DESIGNER NOTEBOOK

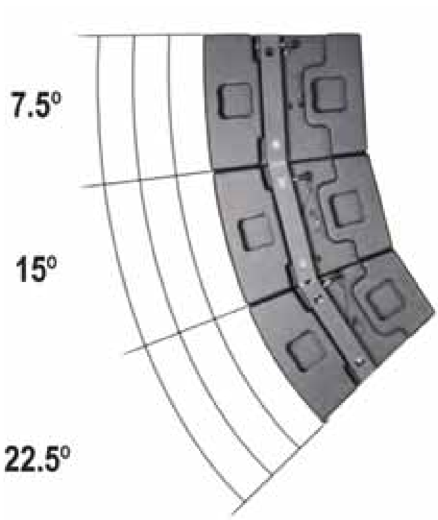
Renkus-Heinz VARIA

Detailing a new modular point-source array.

by Paul Peace

WHEN WE FIRST discussed VARIA, I have to admit my initial reaction was "too good to be true." The concept? Arrayable loudspeaker modules that combine into singular, point source devices. Modules are offered with a wide variety of coverage choices providing near infinite possibilities. Three dimensional coverage combinations simply chosen using angular and inverse square requirements of the room. The Renkus-Heinz tribute to Leonardo: "Simplicity is the ultimate sophistication."

Unlike typical line array loudspeakers, the technology inside VARIA allows it to scale large or small. VARIA is just at home in a 10,000 seat arena as a 200 seat auditorium. Array size does not calculate into the success of the concept. VARIA modules are divided into three enclosure types, based on vertical dispersion angle: 7.5, 15, and 22.5 degrees. These choices relate more to architecture than to acoustics, as they provide form fit to coverage areas.



Vertical seating angles melded into a single array.

Each module is based on a simple 2-way configuration using 1-inch titanium/nitride neodymium compression drivers and 10-inch high-output woofers. Regardless of dispersion, the same internal geometry is maintained from a time origination standpoint, i.e., all modules have identical time signatures, regardless of angle chosen. This is true for all frequencies, since all modules have the same HF and LF components, and it's crucial in producing a unified, coherent wavefront.

A cutaway view behind the grille of a VARIA module.

The high-frequency drivers are mated with a hybrid waveguide, a next-generation constant-directivity horn model. Instead of a traditional exponential/hyperbolic expansion throat section, it takes advantage of our proprietary path length correction technology, which takes energy from the driver (or set of drivers) and, much like a lens in optics, reshapes the wave to a calculated exit.

In this case, the exit is a conic horn section providing engineered directivity. Energy outside the operating angle is non-existent, or at the very least is reduced by a significant order of magnitude. Thus at high frequencies, the modules produce "seamless" coupling to each other. By seamless, I'm describing the absence of interference lobes, which can occur when two sources of

A Renkus-Heinz VARIA array.

similar strength — but different path lengths — combine. This destructive interference usually ruins array behavior (or requires extensive DSP to control).

At low frequencies, VARIA becomes an array of woofers that combine in a very constructive manner. Using simple amplitude shading, constant directivity can be maintained throughout the woofers' spectrum until the wavelength becomes larger than the array.

Within the three module classes (again, 7.5, 15, and 22.5 degrees vertical dispersion), VARIA offers eight horizontal coverage choices, including symmetric 60, 90, or 120 degrees; transitional 60/90 or 90/120 degrees; and asymmetrical 60/90, 60/120, or 90/120 degrees. Any and all combinations can be used within an array.

Of course, this all does indeed "sound too good to be true." The proof is how it works in an actual application. Let's use a megachurch model as an example, presenting a challenging acoustical environment combined with a high performance expectation.

PRACTICAL APPLICATION

A complete sound system layout has been constructed using EASE (**Figure 1**). The room offers basic dimensions of 200 x 160 x 40 feet (h x w x d), while the stage measures 75 x 40 x 4 feet. Overall internal volume of the room is 1,083,200 cubic feet. The RT60 at 2 kHz is 1.86 seconds and rises to 2.33 seconds at 125 Hz, while the average absorption coefficient is 0.28 at 2 kHz.

The stadium seating in the rear of the room rises from the flat floor to 22 feet. From stage front, the Inverse Square Law (ISL) differential from front seat to rear is 14 dB (**Figure 2**). Flanking stage left and right are two walls, each with a very large video screen. This is a critical design element in the room, dictating the lowest suspension point (30 feet) for any loudspeaker.

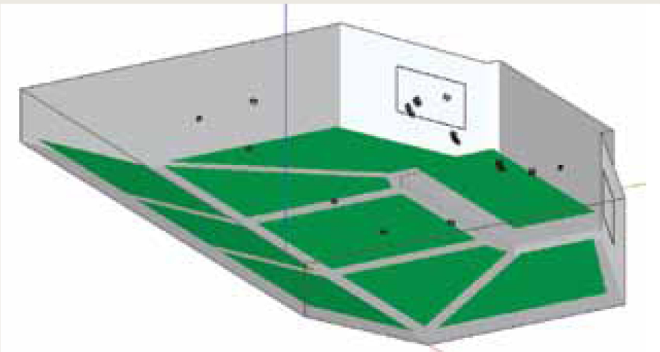


Figure 1

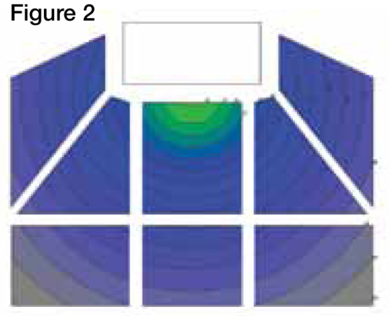


Figure 2

Typical of most worship venues, the room's acoustics are a major factor. There is an equal programming emphasis on live musical performance and spoken word intelligibility, with high standards for both. This particular geometry is a great example of a venue where large line arrays may not produce the desired results, mainly due to two major obstacles: video screen sightline requirements and the in-the-round audience layout.

A distributed array approach, on the other hand, appeared quite viable.

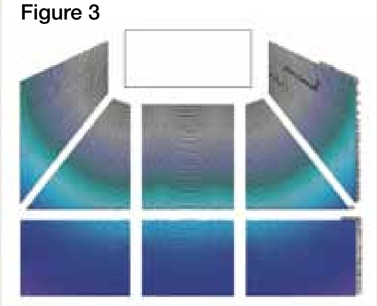


Figure 3

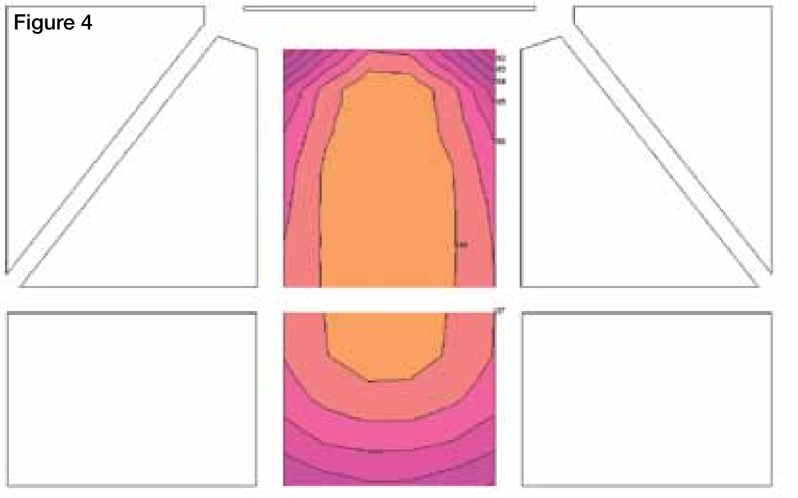


Figure 4

VARIA's flexibility in coverage patterns enabled a design where all arrays can line up precisely to each major seating section, creating strong acoustical cues to the stage (**Figure 3**). The arrays were designed strictly around angular coverage requirements.

The center seating section was the starting point, and a simple evaluation shows that the center riser section spans a vertical angle of 16 degrees with a 4 dB ISL differential between front and back. The main floor spans a 58-degree vertical angle with a 9 dB ISL differential. Therefore, it was logical to begin the array with two 7/60 modules (7.5 degrees vertical/60 degrees horizontal) aimed toward the riser section. My intuition suggested I first try to array these with little to no vertical splay rather than in modular point source mode (7.5-degree splay); however, this did not improve performance for reasons I'll explain a bit later.

Coverage for the floor section was accomplished using 15/6, 15/12, and a 22/12 module, all configured in their natural splay. This created a unified 5-element point source loudspeaker that covered a 76-degree vertical angle, sculpted horizontally to the audience area. ISL shaping was accomplished with simple gain adjustment to each module to achieve the results shown in **Figure 4**. (Note that at this point in the design phase, I wasn't concerned with making this perfect, knowing that a "fine tune" process would be required once all devices were operating.

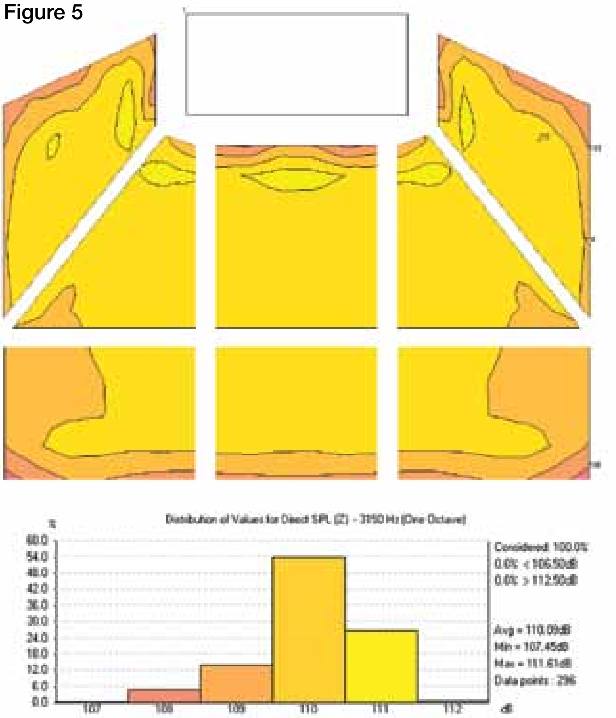


Figure 5

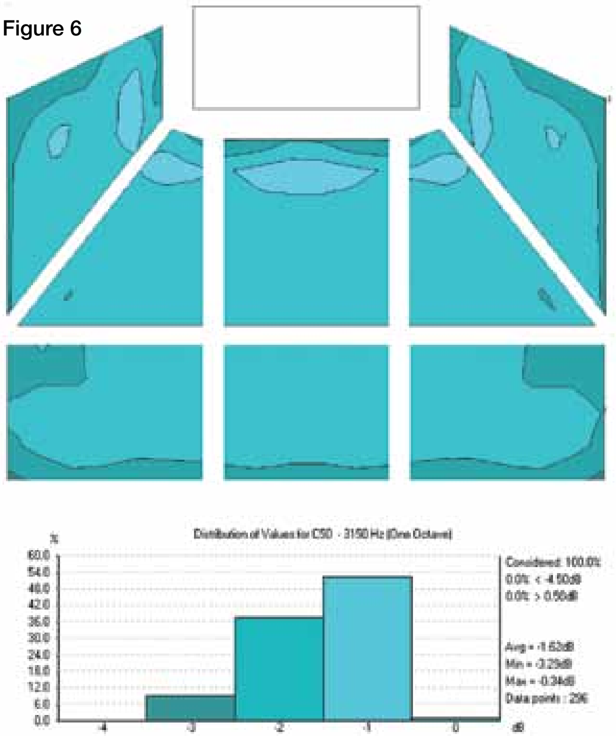


Figure 6

Figure 7

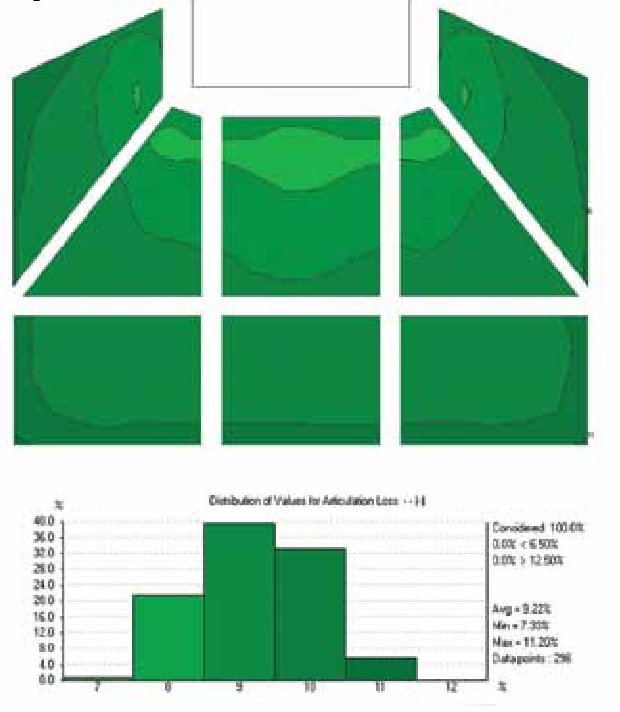
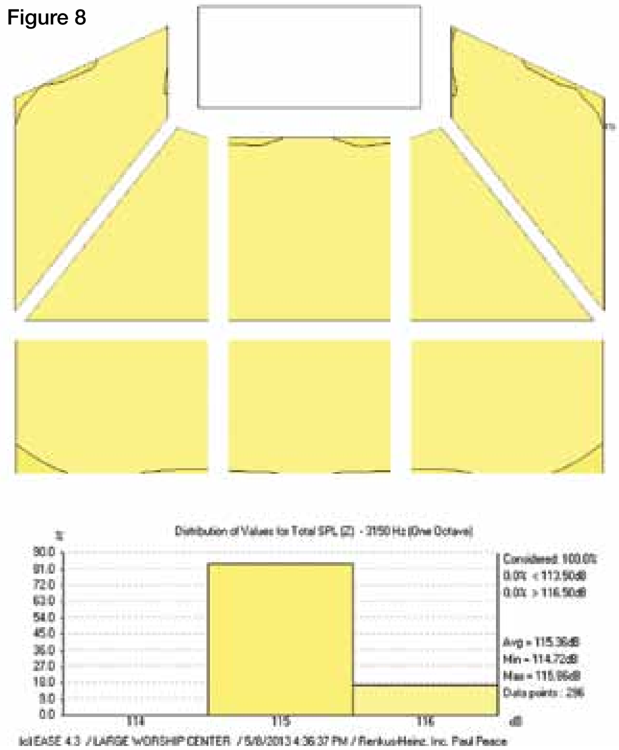


Figure 8



DESIGN DECISION

Similar to the center section, an array was created for each seating area. The sections on either side of center were accomplished with arrays of: 7/6, 7/6, 15/6, 15/6, 22/9. The seating section to stage left and right were accomplished with arrays of: 7/9, 15/9, 22/9.

The odd shape of the stage left and right areas presented a design decision that also correlates with the video requirements. For the seats underneath the video screens, viewing is augmented by large TV screens positioned just off stage. I chose to put a fill loudspeaker above this area to provide better audio cues to the stage and visual media. A 22/6 module was used to fill the area with precision.

After all arrays were configured, individual gains were finalized, along with array rigging angles. Once the detailing was complete, I could have stopped here. General mapping was good. Experience, however, has shown that in large rooms the areas near exits experience higher noise levels than the central seating areas.

In addition, and by design, these areas have a natural fall-off from the main loudspeakers. The best solution is to provide overhead fill to these seats. This is by no means a new concept, but VARIA allows use of the same loudspeakers for these fills (in this case, six 22/12 units) as were used in the primary arrays. The sonic improvement is dramatic.

The finished system results are depicted in **Figures 5**, **6**, **7**, and **8** showing the DirSPL, C50, %ALcons, and SumSPL maps at 3 kHz (3 octaves). It should be noted that the increase in overall level near the stage was intentional, and there's no stage front fill system included in this mapping. It's common practice in a room this size to do so, but would be a luxury in this case, not a requirement.

Returning now to the discussion of the design of the center section, it should be noted that to everyone's benefit, line arrays have become a standard in sound reinforcement. However, as we try to design arrays that scale ever smaller, we find ourselves in cluster design once again with a familiar requirement: each device must have constant directivity. To make matters more confusing, arrays do well when trying to restrict pattern, but do not react well when a wide pattern is needed.

In the example here, the best seats exist in the "underbelly" area of an array — not a good place to be. New developments in DSP and onboard amplification have greatly improved the ability of arrays (small and large). The Renkus-Heinz IC² can do amazing things, and serves as a good example of what is possible and how far this technology has come. These new systems, however, are beyond the reach of many project budgets.

VARIA provides the ability to sculpt coverage patterns — complimentary to inverse square and room geometry — with no array size requirement and no special DSP. It represents a system designer's custom loudspeaker shop in full force. ■

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