



ACOUSTIC DIMENSIONS

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Real-World Design

Case studies in effective, tailored loudspeaker designs that go beyond the cookie-cutter method.

By Robert Rose

The trend in today's successful churches is in incorporating specially-tailored, integrated audio systems. Cutting-edge designers are creating systems that support a church's unique program and worship style, without resorting to cookie-cutter loudspeaker approaches.

Loudspeaker Design

With the proliferation of 3-D room modeling programs, it is often relatively easy to get good loudspeaker coverage within a room. It is then that a designer must begin to look at the other elements that will make up a good system: intelligibility; spatial imaging; realism; dynamics; impact, architectural integration, etc.

There are a variety of system types to choose from: mono, stereo, alternating left-right, left-center-right, etc. Within these groups there are still a multitude of options. Each method has strengths and weaknesses in the areas of supporting speech, supporting music, complexity and cost. It is up to the designer to match the speaker design to the ministry requirements, architecture of the room, and budget.

The following are real-world design examples where creative solutions were developed to meet the needs of the client.

Case Study: The Woodlands United Methodist Church

The Woodlands United Methodist Church (TWUMC) offers two distinctly different worship services every week: the Traditional service, which features formal worship in combination with classical and light contemporary music performed by choirs, ensembles, soloists and the congregation; and the Harvest – an upbeat, informal worship service with a full praise band and lots of music. Both services are presented back-to-back each week, with less than an hour in between for changes in set up.

The 2,200-seat sanctuary at TWUMC is configured in a rectangular shape, with the seats slightly angled towards the platform. A balcony wraps both sides and the rear of the room. The acoustic challenge was that room had to remain live enough to support organ, choir and congregational singing, but required amplified sound for the spoken word, soloists, and the praise band used in the Harvest service.

The first priority was to choose a loudspeaker system that would provide better than average pattern control to deal with a moderately reverberant room. The new breed of line array products provides extremely good pattern control, both vertically and horizontally. Due to a large number of radiating elements, they also exhibit both high efficiency and high maximum output. There



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are downsides to line array products, however. This first is cost. Second is the limitation they place on system design: they are designed to array vertically, not horizontally, so a left-center-right system was not possible. Given the specific musical and acoustical requirements at TWUMC, the decision was made to proceed with a line array design based around the EAW KF761.

The final design was for a modified stereo system, with the left and right line arrays covering most of the room and providing a significant amount of overlap for stereo imaging. To compensate for the additional summation received in the center of the room, the speakers are aimed slightly outward. The balcony seating wraps around quite close to these speakers, so smooth off-axis frequency response was required. Consistent sound pressure levels were achieved because the closer a person gets to the speaker array, the less energy they receive from the opposite array. (A true stereo system would provide even sound coverage from each cluster). Interestingly, separate delay speakers were not required for the balcony due to the ability of the line arrays to maintain pattern control and project sound to the balcony.

While the left and right line arrays provide good coverage to the majority of the room, they leave a hole in the front center. This was covered using a smaller array of 3 cabinets. Signals fed to these cabinets are a combination of the left and right signals from the console. Unlike the left and right clusters, these speakers do not receive low frequency information. This allows the array (which is shorter in height) to maintain pattern control over its given operating range.

The final results were excellent. The line arrays provide a sense of presence and immediacy to the sound not typically found in a room this large or reverberant. Both speech intelligibility and music reproduction are handled effortlessly and believably.

Case Study: Stonebriar Community Church

Stonebriar Community Church is the ministry of Dr. Chuck Swindoll, bestselling author and host of “Insight for Living”. The church is located in Frisco, Texas—a bedroom community north of Dallas experiencing an explosive population growth.

A centerpoint of the church’s ministry is teaching by Dr. Swindoll, so it was important that the sound system provide an intimate means of communication with the audience. Worship is also an important element of services and typically consists of hymns and choruses. Instrumentation can range from a 25-piece orchestra to a small band with a rhythm section.

The main auditorium is a rectangular shape with the platform on the long side of the rectangle. It seats 1500 in a combination of flat floor seating at the front and terraced seating at the rear.

During the initial design stages, several different approaches were discussed. Focus quickly centered on two options, alternating left-right or left-center-right. Both options would provide good speech intelligibility, but there were additional factors. A left-center-right system provides much better spatial imaging, but at a significant cost increase. In the end the Church decided that they were not willing to compromise the sound system and the design for a left-center-right system was begun.



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When you look at the ceiling within the room you are immediately struck by the quantity of speakers. The low ceiling, which is acoustically desirable to create an intimate space, forced the design to utilize more speakers than typically necessary. Every speaker has a purpose, however. Coverage and tonal consistency within the room is excellent. This is due in part to the fact that both the main and delay speakers utilize the same mid and high-frequency drivers and horns. This was a primary factor in choosing the loudspeaker manufacturer and model (EAW MQ series).

The main left, center, and right loudspeakers span the entire width of the platform, 60' wide. This wide spacing provides an excellent sense of spaciousness and envelopment, with a minor compromise to pinpoint stereo imaging. Vocals sent through the center cluster and natural and believable.

Case Study: Park Cities Baptist Church

Park Cities Baptist Church meets in a sanctuary that was built in the 1950's. The traditional style room is a shoebox shape with a balcony that wraps around three sides. A pipe organ is located at the front of the room. A lack of acoustically absorptive elements within the room are ideal for organ and orchestral music but have left speech intelligibility somewhat lacking.

The most recent upgrade to the sound system (completed only a few years before our involvement) included installing six clusters in a distributed mono system hidden above the ceiling. The system utilized a combination of large format JBL horns and dual 15" low frequency cabinets. Large format horns, while not as popular as they used to be, provide substantial pattern control, a trait required in a relatively live room like Park Cities Baptist.

The priorities within the room were to improve speech intelligibility and overall musicality, without modifying the architecture of the room. Re-use of existing equipment was also desirable. It was decided that the existing large format horns would be re-used. New low frequency cabinets (EAW TD415's) were installed that exhibit better low frequency pattern control to reduce the amount of excess mid-bass energy within the room.

Another important addition came to the front of the room: new line array speakers (EAW LS432) were installed to the left and right of the platform. While small in size, the role of these speakers was very important. Since the main clusters were 45' above the audience, it was important to provide sonic cues to add realism to sound reproduction on the main floor. These speakers provide significant reinforcement to the front ¼ of the room. Front fill speakers mounted behind the platform steps also aid in this regard.

The existing over-balcony speakers (standard 8" ceiling speakers) were replaced with Frazier CAT40's, a cabinets that utilize an 8" woofer but adds a dedicated high frequency horn. The selection criteria for these speakers was to improve fidelity to the balcony.

The speech intelligibility issue couldn't be solved with speaker coverage alone. A large, flat, hard-surfaced back wall caused the room to be very "live." Acoustical treatments were added to



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achieve a balance between supporting music performance and preventing speech from sounding “muddy.”

Different Designs with a Common Thread

Although these designs appear quite different at first glance, there are common elements to each. Each design utilizes a loudspeaker cluster tailored to the acoustics of the room. The acoustics within Stonebriar Community Church are the most controlled, allowing loudspeakers with moderate pattern control and wide dispersion to be utilized. Both TWUMC and Park Cities are relatively live and reverberant (to support their traditional un-amplified music component) and utilize loudspeaker solutions that provide extremely tight pattern control. It is important to note that the acoustical treatments were designed in conjunction with the loudspeaker systems.

Each design also focuses on creating a believable image. This requires speakers that are mounted low. In the case of both TWUMC and Stonebriar, the main clusters are mounted relatively low. At Park Cities, supplemental speakers mounted to the side of each column provide imaging cues. All three designs utilize front fill speakers to aid in this respect.

Both TWUMC and Stonebriar also utilize multi-cluster/multi-channel systems for reproduction of music. This was very important to their respective music programs. Park Cities, which is utilized for speech and traditional music (mostly un-amplified), did not require a multi-cluster/multi-channel system.

In the end, the proof of performance is usually in the listening—not just after the system is installed—but in the beginning, when the client is communicating who they are.

About the Author

Robert Rose is a senior consultant at Acoustic Dimensions and has an extensive background in audio engineering and loudspeaker design.

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