, the lower in frequency interference will occur.

Side view of the vertical line array design for the City Church Plateau campus in the Seattle area.

A goal of properly functioning vertical line arrays is to flatten the wave in the vertical plane as much as possible, moving the frequency of interference up to the highest possible frequency to create a true "ribbon of sound". We will go into both these concepts in greater depth later in this article.

VERTICAL LINE ARRAY LOUDSPEAKERS

Let's start by looking at the benefits of line arrays. Line arrays have a number of advantages when applied in the right venue.

ADVANTAGES

Vertical Pattern Control -- Tall line arrays can achieve narrow vertical coverage down to a substantially low frequency. This sends less sound to the ceiling, reducing bothersome reflections back into the listening space and increasing the direct-to-reverberant ratio to the listeners. This also reduces the amount of sound projecting onto the chancel or stage area, decreasing the amount of sound that regenerates back into the microphones, cleaning up the sound and increasing the gain before feedback.

Drop-Off With Distance -- While line arrays don't really project in the "wedge of cheese" shape that early over-simplifications indicated, they do drop off more slowly with distance, resulting in more consistent sound levels from front to back within the room. By adjusting the angle and amplitude of the individual modules of a large array, more sound can be projected to the back of the room than to the front. This further assists with evenness of coverage from front to back.

SPL Capability -- Some models of line array systems utilize a lot of transducers. Using a lot of transducers is one method by which the necessary vertical wavefront flatness is achieved so that adjacent cabinets combine coherently. These line array usually have higher SPL capability than is required just by virtue of the number of drivers, allowing the system to be utilized well below its stress point. This high SPL capability of some models of vertical line arrays can be a real advantage for churches expecting concert-level sound reinforcement for visiting national acts.

Working Systems -- In "working" systems – those that need to be set up for certain services or events and taken down when not in use -- the advanced tour-type rigging allows that to happen quickly with a minimum of personnel required. This is a more common requirement in venues like concert halls where they strike it for symphonic music and raise it for pops music requiring sound reinforcement.

Rigging -- The appearance of a cleanly rigged line array can sometimes be more visually acceptable. For example, the JBL VerTec system at Walt Disney Concert Hall in Los Angeles hangs unscrimmed in the midst of a spectacular Frank Gehry designed room.

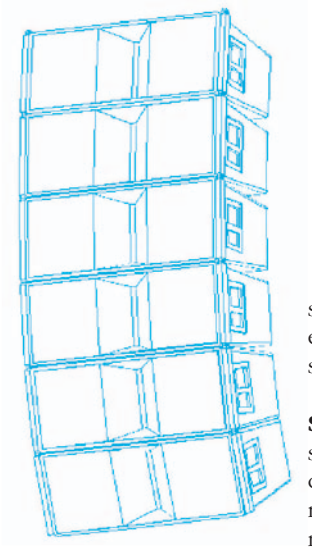
DISADVANTAGES

What are disadvantages of line arrays?

Rear Reflections -- It's difficult when you're projecting so much sound toward the back seating rows to not get some kind of reflection from the back wall. If the architecture of the room is such that the wall is convex or highly reflective (windows, for example), the reflection can be particularly bothersome, muddying music and degrading the intelligibility of speech.

Shallow Rooms -- In rooms that are shallow, a line array system -- which excels at projecting sound long distances – often is not the right match to the coverage requirements of the room.

Height Requirement -- How a vertical line array fits into the architecture of a space depends on the space itself. Vertical pattern control is achieved through height. The line array requires a lot of vertical height, which sometimes does not exist in the room.



Vertical Line Array

If there is not enough vertical space for the line array to be very tall, the array will loose pattern control at a higher frequency, allowing more of the low and mid frequencies to project up to the ceiling and down to the chancel or stage area.

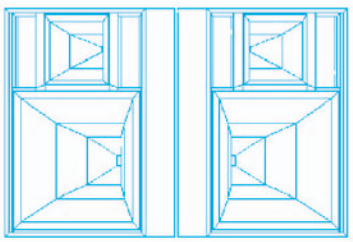
Line Arrays In Shape Only -- A fairly recent issue that the designer needs to be on guard against involves speakers that are line array in shape only, but not in performance. With the popularity of line arrays, some manufacturers have begun simply orienting their regular 2-way speaker cabinets on their sides with a rigging system that forms a vertical line of speakers. It's inexpensive, but unfortunately also ineffective. Whereas proper combination between adjacent cabinets requires that the wave be sufficiently flat vertically, sound waves from single horns emerge in a spherical shape (not flat in either the vertical or horizontal plane). Some real line array systems achieve the required flatness via multiple high frequency and/or mid frequency drivers in each cabinet, or via a reflecting horn design that flattens the sound wave vertically. Simple single horn speakers are not the right component to achieve this wave shape. Such systems loose proper line array performance at a surprisingly low frequency, depending on a number of factors including the box height.

Expense -- Good quality vertical line arrays tend to be expensive. They consist of a large number of fairly expensive cabinets with a higher quantity of drivers. The system designer needs to consider whether this expenditure is best spent on loudspeakers or on other parts of the system.

POINT-AND-SHOOT LOUDSPEAKERS

Let's compare this to point-and-shoot loudspeakers. By "Point-and-Shoot", I mean traditional speakers where each covers a certain defined area of the listening space, either individually or as part of an array. Instead of pointing out advantages and disadvantages, I will touch on some design considerations and points of comparison to line arrays.

Size -- Similar to line arrays, point-and shoot speakers achieve pattern control in proportion to size. In high and mid frequencies, the size of the horn determines the frequency to which pattern in maintained. In low frequencies, spaced drivers are sometimes used to extend vertical pattern control. Many people's experience with point-and-shoot loudspeakers comes from systems utilizing



Point-and-Shoot Speakers

small cabinets with small horns. Loudspeakers large enough to achieve good pattern control can provide a substantial improvement in sound quality.

Suspension -- Single point-and-shoot speakers can be simple to suspend via load-rated eyebolts and aircraft cable. While many point-and-shoot loudspeakers are now available with pre-engineered rigging systems, rigging can be more involved for complex point-and-shoot arrays.

Versatility -- Point-and-shoot speakers are versatile in their ability to match the requirements of the room architecture. Being more compact than a tall line array, they can be easier to build into facades, if the visual appearance requires.

The versatility of point-and-shoot speakers also exhibits itself in the designer's ability to select from a broad pool of point-and-shoot models to find the desired vertical coverage combined with a more flexible selection of whichever horizontal coverage angle is required – from narrow to wide -- to match the coverage requirements of the architecture.

Low Frequency Pattern Control -- Vertical pattern control in point-and-shoot speakers often does not extend as low in frequency as vertical line arrays, because the size of the line array may be greater than that of the point-and-shoot individual speaker or array. Nevertheless, an acceptable degree of pattern control can often be achieved. In some venues, the amount of splash onto the stage is not a problem. When it is a problem, vertical pattern control can be extended down in frequency by use of a "bipole" configuration (sometimes incorrectly called a "dipole", which actually refers to sources that are out of polarity with one other). A bipole consists of two driver sources – either individual drivers or multiple driver cabinets -- separated vertically in space by a certain distance. One of the drivers can be in a traditional multi-way cabinet and the other can be a second cabinet installed below or above it.

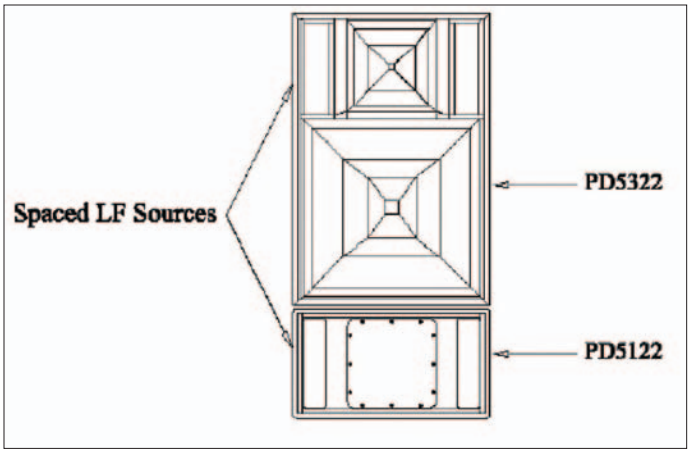


Figure 3
Bipole configuration using point-and-shoot loudspeaker.

To achieve an additional extension of pattern control requires a second set of drivers spaced even farther apart and operated at a lower frequency. Even taking advantage of bipole layout, these speakers are often not as tall as a full line array and therefore may not control as low in frequency.

Once this bipole system is installed, the low frequency "beam" can be steered upward or downward to some extent by simply delaying the signal to one of the elements in relation to the other. For example, delaying the signal to the bottom element shifts the beam farther downward. Conversely, delaying the signal to the top element shifts the beam farther upward. By utilizing a separate DSP output and power amplifier channel for each dipole element, this can be a useful process for achieving the best coverage of the seating area while minimizing spill onto the stage or to other areas you don't want covered.

You can read more about this topic is discussed in the white paper "Basic PD5322 and PD5122 Array Applications", available on www.jblpro.com.

Interaction -- You tend to get more device interaction in point-and-shoot arrays. These interactions can often be mitigated, but it can make adjusting the system a bit trickier. Of course, the larger the horns and the better the phase response of the individual speakers selected, the less troublesome the interaction will be.

A central vertical line array design fits the architecture and room shape of Roswell First Methodist Church in Georgia. Pictured here is the JBL VerTec Series system designed by Brawley & Associates, with delay reinforcement from JBL AE Series and Control Contractor loudspeakers.

Expense -- Last, because point-and-shoot cabinets tend to be less expensive, and fewer of them are utilized, a point-and-shoot system can be substantially less expensive than a line array system.

SUMMARY

There are advantages and disadvantages with any loudspeaker type. Knowing about each can help you decide which type is appropriate for your church, allowing you to get the best possible performance for any budget. Either loudspeaker type can be wonderful if selected appropriately and designed properly into the venue.

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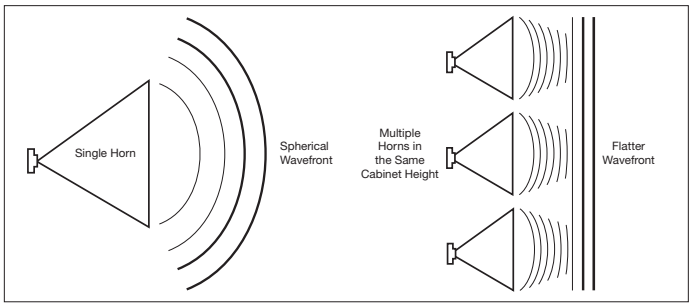

Spherical wavefronts tend to cause interference with adjacent loudspeakers. One common method for "flattening" the wavefront projecting from a vertical line array loudspeaker is to use multiple smaller horns instead of a single horn.

A point-and-shoot system was the appropriate choice at Mountview Church in Olympia, WA, designed and installed by CCI Systems. Shown here are PD5212 loudspeakers (/64 for long-throw and /95 for short-throw) from JBL's Precision Directivity Series.

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